SECTION 23 73 28 – FACTORY FABRICATED CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements and applicable sections of Division 20, Division 21 Fire Suppression, Division 22 Plumbing, Division 23 Heating Ventilating and Air Conditioning (HVAC), Division 26 Electrical, Division 27 Communications, Division 28 Electronic Safety and Security and Division 33 Utilities.

Additionally all other related documents consisting of all of the rest of the Divisions Specification Sections listed within the Specifications Index and Table of Contents applies to all of the work of this section.

It is the Contractors responsibility to read, review and coordinate with the entire specifications and drawings and other Contract Documents to provide a complete and working system of equipment, accessories, components and materials including all software, graphic and programming of systems. The specific requirements of this Owner's Appendix to Common Work Results for HVAC are intended to supplement the requirements of Contract Documents including General Conditions, Supplementary Conditions, and Sections under Division 01 General Requirements and applicable sections of Division 20, Division 21 Fire Supression, Division 22 Plumbing, Division 23 Heating Ventilating and Air Conditioning (HVAC), Division 26 Electrical, Division 27 Communications, Division 28 Electronic Safety and Security and Division 33 Utilities. Where there is conflict between the requirements of this section and other General Division sections the more stringent portions apply and must be included in the bid cost associated with the project.

Section 20 05 13 - Motors

Section 20 05 14 Variable Frequency Drive (VFD) System

Section 23 01 30.51 – HVAC Duct Cleaning

Section 23 05 53 - Identification for HVAC Piping and Equipment

Section 23 09 00 OSA – Owner Supplemental Appendix Existing Control Systems Requirements

Section 23 09 03 - Control Instrumentation

Section 23 09 23 - Direct Digital Controllers and Networks

Section 23 09 93 - Control Sequences

Section 23 21 18 – Valves

Section 23 31 13 – Metal Ducts

Section 23 33 00 - Air Duct Accessories

Section 23 34 16 – Centrifugal HVAC Fans

Section 23 36 00 - Air Terminal Devices

Section 23 37 13 – Diffuser, Registers and Grilles

Section 23 41 00-OSA Owners Supplemental Appendix Particulate Air Filtration

Section 23 81 23 – Computer Room (CRAC) Air Conditioner Units

1.2 SUMMARY

A. Work Included:
1. Air Handling Units (Site –Assembled Custom & Semi Custom)

1.3 SUBMITTALS

A. General: All submittals shall comply with the requirements of related sections.

B. Product Data: Submit data on the following items:
1. Air handling units (including fan performance curves)
2. Coil Sections with Cooling~~, Hot Water (HW) Preheat or HW Reheat Coils~~
3. Diffuser Plate Section
4. Access Sections
5. Filter Sections
6. ~~Sound Attenuator Sections~~
7. UV-C Light ~~or GPS I-Bar NPI~~
8. Discharge and/or Return Air Plenum Sections
9. Return and Outside Air Mixing Box Section with Ultra Low Leakage Dampers
10. ~~Piping Vestibule and Access Sections~~
11. ~~Roof Curbs (rooftop units only)~~
12. Motors and Bearings (including bearing shaft diameter and maximum fan RPM) and 2" Internal Spring Vibration Isolation
13. ~~Provide 3rd Party Certification of High Wind and Hurricane ratings for wind loads of up to 150 MPH static and cyclic wind loading and Missile Impact in accordance with TAS 201 Large Missile Impact (ASTM E1996), TAS 202 Uniform Static Air Pressure Test (ASTM E330) and TAS 203 Cyclic Wind pressure Load Test (to be conducted after the completion of TAS 201). Provide maximum unit wind profile size in Square Feet to be certified and rated, Provide NOA and FLPA certification listing numbers. Provide mechanical trade and the General Contractor the structural roof attachment requirements in terms of type and quantity of fasteners per side and total fasteners with reaction loads to meet the 3rd party Certification of High Wind and Hurricane Ratings.~~
14. Since all fans are factory tested in accordance with AMCA standards and data catalogued consists of fans capacity (CFM at external static pressure) while connected to straight inlet and discharge duct conditions, the manufacturer shall be responsible for calculating the "System Effect" pressure drop of the units' inlet and discharge connections to the ducts shown on the drawings. This static pressure will be added to the external static pressure of the fan and the submitted fan, fan accessories and fan curve shall indicate the RPM, CFM and BHP, tip speed and other required capacity data to be corrected to account for the "System Effect" pressure drop and for a minimum of 5% or higher belt drive losses based upon the size and number of V-belts required for the fan sheaves in the selection of the actual motor horse power to provide.
15. Computerized coil selection programs shall be used in the selection of cooling ~~and heating~~ coils. .The following information shall be input as fixed and unchangeable by the program:
    a. Airflow CFM
    b. Minimum coil face area
    c. Entering air conditions, degrees F dry bulb (DB), degrees F wet bulb (WB)
    d. Entering water temperature (EWT)

e. Water flow in gallons per minute (GPM)
f. Unit external static pressure (ESP) in inches water gauge (WG)
g. Minimum number of rows
h. Maximum fins per inch (FPI).

b. The coils selection program shall be run and the best overall match to meet or exceed the coils scheduled design conditions with the following priority:
   1) Sensible and total capacity in BTUH
   2) Leaving air conditions FDB, FWB,
   3) Leaving water temperature LWT
   4) Air and water side pressure drops
   5) Unit total static pressure (TSP) inches WG
   6) Motor horsepower.

16 Fan Curves – Provide full family of fan curves for selected fan which shall include the series of curves indicating relationship of cfm and static pressure for various rpm, brake hp curves and selection range (surge curves, maximum rpm, etc.)

17. For direct drive plenum plug fans singly, or in multiple fan wall or fan arrays furnished with single or multiple VFDs provide fan torque requirements for all fan hertz ranges from 20 to 90 hertz along with full fan curves shall include a series of curves indicating relationship of cfm and static pressure for various rpm, brake hp curves, and selection range (surge curves, maximum rpm, etc.)

18. ~~For belt drive constant volume fan applications verify that fan curve and motor combination selected is fully non-overloading over the entire range of variable total static pressure operation from clean to dirty filter PD allowance (a 1.0 to 2.2" W.G. drop in Total static pressure when filters are changed out)~~

19. Since all fans are factory tested in accordance with AMCA standards and data catalogued consists of fans capacity (CFM at external static pressure) while connected to straight inlet and discharge duct conditions, the manufacturer shall be responsible for calculating the "System Effect" pressure drop of the units' inlet and discharge connections to the ducts shown on the drawings. This static pressure will be added to the external static pressure of the fan and the submitted fan, fan accessories and fan curve shall indicate the RPM, CFM and BHP, tip speed and other required capacity data to be corrected to account for the "System Effect" pressure drop and for a minimum of 5% or higher belt drive losses based upon the size and number of V-belts required for the fan sheaves in the selection of the actual motor horse power to provide.

20. For variable volume application, indicate operating points at 100, 80, 60, and 40% of design capacity on fan curves including data to indicate effect of capacity control devices such as VFDs on flow, pressure and hp. Modulating fan inlet dampers are not allowed for VAV application.

21. All AHU submittals with multi fan arrays must include a Completed Excel Spreadsheet for each AHU indicating the Multi-Fan Array CFM @ "WG TSP, Unit RPMs and Hertz Schedule

22. Shop Drawings for all equipment including, but not limited to, the following:
   1) Appropriate identification
   2) Complete drawings showing plans and sections including details of construction
   3) Overall unit dimensions and individual components and sections dimensions
   4) Shipping and operating weight of unit and/or sections
   5) Structural design load
   6) Details of component support
   7) Capacities/ratings
   8) Materials of construction

9) Thermal and acoustical performance of wall, roof and floor panels
10) Pressure ratings and leakage ratings
11) Thermal break construction details and performance calculations or test data
12) Each component manufacturer's name, model number and data (Refer to each component section for submittal requirements.)
13) Air leakage rates and test data
14) Wiring diagrams and terminal points for control panels provided with units
15) Manufacturer's installation instructions
16) Air handling unit manufacturer's local representative and phone number

C. Operation and Maintenance Data: Provide data on the following items:
1. Air handling units
2. Coils
3. Filters
4. Bearings
5. Dampers
6. VFD's
7. UVC Lights ~~or GPS I-Bar NPI~~
8. Belts, sheaves and belt housings

1.4 QUALITY ASSURANCE

A. Standards:
1. Air Conditioning and Refrigeration Institute (ARI):
a. Standard 410, Standard for Forced Circulation Air-Cooling and Air-Heating Coils.
b. Standard 430, Standard for Central-Station Air-Handling Units, Latest Edition.
2. Air Movement and Control Association (AMCA): Standard 210, Laboratory Method of Testing Fans for Rating.
3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE): Standard 52 & 52.1, Methods of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
4. American Society for Testing and Materials (ASTM): Standard E84, Surface Burning Characteristics of Building Materials.
5. Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA): Standard 9, Load Ratings and Fatigue Life for Ball Bearings.
6. Mechanical Power Transmission Association (MPTA) and Rubber Manufacturer's Association (RMA):
a. Engineering Standards for Drives Using Narrow Multiple V-Belts.
b. Standard 1977, Engineering Standards for Drives Using Classical Multiple V-Belts.
7. National Electrical Manufacturer's Association (NEMA): Motors and Generators.
8. Underwriter's Laboratories (UL): Standard 900, Air Filter Units.
9. Intertek ETL listed: The Intertek ETL listing tag and certification report or other National Recognized Testing Laboratory (NRTL) tag and certification report that is signed and sealed by a licensed testing professional recognized by OSHA and accepted by AHJs across North America as a product's mark of compliance to applicable electrical, gas and other safety standards. Intertek ETL is an OSHA recognized NRTL (Nationally Recognized Testing Laboratory) and accredited as

a Testing Organization and Certification Body by the Standards Council of Canada. Site Built AHUs shall be inspected and tested to meet Intertek ETL National Field Labeling Program Hotline at 1-800-WORLDLAB. See attached Application for Certification form to be completed by the contractor and Vendor requesting the NRTL and all applicable fees shall be included in the base bid of the unit. The Scope of Work shall include 1) Perform Nationally Recognized Testing Laboratory Field Evaluation, 2)Provide preliminary report upon completion and affix testing label to equipment, and 3) Provide final report to electrical inspector. Testing field inspection to be performed by Met Laboratories Inc. - Nationally recognized testing laboratory by OSHA

1.5 GENERAL

A. Units furnished shall be complete with all components assembled. All features considered standard by the manufacturer and which are required to complete the system, and to make it functional, shall be included without respect to specific detailing in these specifications.

B. Acceptability of any listed or non-listed manufacturer's is based on meeting the HMH Design Criteria, and Master Specifications as well as meeting or exceeding the scheduled unit capacities & other noted required criteria & accessories. Verification of Dimensional fit within the MER space allocated and/or available to install the AHU unit within. The units may require shipping splits or complete take down to be able to be installed. Verify in writing with HMH Design Engineer and FMS prior to start if design and release for contractor bidding. Document in the D&C decision Tree. Be aware that you as the Vendor have to meet or exceed the specified requirements and scheduled capacities. Leaking access doors, exterior atmospheric condensation and displaced fan isolation bases are the full and sole responsibility of the manufacturer. The factory has to supervise the installation of the unit components when shipped in modular shipping splits and perform final inspection to certify in writing that the units have been correctly installed and set up by the installing contractor and provide the signed factory Start-up AHU checklist for each unit.

C. A specific configuration of the supply, return and outside air duct, chilled ~~and heating~~ water coil piping and cooling coil drain piping at each unit has been indicated on the drawings. If the configuration of the units furnished on the project differs from that indicated on the drawings (whether or not the units furnished are the scheduled units, a listed manufacturer or an acceptable substitute), it shall be the Contractor's responsibility to modify supply, return and outside air duct, chilled and heating water coil piping and cooling coil drain piping, etc., as required to accommodate the actual configuration of units furnished on the project.

D. Actual fan motor horsepower shall not be less than 120% of equipment brake horsepower and shall be non-overloading over the entire range of system flow and system total static pressure with system effect calculations and belt losses included. Constant volume systems shall be non-overloading at system selection point RPM with a 25% reduction in system external static pressure.

E. Where necessitated by access conditions to existing air handling unit location, units shall be shipped knocked down into sections sizes that will fit through existing doors, corridors and elevators. The manufacturer shall individually protect and seal each section's exposure to physical damage or damage caused by the weather elements during shipping. The broken down units shall have alignment pins and shall be clearly marked as to each section place in the AHU lineup. Manufacturer shall provide stainless steel nuts, bolts, fasteners, washers, lock washers and all required gasket materials to

assemble the individual air handling unit sections into the assembled air handling unit. The unit assembly shall be supervised by a qualified service technician in the employ of the manufacturer. The unit shall be tested by the service technician for vibration and air leakage after assembly. The manufacturer shall furnish a complete set of spare gaskets and recommended sealant material for Owner's use.

F. Belts, sheaves and belt housings when applicable shall be shipped with the unit.

1.6 DESIGN CRITERIA

A. For housings and floors operating under positive pressure (fan discharge side), maximum allowable deflection shall not exceed 1/240th of any span in any direction at 10" WG.

B. For housings and floors operating under negative pressure (fan inlet side), maximum allowable deflections shall not exceed 1/240th of any span in any direction at 10" WG.

C. Air handling unit manufacturer shall provide equipment as specified and install equipment furnished by others to result in complete and operational unit. Unit manufacturer shall assume single source responsibility for all air handling unit components and accessories.

D. Furnish units complete with fans, piping, valves, piping specialties, actuators, motors, coils, humidifiers, drain pans, filter sections, damper sections and interior lighting, meeting configuration and as shown on drawings, specified and as scheduled. All unit components shall meet this Section of specification and all requirements specified in each section and division listed under Related Work. Control dampers shall be provided by unit manufacturer. Control dampers actuators will be furnished by Control Contractor for factory mounting by unit manufacturer.

E. All materials shall meet NFPA 90A Flame and Smoke Generation Requirements.

F. All materials shall comply with FM Global Insurance Requirements.

G. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled total static pressure without operating into motor service factor.

H. Motor furnished with fan shall not operate into motor service factor in any cases.

I. Air handling unit static pressure to take into consideration actual static pressure loss of components furnished within unit.

J. Wire brush all welds with solvent and wipe clean all bare metal before painting.

K. When two (2) or more units are stacked on top of each other, structural integrity of base unit(s) shall be sufficient to support upper operating unit.

1.7 FINAL CLEANING

A. Outside and inside of each air handling unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mill finish or grease. All proposed cleaning materials shall have contents identified and approved prior to use. Cover unit openings with sheet metal or other proper material until ductwork is connected to maintain unit cleanliness.

1.8 AHU Selection Checklist:

A. Refer to the document with the specifications, e.g., "HMH AHU Component & Accessory Check List" to assist in the in the bid development for the project. This document must be submitted as part of the overall paragraph by paragraph Comply-Do Not Comply-Deviations and Cover letter as part of the submittal process.

B. All AHU submittals with multi fan arrays must include a Completed Excel Spreadsheet for each AHU indicating the Multi-Fan Array CFM @ "WG TSP, Unit RPMs and Hertz Schedule

Designer & selection Info to be delete during editing

1.8 AIR HANDLING UNIT SELECTION CRITERIA FOR SYSTEM DESIGN AND SELECTION

A. Size Criteria to utilize for the fan wall or array type concept of 2 to 4 direct drive plenum type fans with VFD. The break point would be 7,500 CFM and larger AHU's should be considered for Fan Wall or Fan Array applications where it makes sense. If there is to be a large variation in SA CFM or " WG TSP between Present and Future operation points then belt drive DWDI centrifugal or BI fans with VFD's must be used. Multiple direct drive fan concept does not apply well to smaller AHU's, but could be considered there also if there was a good reason for it.

B. New AHU cooling coil face velocity, existing space limitations permitting, should be held to 400 to 425 FPM to meet the motor HP requirements per 1,000 CFM of ASHRAE 90.1-2004 energy code which has been adopted as modified by the City of Houston effective August 1, 2008. Higher coil face velocities are permissible only with written authorization from FMS Engineering. Discussion about unit coil face velocity listed in BOD with 400 FPM as desirable but realizing that up to 500 FPM + might be required to make the existing available MER space work with the new unit size based on typical modular factory units. Absolute maximum cooling coil face velocity is 510 to 525 FPM. Design and select for as low a cooling coil face velocity as practical when designing around existing units physical size limitations. The semi-custom or the site-built AHU's allow more flexibility than the factory modular AHU's in this scenario.

C. Existing AHU and or cooling coil replacements must match the size constraints imposed by the existing unit housing, including rows of depth. Number of fins per inch shall be the minimum that will achieve the required design conditions selection constraints. Psychrometric charts will be drawn up based on the AHU coil design SA, RA and OA CFM airflows, mixed air calculations based upon RA FDB/FWB, OA where not pretreated OA EAT 90.0 FDB/ 81.0 FWB, or if OA is pre-treated then the FDB/FWB that the air is pretreated to plus the motor heat gain to the airstream. Actual coil LAT will be based on design FDB/FWB minus the motor heat gain to the airstream. Typically this will be 20 to 25 degrees F below the desired space temperature.

D. Unit component line-up shall include but not be limited to the following: minimum 36" long RA Plenum, OA/RA Mixing Box Section with Ultra-low Leakage Motorized Modulating Dampers, Low (200 to 250 FPM) or High (500 FPM) filter face velocity through the Pre-filter Section (MERV-11 60-65% 4" thick filters), Pre-Heat coil where mixed air temperature gets below 40ºF utilizing 20ºF or the AHU is handling up to 100% OA intake, 8" access section, HDT cooling coil section with polished aluminum internal metal liner (Note: if cooling coil FPI is greater than 10 FPI, then maximum row depth in single coil is 6 rows of cooling coil; if cooling coil FPI is 10 FPI or less, then maximum row depth in a single cooling coil is 8 rows; provide 18" access section between series cooling coils for cleaning purposes), UV lights or GPS I-Bar NPI upstream of the first cooling coil section, HDT or VDT fan section with 2" Internal spring isolation, DWDI belt drive BI or Airfoil Centrifugal Fan or BI or Airfoil Direct Drive Plenum Fan, Diffuser Plate; Reheat Coil

Section where Required, Final Filter Section for MERV=16 90 to 95% Efficient or 99.997% Efficient HEPA Final Filters and Minimum 36" Long SA Discharge Plenum.

E. Provide for marine type enclosed internal service light with switch and viewport at pre-filter, coil, fan and final filter sections. Provide junction box with disconnect switch sealed off in the cooling coil section downstream of the cooling coil for future addition of UV or GPS I-Bar NPI if either are VE'd out of project or not provided for any reason.

G. Provide empty final filter section sized for 12" thick cartridge filters, even if no final filters are required by the system installed.

H. Cooling Coil Selection General:

1) Required AHU Cooling Coil LAT indicated in BOD is be in the 48 FDB range. The existing installed AHU's current cooling coil LAT is in the 54 to 56 degree range which translates to about 57 to 60 degrees by the time motor heat pickup is calculated for the HDT style units resulting in warm temperatures in the spaces unless the unit water flow is allowed to drive the coil discharge air temperature as low as it will go.

2) The typical space is designed for 75 degrees and the airflow calculation is usually based on a 20 F Delta T between the room RA temp and the Unit SA discharge temperature. Hospitals with 90 to 95% or 99.9999% HEPA final filters require much larger motor sizes to get the airflow to move through the coils and filters. SA temperature rise must be kept to 0.5 degree F or below from duct temperature transfer to keep from losing more than 2.5% of capacity to duct heat gains.

3) Looking at the 26 series AHU's with the OA pretreated and mixing with room Return air the cooling coil LAT could be as low as 48 to 49 degrees F or as high as 50 to 51 degrees F as long as the motor heat calculation doesn't produce more than 55 degree AHU discharge air temperatures.

4) Looking at the 27 series (100% OA) AHU's with the OA untreated the cooling coil LAT could be as low as 60.0 FDB/59.5 FWB to 65.0/64.5 FWB as long as the motor heat calculation doesn't produce more than 63.0 to 68.0 degree AHU discharge air temperatures.

5) In Operating Room AHU's the cooling coil should be selected with as low a LAT as possible with the 80/20 RA/OA ratio. However since the units must be tested in smoke exhaust mode without causing the walls and ceiling to condense atmospheric moisture within the operating room space at equilibrium @ 65 FDB, the unit cooling coil should be capable of cooling 100% OA intake from 90 FDB/81 FWB EAT conditions down to a LAT FDB/FWB condition that is well below the space surface dew point temperature of 65 degrees F to keep atmospheric moisture from condensing on the walls during smoke testing intervals.

6) Select cooling coils for 44ºF CHS with a 14 ºF ΔT (1.72 GPM/Ton) for 58ºF CHR and then operate them at 42 ºF CHS with a 12 ºF Delta T rise to 54ºF CHR (Note: the cooling coil will have more rows and FPI than is really needed, but should operate just fine with the chilled water control valve maintaining proper flow to meet coil discharge air temperature control set points).

7) Unless we have some unusual situation the temperature at the secondary building CHP's and the AHU's the coil ECHWT should be the same 42 ºF ECHWT (CHS) with a 12 ºF Delta T rise to 54ºF LCHWT (CHR),i.e., 2.0 GPM/TON. There should not be more than a fraction of a degree temperature rise in the chilled water supply before it gets to the buildings because even 0.1 ºF rise means we are losing nearly 1% (0.8%/0.1ºF rise) of our capacity to pumping and system temperature losses.) TMH FMS needs to maintain the 42 ºF CHS with a

12 ºF Delta T rise to 54ºF CHR that the chillers were designed and selected around to maximize our chiller capacity production for the RIB addition.

H. Where cooling coil FPI is greater than 10 FPI, then maximum row depth in single coil is 6 rows of cooling coil; where cooling coil FPI is 10 FPI or less, then maximum row depth in a single cooling coil is 8 rows (provide 18" access section between series cooling coils for cleaning purposes), provide UV-C lights or GPS I-Bar NPI Upstream of the first cooling coil. Realizing that there are some space limitations that would make this impossible to achieve for existing AHU's replacement and where greater single cooling coil rows depth is required to meet design supply air conditions. All new AHU installations are to have UV lights to keep coils clean or at the very least space in the existing coil section to receive the UV lights later.

I. Select pre-heating and re-heating coils for 180ºF HWS with a 30 ºF ΔT drop for 150ºF HWR and then operate them at 120 ºF to 140 ºF HWS with a 20 ºF Delta T drop 120 ºF to 100 ºF HWR with an OA temperature reset. Pre-heat and reheat coils located within the unit should be essentially the same face area size in square feet as the cooling coil. This is typically a single row, occasionally a two row 6 to 10 FPI heating coil.

J. Duct mounted heating coils should be sized for maximum 800 FPM face velocity and typically should be single row depths with 6 to 10 FPI coil fin density.

K. Utilize VFD's on all AHU's 3 HP and larger with dirty filter loading requirements in excess of 0.5" W.G. ΔP. Use clean 2" MERV 8 pre-filter PD of 0.30" W.G. and dirty filter of 0.80" W.G. with filter frames, filter gaskets and filter clamp mechanisms. Use clean 12" MERV 16 final-filter PD of 0.60" W.G. and dirty filter of 1.20" W.G. with filter frames, filter gaskets and filter clamp mechanisms. Use clean 12" 99.997% HEPA final-filter PD of 1.20" W.G. and dirty filter of 2.40" W.G. with filter frames, filter gaskets and filter clamp mechanisms. Where VFD 's control multiple motors separate overloads must be provided for each motor, i\If you are controlling three motors with one VFD and one motor fails, the VFD will continue to run the two remaining motors as long as it only trips the overload. NEC standards require that there be one overload per motor. If the motor fails bad enough to cause a complete VFD failure, the bypass will run the two remaining motors as long as the bypass is also configured with one overload per motor. All you need to do to make this happen is make sure that Yaskawa knows that the single VFD is controlling three motors. They will automatically give you three overloads on both the VFD and the Bypass.

L. All AHU motors shall be premium plus high efficiency TEFC and inverter rated not just EPA EPACT rated high efficiency motors.

M. Utilize OA flow sensors and modulating RA and OA dampers to maintain constant minimum OA CFM setting for each AHU.

N. Submit "System Effect" Calculations for each AHU supply and return fan where applicable. Submit plenum to abrupt exit/entrance loss calculations with a expanded rectangular tap for rectangular duct or a conical or bell-mouth tap for round ducts for all supply and return duct connections to plenums.

O. All AHU's should be internally isolated with 2" deflection springs, have 2" thick double wall construction minimum R=12 when installed in plenums or MER's with thermal break between interior and exterior housings and with foamed insulation minimum R=12 with thermal break between interior and exterior housings when mounted outdoors on roofs.

~~P. Cooling coil section should have ASHRAE 62.1-2004 compliant SS double wall, internally insulated cooling coil condensate drain pans. The cooling coils shall have SS headers and support structure and the 100% OA AHU's shall have a SS inner liner in lieu of standard galvanized liner for the cooling coil section.~~

~~Q. All RA and OA dampers shall be fully modulating ultra-low leakage control dampers with end switch and potentiometer position indication furnished by the ATC Contractor and must meet ASHRAE 90.1-2004 as amended by 2008 COH Commercial Energy Code.~~

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS

A. General:
1. Air handling units shall be the factory fabricated, central station type. Units shall be provided in the configuration shown on the drawings complete with fan section with internally isolated motor and drive, ~~preheat and~~ cooling coil sections, UV light Section, pre-filter and final filter section with 4" thick MERV 11 (60-65 % efficient) prefilters and 12" thick MERV 15 (95% efficient) cartridge final filters, respectively, ~~Sound Attenuator Section~~, access sections and return air plenum section and casing, and mixing box with motorized outside and return air dampers, unless noted otherwise . Units shall have performance ratings certified in accordance with ARI 430.

B. Manufacturers: (all manufacturers must meet specifications sections as applicable)
1. Site-assembled (Custom) type air handling units shall be as manufactured by:
a. Temtrol ~~QX~~ITF
b. Daikin Custom
c. Air Enterprises
d. Haakon Custom
e. Isolate, Inc.
f. Climate Craft
g. Energy Labs
h. Custom Air Products (CAP) Houston, Texas Manufacturer

C. Arrangement
1. Air handling unit type i.e., horizontal or vertical draw through, horizontal or vertical blow through, variable air volume, constant air volume or single zone unit, roof mounted units shall be as indicated on the Drawings.
2. Inlet and discharge orientation shall be as indicated on the Drawings.
3. Components and component arrangement shall be as indicated on the Drawings.
4. Contractor is responsible for all required hand locations for coil access, motor access, cooling or heating coil piping connections, internal light and switch hand locations, view port in access door hand location fan rotation and discharge locations. Verify prior to equipment submittal and release of equipment purchase order.
5. All access and service doors shall open against pressure.

D. Casing:
1. Casing for fan, coil section, access section where indicated, and filter section shall be double wall constructed of 18 gauge (minimum) galvanized sheet steel double wall insulated panels reinforced with steel framework. Panels shall be secured to frame with corrosion protected screws or bolts. Panels shall be removable for access to internal parts.

2. Panels shall be corrosion protected at the factory by galvanizing or painting. Painted surfaces shall be chemically cleaned, inside and out, and dried prior to painting. Paint shall be baked enamel in manufacturer's standard color.
3. Casing frame and double wall panels shall be insulated with fibrous glass insulation. Insulation must comply with ASTM E84 for maximum flame and smoke ratings of 25-flame and 50-smoke. Insulation thickness shall be 2 inch formed in place, with minimum insulation R=12 installed. Panels shall be designed to allow for full thickness of insulation. Prior to fabrication, Insulation shall be adhered to panel wall with a waterproof adhesive. The 100% OA AHU only unit casing shall have a 18-gauge 316L stainless steel inner liner including access doors inner liner and stainless steel bolts and fasteners in contact with the outside air-stream in lieu of galvanized liner and bolts.
4. The air handling unit manufacturer shall be responsible for providing all internal to the unit electrical connections to motors, UV-C lights, Marine lights and controls from a exterior J-box mounted low on the side of the AHU casing exterior and shall include a neoprene or EDPM grommet around all air handling unit casing motor, light switch and light flexible electrical “Sealtite” power conduit penetrations to properly seal the penetration and to provide a thermal break.
5. Filter section shall have a 4”-thick MERV = 11(60-65% efficient) filter track for pre-filter and a suitable track for the 12“-thick MERV = 15 (95% efficient) cartridge final filter ~~or HEPA filter~~, unless noted otherwise, with access doors on both sides and a suitable filter pull strap furnished by the unit manufacturer. Filter track shall have gasket material and clamping mechanism to reduce air bypass around filters. ~~HEPA filter sections shall be of special construction as required to meet the constraints of the HEPA filters to provide no leakage and cartridge edge sealing~~.
6. Primary drain pans shall be double wall, sandwich type constructed of stainless sheet steel with insulation between the inner and outer walls. Insulation material shall be the manufacturer's standard material; insulation thickness shall be 1-1/2 inch (minimum). In horizontal draw through units, the drain pan shall be provided under both the fan section and cooling coil section; in vertical draw through units, the drain pan shall be provided under the coil section only. Drain pan shall meet ASHRAE 62.1-2004 Indoor Air Quality requirements of positive slope to drain, no standing water and accessibility for cleaning and have a 1-1/2 inch (minimum) stainless steel welded threaded outlet on one side of unit only; outlet shall be shipped with threaded malleable iron pipe cap.
7. Draw through and or blow through units shall have an extended air discharge collar. Collar shall extend 1 inch (minimum) beyond the casing and shall have a flexible duct connector between fan discharge and casing when internally isolated.
8. Access sections, where indicated, shall be sized to match air unit width and height. Access sections shall be 18 inches (minimum) in depth with a minimum door opening of 12” in width by 6’-0” high on AHU casings taller than 6’-6”.
9. Access doors shall be double wall, sandwich type constructed of galvanized sheet steel with insulation between inner and outer walls. Insulation shall be manufacturer's standard material; insulation thickness shall be 2 inch (minimum). Access doors shall be hinged on one side and latched on the other. Doors on the suction side of the fan shall open out. Doors on the discharge side of the fan shall open in. Access doors shall have vision see through panel in each door and shall have replaceable gaskets material around the full perimeter of the door and frame. Casing access doors for fan section shall have safety locks. Casing access doors shall be provided in the unit casing as follows:
   a. Fan section (one side).
   b. Coil section (both sides).
   c. Return Air (Mixed) Plenum section (one side).

d. Filter section (both sides).
e. Access sections (both sides).

E. Fans:

1. Fans shall be double width, double inlet, backward-inclined or airfoil type centrifugal fan wheel type with galvanized steel scroll housing. Fan wheels shall be forward curved blades or backward incline airfoil blades as indicated on the Drawings. Where fans are SWSI plenum type plug fans with direct drive provide matching VFD. Fans shall be constructed and rated in accordance with AMCA 210 for air quantity and system total static pressure. Fans shall have the same corrosion protection and finish as specified for casing. Fan scroll housing discharge shall be attached to casing using flexible duct connection suitable for static pressure rating of the fan.
2. Fans shall be statically and dynamically balanced in the casing at the factory. Fans in units specified to be variable frequency motor speed controlled shall be balanced over the full range of fan wheel RPM modulation. Fans shall be mounted and keyed to fan shaft. Fan shafts shall be turned, ground, and polished hot rolled steel with a maximum RPM not to exceed 80% of the first critical speed and protectively coated with lubricating oil. Fan shaft shall not pass through its first critical speed as the unit comes up to rated RPM.
3. Shaft bearings inside the casing shall be self-aligning pillow block grease lubricated, ball or roller bearings. Shaft bearings outside the casing shall be flange type. Bearings shall have AFBMA Standard No. 9 rated L-50 life of not less than 200,000 hours at the maximum catalogued RPM for the fan in the air unit casing; bearing rated at design conditions will not be acceptable. For units having coils larger than 25 sq. feet, bearings shall be grease lubricated and equipped with grease fitting on each bearing. For units having coils 25 sq. feet and smaller, bearings mounted internally, or otherwise inaccessible, shall have copper extended grease lines to exterior of casing terminated with grease fitting in a serviceable location.
4. Where capacity modulation is scheduled on the drawings, the fan shall have stable operation at both full load and at minimum CFM-static pressure indicated.
5. Fan and motor assembly shall be internally mounted on common base. Access to motor, drive, and bearings shall be through hinged access doors. Fan and motor assembly base shall be mounted on internal spring type vibration isolators. Spring isolators selected for a minimum 2" deflection shall be furnished and installed for the supply fan base by the manufacturer. Fan scroll housing discharge shall be attached to casing using flexible duct connection suitable for static pressure rating of the fan.

F. Motors and Guards:

1. Fan motors shall comply with Section ~~15170~~ 20 05 13 MOTORS.
2. Internally mounted motors shall be premium plus high efficiency inverter rated totally enclosed fan cooled (TEFC) type with common mounting base provided for fan and motor. Internal mounting bases shall be provided with spring isolators having a minimum static deflection of 2” inches. Motors shall be mounted on adjustable steel bases. Units with externally mounted motors and drives shall have sheet steel belt guards with tachometer holes; units with internally mounted motors and drives shall have expanded metal belt guards totally enclosing belt.
3. Motor shall be sized to drive the fan taking into account belt drive losses and calculated “System Effect” static pressure losses. Whenever fan wheel torque starting requirements exceed operating torque requirements, the motor shall be large enough to start the fan without overheating. As a minimum, motors shall be sized at 120 percent of design brake horsepower requirements and shall be non-overloading on a drop in external static pressure of 25% of the unit

scheduled External Static pressure or a minimum of 0.75" water gauge due to dirty filter change out. No motor shall be selected within the service factor range. Motor RPM shall not exceed 1,800 RPM nominal.

4. In calculating the fan brake horsepower, the following shall be added to the external static pressure indicated on the drawings:
   a. Casing losses internal to the unit.
   b. Coil losses.
   c. Air density.
   d. Belt drive losses, where applicable.
   e. "System Effect" static pressure losses.
5. The following features shall be provided on the unit:
   a. An internally casing mounted marine light with expanded metal shield.
   b. Externally casing mounted light switch pre-wired to the light. Lights shall be furnished in the fan section, upstream and downstream of the cooling coil and upstream of the final filter section.
   c. The air handling unit manufacturer shall be responsible for providing all internal to the unit electrical connections to motors, UV-C lights, Marine lights and controls from a exterior J-box mounted low on the side of the AHU casing exterior and shall include a neoprene or EDPM grommet around all air handling unit casing motor, light switch and light flexible electrical "Sealtite" power conduit penetrations to properly seal the penetration and to provide a thermal break.
   d. Access doors on both sides of fan section and where lights are noted to be provided including the UV-C light Section. Doors shall have tempered wire glass panels for viewing. Access door shall be sized to allow for removal of motor.

G. Fan Drives:
1. Fan drive shall consist of matched set of multi-belt V-belt, variable and fixed pitch drive and fan sheaves.
2. Belts shall be designed for 150 percent (minimum) of the connected motor capacity. Belt speeds shall be between 1,000 and 6,000 feet per minute velocity. The area of the belt contact on the smaller sheave shall be not less than 120 degrees. Belts shall be notch grip type, anti-static and oil resistant. Provide matched drive belt sets where multiple belts are required.
3. Sheaves shall be fixed pitch type selected based on the scheduled design conditions. Sheaves shall be as large as the minimum size recommended for each belt section by MPTA and RMA Standards (latest edition). The motor sheave shall comply with NEMA MG1-14.42a for minimum diameter and maximum width. Centerline distance between fan and motor sheave shall not exceed three times the sum of the sheave diameters nor be less than the diameter of the larger sheave.
4. Where required, an additional variable pitch drive sheave and additional fixed sheave shall be provided and installed based on the final balanced air requirements.
5. Units shall have internally mounted motors and fan isolated with factory installed spring isolators. Fan discharge shall be connected to casing with flexible connection.

H. Coils:
1. Coil performance shall be certified in accordance with ARI 410. Coils shall bear the ARI label.
   a) Water coils shall be constructed of copper tubes with aluminum fins. ~~Coil tubes 1/2 inch (minimum) O.D. shall have 0.025-inch (minimum) wall thickness~~. Coil tubes 5/8 inch (minimum) O.D. shall have 0.~~028~~035-inch

(minimum) wall thickness. Fins shall have 0.008-inch (minimum) thickness. Fin collars shall be drawn and belled, then bonded to the tube by means of mechanical expansion of the tube. U-bends shall be round, seamless copper tubes, same outside diameter as tubes and shall be machine die-formed on each end to provide a fit for silver brazed joints. Refer to Air Handling Unit Selection Criteria herein for maximum coil row and fins per inch spacing requirements, but in no case shall coil rows exceed 8 rows and fins per inch shall not exceed 9 for a single cooling coil. Dual cooling coils shall be series circuited unless approved in writing by FMS otherwise in writing prior scheduling.

b) Coils shall have cast-iron, copper, or steel water headers with threaded connections. Coils shall have stainless steel supports and channels. Headers shall be internal to air unit casing. Access for piping connections shall be through factory punched holes (tagged inlet and outlet) in the air unit casing with a neoprene or EDPM grommet to seal pipe penetration. Unless indicated otherwise, coils shall have supply and return connections at the same end with the inlet connection at the bottom of the coil and the outlet connection at the top of the coil.

c) Coil casing shall be 16-gauge (minimum) 316L stainless steel channel. Where fin length exceeds 48 inches, intermediate tube supports shall be provided.

d) Coils shall be factory tested at 300-psig and proven airtight. Coils shall be rated for 250-psig and 300° F operating conditions.

e) Coils shall have manual needle valve vent at high point.

f) Chilled water coils shall be counter flow circuited.

g) Units with multiple stacked chilled water coils shall have completely separate coils, i.e., separate rows, separate fins and separate headers properly supported with a separate stainless steel support track and shall be provided with a separate stainless steel secondary drain pans under each upper coil section with stainless steel downspouts to primary drain pan. Secondary drain pans shall be not extend more than 6” past the cooling coil section and shall be sloped upward in the direction of airflow at a minimum 45º angle with a rolled ½” diameter catch lip at the end of the drain pan. Each secondary coil drain pan shall have a down drain minimum ¾” diameter at each end of the coil and at any intermediate coil support header track.

2. All exposed coil surfaces shall be covered at the factory with 1/4 inch plywood with kraft paper facing on each side for protection during transit and storage. Plywood shall be secured in place with bolts, utilizing pre-punched holes in the coil casing flange. Re-install plywood covers removed at the job site for inspecting units on delivery and assure that they remain in place until units are set in place and ready for duct connections.

I. UV Lights:

1. UV lights shall be located so as to shine on the leaving face of the cooling coil. Configure UV-C lights in accordance with the manufacturer’s recommendations for optimal coverage of the entire cooling coil face.
2. A hard-wired kill switch on all access doors for the UV light compartment shall be provided to de-energize the UV light when the door is opened.
3. Interior lining of AHU sections housing UV lights shall be polished aluminum with an 88% minimum reflectance.
4. UV light ballasts shall be located on the outside of the AHU housing with factory-provided thermally broken pass-through to fixture inside unit. Ballast shall be removeable without accessing AHU interior. Provide on-off switch for UV lights

on unit exterior and identify with permanent signage to distinguish switch from switching for interior light fixture.

5. Exposed gasket sections inside AHU section housing the UV light shall be UV resistant.
6. UV lamps shall be Fresh-Aire APCO UVC Lights on downstream side of cooling coil only with Teflon coated 2 year high output UVC lamps with multi-voltage life time warranty power supply, remote mounting ballasts and loom kit of sufficient length to make connections and neatly tie off cable along interior panel sections.
   a. Where more than 8 row coil 10 FPI used (must have prior written permission from HMH FMS) provide on both sides of the cooling coil (HMH Design Standard when UVC is utilized)
7. Approved Vendor: Filter Technology Company, Inc. Contact Jerry Wittman @ Phone 713-910-1395, Fax 713-910-0071, 1-800-874-1045, Cell 832-643-1395, e-mail: jwittman@filtertexas.com.

~~J. GPS I-Bar Needle Point Ionization System on upstream side of cooling coil only High VOC Applications UV Lights and GPS I-Bar Needle Point Ionization System on upstream side of Carbon Filters only High VOC applications~~

~~1. GPS I-Bar Needle Point Ionization systems shall be located so as to discharge on the entering face of the cooling coil. Configure system in accordance with the GPS I-Bar Needle Point Ionization manufacturer's recommendations for optimal coverage of the entire cooling coil face.~~

~~2. Provide hard-wired on-off switch on unit exterior and identify with permanent signage to distinguish switch from switching for interior light fixture for the GPS I-Bar Needle Point Ionization compartment shall be provided to de-energize the GPS I-Bar Needle Point Ionization. The GPS I-Bar shall be internally wired for complete automatic restart and reset of I-Bar Needle Point Ionization upon loss of power and subsequent restoration of power connection.~~

~~K. GPS NPI I-BAR Ionization for VOC Control and to not deteriorate composite fan wheels of Direct drive ECMs and Address know VOC issues GPS I-Bar Needle Point Ionization System (HMH Basis of Design)~~

L. Airflow Monitoring Station:
   1. A factory-mounted damper shall be provided for units with outdoor air openings to measure outside air intake airflow.
   2. Damper blades shall be galvanized steel, housed in a galvanized steel frame and mechanically fastened to a rotating axle rod.
   3. The dampers shall be rated for a maximum leakage rate of less than 1% of nominal airflow at 1-inch wg.
   4. The airflow measurement station shall measure from 15 to 100% of total outside air and/or return air flow.
   5. The airflow monitor shall adjust for temperature variations.
   6. The airflow monitoring output shall be a 2-10 VDC signal proportional to velocity.
   7. The accuracy of the airflow measurement station shall be ± 5%.

2.2 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS

A. The Mechanical Contractor shall furnish each air handling units as scheduled with a variable frequency motor speed controller complete with manual bypass. Installation and wiring shall be as described in Division 16 .

B. Variable frequency motor speed controller drives shall be as specified in VFD specifications - Yaskawa Series V1000U provide single VFD without three contactor

bypass for single or multiple motors with separate disconnects and overloads for each motor.

C. Variable frequency drive shall be field installed on wall within air-conditioned space within a mechanical room or electrical room as indicated. Install VFD such that minimal wire runs are required between the VFD and motor load. Maximum length shall be as recommended by VFD manufacturer.

2.3 FILTERS

A. Refer to Section 23 41 00-OSA Owners Supplemental Appendix Particulate Air Filtration for specific filter requirements.

B. All manufacturer-furnished galvanized sheet metal spacers with neoprene gasket material for filter tracks shall be in place any time the filters are installed and unit is in operation. Contractor shall be responsible for receiving, storing and furnishing on jobsite galvanized sheet metal spacers and demonstrating by-pass free filter assemblies at time of final completion.

C. Contractor shall be responsible for all required coil cleaning resulting from faulty filters during fan operation prior to Owner's acceptance.

2.4 SITE ASSEMBLED (CUSTOM OR SEMI-CUSTOM) AIR HANDLING UNITS

A. General:

1. Site-assembled (Custom or Semi-Custom) built-up units shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured. The units shall be constructed for indoor installation. The units shall be factory built for planned field assembly. The unit manufacturer shall be completely responsible for the unit's assembly and proper installation and testing with certification.
2. Site-assembled (Custom) air handling unit components shall be the same as specified above, i.e., arrangement, casing, fans, motors and drives, coils, fan drives specification shall be the same as noted above in air handling units, except where specifically noted below.
3. The units shall be as shown on the drawings and may consist of intake sections for return and outside air, mixing section with dampers for outside air and return air, pre-filter section, final filter section, heating coil section, cooling coil section, humidifier section, supply and return fan sections, and discharge section .
4. Unit shall employ aluminum material (panels, bases, supports, safing, etc.) to reduce overall unit weight and to minimize corrosion.
5. Provide safing between internal components and unit casing to prevent bypassing of conditioned air. Safing material shall match unit interior. All seams or voids between safing, components and unit casing shall be caulked and sealed airtight.
6. Provide hygienic unit design with interior suitable for washing down. Do not use support members framed within the unit casing which trap debris. Unit insulation shall be completely encapsulated.
7. The unit sizes shown on drawings are selected based on unit performance, site constraints, and access requirements. Unit physical sizes and lengths shall not be altered without specific written approval of the Owner.

B. UNIT BASE:

1. The unit shall be constructed on an all-aluminum or stainless steel structural base. The base shall be designed to distribute loads properly and be braced to support internal components without sagging, pulsating or oil-canning.
2. The unit base shall be provided with sloped sumps in areas as indicated on the drawings. Sumps to be welded and guaranteed waterproof to serve as a drain pan to prevent building water damage from the unit. The cooling coil condensate sump is to be double-sloped (min. ¼" per foot) towards units drains to positively remove condensate from the unit and meet the requirements of ASHRAE 62.1-2004 for accessibility and clean-ability.
3. The base floor shall be minimum 3/16" thick aluminum plate welded at all joints and also to structural members. Floor material shall have safety-tread surface. The base floor shall be designed for a minimum live load of 100 pounds per square foot throughout the unit. Caulking, gaskets and mechanical fasteners to achieve air seals and water tightness of joints are not be acceptable.
4. Base shipping splits shall be provided as needed based on unit rigging limitations. Shipping splits shall be designed with a raised flange for connecting of base sections. The raised flange shall allow the base sections to be bolted together and maintain a minimum of 2" deep sump. The perimeter support members shall be properly sized to support all major components and the housing during rigging, handling and operation of the unit.
5. The underneath side of the base pan and base perimeter shall be insulated with minimum 2" thick 1.5-pcf high density polyisocyanurate foam insulation to form a vapor barrier. The installed system shall have a minimum insulating value of R-12.
6. Each section of the unit base shall contain a minimum 1" NPT drain to facilitate system wash-down, maintenance and condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Clean out drains shall be provided with removable caps of non-corrosive material.
7. All equipment within air handling unit shall be provided with a minimum 2" high base to raise equipment off unit floor for housekeeping.
8. Supply air openings shall be framed with 2" high water dam continuously welded to the pan to allow proper duct connections and to prevent moisture from entering the openings. Framed openings shall be provided with removable aluminum or 304 stainless steel grating designed and fabricated for a live load of 100 pounds per square foot. Galvanized or painted steel grating will not be accepted.
9. All unit base service openings shall be framed with a minimum 2" high water dam continuously welded to the floor. All pipe and electric conduit chases with openings to building or elements shall be covered with thin gage aluminum or 304 stainless steel. Penetrations by contractors will not be allowed.
10. Fastening to floor plate or joining of unit sections shall be accomplished by bolts securing gasketed joints above the floor line or by continuously welding. Fasteners which penetrate base floor plate are not acceptable.
11. Unit shall be provided with properly located permanent lifting plates or removable lifting lugs for each section to adequately allow rigging of the unit sections in place.

C. UNIT CASING

1. Air handling unit casing shall be built up from the unit base or floor with panels. The unit manufacturer shall be the manufacturer of the panel system. Panels shall be load bearing and capable of forming the enclosure without additional structural members. Panels shall be joined together with independent joining member and fastened with closed end aluminum rivets or stainless steel fasteners. Plated fasteners will not be accepted.

2. Panel joints and seams shall be sealed with FDA approved sealant. Other sealing methods or materials must be approved by the Architect/Engineer/Owner in writing before application.

3. All panels shall be double wall all-aluminum construction with minimum 0.040" exterior and interior skin thicknesses. Interior finish shall be smooth, mill finish; exterior finish to be a low-reflective textured mill finish. Each panel shall contain an integral frame or be properly supported by a structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation.4. The minimum panel thickness shall be 2-1/2" thick with poly-isocyanurate foam insulation. The panel R value shall be a minimum of 12 or greater.

5. Thickness of the panel skin, core density, rib structural frame spacing shall be regulated to eliminate panel pulsation and restrict the maximum deflection to 1/200 of any span at design load of 1-1/2 times the design positive or negative pressure plus snow and wind loading.
6. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. Leakage shall be guaranteed at no more than 1% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater.
7. All casing walls shall be of panel construction, including but not limited to the fan discharge walls, mixing section walls and divider wall to the access corridor.
8. Panel system shall incorporate an integral thermal break system downstream of cooling coil such that there is no through metal path between the interior and exterior surface of the unit casing at all locations. The thermal break shall consist of a minimum 1/2" structural epoxy bridge. Adhesive tapes or gaskets do not constitute an acceptable thermal break. Criteria to evaluate requirement for thermal break system shall be based upon scheduled unit performance and ambient conditions anticipated around the units.
9. Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable.
10. All ductwork penetrations through unit enclosure shall be provided with framed openings of size and arrangement as indicated on drawing. Openings in casing are to be provided with flanged duct connections of same material as casing interior extending a minimum of 4" from surface of unit casing.
11. Pipe and conduit penetrations through the unit casings shall be provided by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations sealed by simply caulking around penetration are not acceptable.
12. Provide minimum 24" wide access doors for access to all internal components. Access doors shall be installed to open against the greatest pressure relative to air pressure on each side of access door.
13. Access doors shall be of the same construction as panels described above.
14. The access doors shall incorporate two continuous separate gasket seals around the entire periphery of the door. Gasket material shall be UV-resistant, closed cell neoprene; gaskets shall be attached by adhesive and not mechanically held in place. Single gasket seals will not be accepted.
15. Each access door shall contain a thermopane safety glass window (min. 10" square).
16. Provide 1" dia. test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement.
17. Each access door shall be mounted with a corrosion-resistant continuous piano hinge and shall have a least two (2) non-corrosive handles operable from either side.

18. Removable access panels shall be provided as indicated on the drawings for service and maintenance. Access panels shall be of the same construction as panels described above. Removable access panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels. Airtight integrity must be maintained.

D. DAMPERS

1. Dampers shall be ultra low leakage, opposed blade design capable of withstanding 8" wg differential pressure at 2,000 fpm approach velocity. Leakage rate not to exceed 6 CFM per ft.2 at 4" wg differential pressure and 2,000 fpm approach velocity.
2. Motorized isolation type control dampers shall be parallel blade type and modulating type control dampers shall be opposed blade type. Motorized control dampers when furnished by the AHU manufacturer shall be properly sized by the AHU manufacturer to achieve the desired control functionality and control authority. Motorized control dampers when furnished by the DDC controls vendor shall be properly sized by the DDC controls vendor to properly fit within the referenced AHU to achieve the desired control functionality and control authority. Velocity through damper shall be as required to achieve desired control function.

   Motorized Damper shall be per the following:

   a. Dampers to be installed with the damper blades positioned vertically. Dampers shall be ultra-low leakage, opposed blade design capable of withstanding 8" WG differential pressure at 2,000 FPM approach velocity. Overall leakage rate is not to exceed 6 CFM per SF at 4" WG differential pressure and 2,000 FPM approach velocity.
   b. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and extruded silicone blade edge seals.
   c Dampers shall be provided with two sets of linkage; one set concealed in the side frame of the damper and one set mounted from the blades on the face of the damper. Dampers are to be driven from an extended drive rod.
2. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and flexible synthetic blade edge seals.
3. Acceptable dampers manufacturers & model numbers: Arrow 'AFD-20', Ruskin 'CD-60', TAMCO 1500, Greenheck or approved equal.

E. SUPPLY & RETURN FAN SECTIONS:

1. Provide fans, motors and drives of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications.
2. Housed Fans: Sections shall be complete with DWDI, arrangement 3, centrifugal fans as per the following:

   a. Fan housing shall be heavy gauge construction with spun inlet cones. Housings shall be suitably braced to prevent vibration or pulsation. Scroll housing shall be connected to sideplates with a high quality air tight seal; seam shall be continuously welded as required for application. Bearing supports shall be rigid and shall provide a firm foundation for the shaft and bearings. Bearings supported from the fan housing will not be acceptable.
   b. Fan wheels shall be non-overloading, airfoil type or backward inclined. Impellers shall be statically and dynamically balanced to a level of G6.3

(per ANSI 2-19) or better. Hubs shall be straight bored, keyed and set screwed to the shaft. Shafts are to be solid steel sized for first critical speed of at least 1.25 times the maximum speed for the class for class I and II fans and 1.42 times the maximum speed for class for class III and IV fans.

c. Bearings are to be heavy duty, grease lubricated, anti-friction, self-aligning, pillow block type and selected for minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM. All bearings shall be equipped with grease injectable Zerk fittings with lubrication lines extended to accessible location outside of the airstream, on fan housing, for easy access for lubrication.

d. Fan shall be provided with heavy gauge wire inlet screens, housing access door, and scroll drain as required.

e. Fan shall be cleaned, prime coated and provided with two coats of enamel final coat.

f. Each fan shall be test run at its operating speed and at the maximum RPM for the particular fan's construction class prior to shipment. The fans shall be balanced and records maintained of the readings in the axial, vertical, and horizontal direction on each of the fan's bearings. Final peak velocity measurements shall not exceed 0.1 in/sec.

g. When needed for placement in the building, fans shall be designed with split housing to allow for field disassembly & re-assembly.

h. Acceptable fan manufacturers: Twin City Fan, Greenheck, Cook, New York Blower

3. Plenum Fans: Fan sections shall be complete with SWSI, arrangement 4 (direct-drive), plenum fans as per the following:

a. Fan unit shall be formed by welding heavy gauge steel inlet plate with spun inlet cones to steel angle frame. A square formed lip shall surround the unit, suitable for attachment of flex connector.

b. Fan wheels shall be non-overloading, airfoil type or backward inclined. Impellers shall be statically and dynamically balanced to a level of G6.3 (per ANSI 2-19) or better. Hubs shall be straight bored, keyed and set screwed to the shaft. Shafts shall be solid steel sized for first critical speed of at least 1.25 times the maximum speed for the class for class I and II fans and 1.42 times the maximum speed for class for class III and IV fans.

c. Bearings shall be heavy duty, grease lubricated, anti-friction, self-aligning, pillow block type and selected for minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM. All bearings shall be equipped with grease injectable Zerk fittings with copper lubrication lines extended to accessible location on fan housing for easy access.

d. Fan shall be provided with wire mesh protective wheel enclosure and heavy gauge wire inlet screen.

e. Fan shall be cleaned, prime coated and provided with two coats of enamel final coat.

f. Each fan shall be test run at its operating speed or at the maximum RPM for the particular fan's construction class prior to shipment. The fans shall be balanced and records maintained of the readings in the axial, vertical, and horizontal direction on each of the fan's bearings. Final peak velocity measurements shall not exceed 0.1 in/sec.

g. Direct drive fans shall be designed with a bolted frame to allow the motor and wheel to be disassembled from the inlet scroll.

h. Acceptable fan manufacturers: Twin City Fan, Greenheck, Cook, New York Blower

F. Motors and Fan Assembly:

1 Motors shall with the requirements of Division 23 specifications, entitled “Motors”:

2. The entire fan assembly shall be provided with a minimum of 18” clearance on all unattached sides for proper service access. Fan inlets to be provided with a minimum clearance distance equal to 75% of the wheel diameter.

3. The unit manufacturer shall provide flexible connection between fan and fan wall. Fan assembly shall be provided with thrust arrestors as required to prevent damage to the flex connection. Flex connection material shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.

4. The fan and motor shall be factory-mounted on a spring type vibration base. The base shall be mounted on stable free standing spring isolators with 3” maximum deflection rating.

G. Dampers: Each fan in dual or multiple fan arrangements shall have an isolation damper to isolate one of the fans off-line for servicing while the other fan or fans continues to operate. Motorized isolation type control dampers shall be parallel blade type and modulating type control dampers shall be opposed blade type. Motorized control dampers when furnished by the AHU manufacturer shall be properly sized by the AHU manufacturer to achieve the desired control functionality and control authority. Motorized control dampers when furnished by the DDC controls vendor shall be properly sized by the DDC controls vendor to properly fit within the referenced AHU to achieve the desired control functionality and control authority. Velocity through damper shall be as required to achieve desired control function. Motorized Damper shall be per the following:

1. Dampers to be installed with the damper blades positioned vertically. Dampers shall be ultra-low leakage, opposed blade design capable of withstanding 8” WG differential pressure at 2,000 FPM approach velocity. Overall leakage rate is not to exceed 6 CFM per SF at 4” WG differential pressure and 2,000 FPM approach velocity.

2. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and extruded silicone blade edge seals.

3. Dampers shall be provided with two sets of linkage; one set concealed in the side frame of the damper and one set mounted from the blades on the face of the damper. Dampers are to be driven from an extended drive rod.

4. Acceptable damper manufacturer and model numbers: Arrow ‘AFD-20’, Ruskin ‘CD-50’, TAMCO 1500 or approved equal.

I. Lights and Accessories: Unit manufacturer shall provide the following devices as detailed on the submittal drawing. Lighting system to include light fixtures, switches, and a GFCI receptacle per the following:

1. Lighting Fixtures: vapor tight incandescent marine type guarded service light fixture, 100 watt (A-21) R.S. bulb. Each access section shown is to be provided with minimum of one (1) light fixture. Fan sections and filter sections shall be provided with minimum of two (2) light fixtures.

2. Light Switches: 20 AMP, single pole, specification grade, toggle switch in lug type device box with weatherproof cover.

3. Fan Disconnect Switch: Unit manufacturer shall provide a mounting plate for fan motor disconnect for each fan motor.

J. Controls:

1. Control devices shall be by same manufacturer providing control devices for the remainder of the building.

2. Control devices, will be furnished by Control Contractor and shall be factory installed by unit manufacturer as shown on plans and as described in control section of Specifications.

3. Control devices will be provided by Control Contractor. Unit manufacturer shall coordinate with Control Contractor and provide sleeved openings on unit housing for control devices as required and as shown on drawings.

PART 3 - EXECUTION

3.1 STORAGE

A. All air handling units shall be received and stored on the job site with the wooden shipping skids in place. Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.

B. Unit delivery shall be coordinated with building construction and units shall be delivered to the job site just prior to their installation. Cover air handling units stored on the job site with 6 mil polyethylene sheet, taped in place, to protect the units from damage and the weather. Units that receive water damage due to improper handling or storage shall be removed from the site and new ones furnished at no additional charge to the Owner.

C. For stored AHU's, rotate fans through two full revolutions weekly to avoid pooling of lubricant.

3.2 INSTALLATION

A. Mount floor mounted units on concrete housekeeping pads and Galvanized or aluminum base support channels a minimum of 6"high and provide 3/8" thick neoprene isolator pads. Minimum eight (8) per unit between base rail and concrete pad.

~~B. Roof mounted air-handling units, piping vestibules and roof curbs shall be coated with baked on primer suitable for field painting by General Contractor in color directed by the Owner.~~

~~1. Mechanical Contractor shall coordinate all required roof openings with the roof structural plans or existing roof structure and shall provide a roof opening shop drawing with the required roof openings dimensioned and sized for the General Contractor to frame out and provide roof openings. Rooftop AHU's shall reuse existing penetrations through roof unless otherwise directed by the plans and specifications. Refer to structural plans for required roof opening framing.~~

~~2. Roof curbs shall be furnished and located by the Mechanical Contractor for the General Contractor's or Owner's bonded roofing contractor to install.~~

~~3. Secure unit curb cap to roof curb with stainless steel or cadmium-plated screws a maximum of 12" on center minimum four per side.~~

~~4. All roof-mounted equipment must be properly secured to the building structure to withstand Texas Coastal Windstorm criteria, i.e., minimum 150 MPH hurricane force winds. Protecting against failure of building structural elements is beyond the scope of the project, however, secure attachment of the unit curb to the existing roof structure is part of the scope of work. Provide 3rd Party Certification~~

of High Wind and Hurricane fans ratings for wind loads of up to 150 MPH static and cyclic wind loading and Missile Impact in accordance with TAS 201 large Missile Impact (ASTM E1996), TAS 202 Uniform Static Air Pressure Test (ASTM E330) and TAS 203 Cyclic Wind pressure Load Test (to be conducted after the completion of TAS 201). Provide maximum fan size to be certified and rated, Provide NOA and FLPA certification listing numbers. Provide mechanical trade and the General Contractor the structural roof attachment requirements in terms of type and quantity of fasteners per side and total fasteners with reaction loads to meet the 3rd party Certification of High Wind and Hurricane Ratings.

C. Mount suspended air handling units with minimum four properly sized galvanized all-thread support rods and vibration isolators.

D. Horizontal air handling units when mounted above ceiling or when located exposed over countertops or equipment susceptible to water damage - provide an insulated galvanized auxiliary drain pan with auxiliary drain connection routed to drip above nearest sink or approved plumbing drain fixture as detailed and specified or provide an insulated paint-grip galvanized auxiliary drain pan with auxiliary drain connection closed ball valve and ¾" diameter hose connector and float switch to shutoff fan motor unit, close chilled water coil control valve and energize red ceiling mounted pilot light upon detection of water within the auxiliary drain pan. Auxiliary drain pan shall be 2" deep with minimum 2" larger in each dimension of the unit cross-broken to drain and painted color to match air handling unit.

E. Pipe cooling coil condensate drain line full size (minimum ¾" diameter) to nearest floor or open drain. Slope the drain line down in the direction of flow at a 1/4 inch per foot (minimum). Provide an insulated cooling coil condensate drain trap and air vent connection at the air handling unit and maintain a minimum 1" air gap at the floor drain connection to the building sanitary sewer.

F. Coordinate 120 volt circuiting to UV light systems and interior work light switches furnished with air handling units with Division 16.

3.3 INSTALLATION OF SITE ASSEMBLED (CUSTOM OPR SEMI-CUSTOM) AIR HANDLING UNITS

A. GENERAL

1. Unit manufacturer shall be responsible for the supervision and testing of complete installation of the air handling unit. The unit manufacturer shall coordinate with other trade contractors, all necessary requirements to assure proper air handling unit installation.

2. The unit manufacturer shall provide factory training for the mechanical Contractor's field personnel (minimum the Mechanical contractors lead supervisor and lead technician) to instruct them in the assembly procedures of the specific units being provided.

3. The unit manufacturer shall furnish on-site factory supervision of the installation and field testing of the equipment by the mechanical contractor.

4. The unit manufacturer shall provide a list of all required tools and where costly specialty tools are required they shall make an arrangement for rental of said equipment to the Contractor.

5. The unit manufacturer shall provide all required assembly instructions and conduct a pre-build construction meeting prior to the start of assembly on the site of the AHU in question.

B. Unit manufacturer shall coordinate exact quantity and locations of casing penetrations. All penetrations shall be sealed.

C. The unit manufacturer shall coordinate unit shipping and installation schedule with Mechanical Contractor.

D. Mechanical Contractor shall make all final ductwork and piping connections required for a complete operating system.

E. Unit manufacturer shall provide all conduits, fixtures, motor wiring, disconnect switches, and lighting within unit.

F. The temperature controls contractor shall install temperature controls and panel, including, control wiring, etc., required for a complete and operating control system. Electrical contractor shall make final connections to the temperature control panel after the unit is installed.

G. Coordination: Coordinate with other work, including ductwork, piping, and controls as necessary to interface installation of air handling units with other work.

H. Access: Provide access space around air handling units for service as indicated and/or required, but in no case less than that recommended by manufacturer.

I. Drain Piping: Provide insulated trapped copper drain line for indoor air handling units from each drain pan connection and run drain line to nearest floor drain or floor sink. Trap shall be constructed with depth and arrangement as indicated on the drawings to provide proper coil drainage.

J. Piping Connections: Refer to Division-15 Section "Hydronic Piping" and/or “Steam and Condensate Piping”. Provide piping, valves, accessories, gages, supports, and flexible connectors as indicated.

K. Duct Connections: Refer to Metal Duct and Duct Accessories specifications. Provide ductwork, accessories, and flexible connections as indicated.

L. Grounding: Provide a positive equipment ground connection for all air handling unit components.

3.4 FIELD QUALITY CONTROL FOR CUSTOM OR SEMI-CUSTOM AIR HANDLING UNITS

A. FIELD UNIT TESTING: Unit manufacturer shall provide tests to insure structural integrity, as well as compliance with this specification.

B. Fan Vibration Testing: The unit fan assembly including the base, spring isolators and fans shall be operated at the design RPM and a complete vibration spectrum shall be conducted. Such tests shall be performed on a completely assembled unit including all components. Readings shall be taken in the horizontal, vertical, and axial direction at each fan and motor bearing. This test shall be conducted at the factory before shipping and in the field.

C. Basin Leakage Testing: The basin shall be tested for leakage. The base sections shall be filled with 2” of water for 24 hours. Any leaks shall be repaired and the basin re-tested.

~~D.~~B. Coil Pressure Tests: The heating and cooling coils, as well as any other piping included with the air handling units shall be pressure tested at 150 PSI for minimum of 1 hour.

~~E.~~C. Electrical System Tests: The entire electrical system shall be functionally checked including motors, lights, utility outlets, etc. for proper operation.

~~F.~~D. Unit Performance Test: Unit manufacturer shall demonstrate that the actual performance matches scheduled unit performance by testing and operating unit at the design conditions; simulating external static pressure (providing for dirty filters and wet coils). Test shall include measurements of CFM, BHP and RPM at design TSP.

~~G.~~E. Casing Leakage Test: The casing leakage test shall verify that unit casing leakage is less than 1% of design air flow at 1-1/2 times the design static pressure. The unit shall be sealed; pressure sections shall be put under positive pressure and suction sections shall be put under negative pressure. The leakage shall be measured in each section using a calibrated orifice plate. The total casing leakage (positive plus negative) shall be considered the sum of the positive and negative leakage.

~~H.~~F. Sound Test: The assembled air handling unit shall be field tested for sound power at the unit inlet and outlet; and sound pressure level at a three (3) foot distance from the unit casing. The sound power level shall be verified through actual measurements and calculations in accordance with AMCA Standards 300 and 301. During test, unit shall be isolated from background noise and vibration or tested during periods when background noise and vibration are at a minimum.

~~I.~~G. Panel Deflection Test:

1. Unit manufacturer shall provide factory panel deflection test. Conduct this test in conjunction with casing leakage testing.
2. Panel deflection test for panels under positive pressure shall verify that unit casing deflection is less than 1/200 of the longest plane being measured at 1-1/2 times design static pressure or 10” WG positive, whichever is greater.
3. Panel deflection test for panels under negative pressure shall verify that unit casing deflection is less than 1/200 of the longest plane being measured at 1-1/2 times design static pressure or 10” WG negative, whichever is more negative.
4. Deflection shall be measured at 2 points for positive pressure sections and 2 points for negative pressure sections (total 4 points at panel seams) at mid-point of panel height

J. Field testing shall assure the Owner and Engineer that any potential system performance concerns are addressed before owner acceptance. Any unit modifications necessary as a result of field testing not meeting specified performance levels shall be done by the unit manufacturer at no additional cost to the owner prior to unit acceptance.

K. The Owner’s representative or the Engineer shall have the option to witness all tests. The manufacturer shall notify the Owner’s representative/Engineer two weeks prior to the scheduled tests.

L. A formal written report, including test results, shall be submitted to the Owner / Engineer.

3.5 IDENTIFICATION:

A. Refer to applicable painting and cleaning requirements elsewhere in Division 23.

B. Refer to TMH standards and other Division 23 specifications for applicable identification, nameplates and labeling requirements.

3.6 WARRANTY NOTE:

~~B.~~A. Refer to Division 23 front end for warranty requirements.

~~C.~~B. Warranty period shall begin from turnover of AHU to the client, not from shipping date, installation date or startup date.

END OF SECTION 23 73 28

REQUEST FOR TECHNICAL INFORMATION

Name of equipment to be inspected: _____

Model Designator of equipment: _____

Serial Number of Equipment: _____

Intended use of equipment: (Hazardous/non-hazardous location/environment)

_____

Manufacturer Name:_____

Electrical Data:

Voltage: Amperage: Phase: Hertz

Largest load served or more than one voltage source:

Does this device have stored energy (capacitors, springs, hydraulics, balanced weight) _____

Location where inspection will be conducted:

Name of Location/Company:

Point of Contact on Site:

Telephone number of Prime Contact

Telephone Number of Secondary Contact:

Location where equipment will be installed if not the same as above:

Name of Location/Company

Address:

Application for Inspection Services

Application and/or Request for Quote for MET Safety Inspection Services for Field Evaluation

Applicant Company Name	
Applicant Address:	
Applicant Contact Information: Phone, Fax, E-mail	
Inspection Required: Include a no later than date:	
Location Where is the Inspection to take place:	
Location of Final Installation of the Equipment:	
Point Of Contact at the Inspection Location: Name and Phone Number	
Equipment Requiring Inspection (If not equipment, what requires inspection) Number of Items covered under this application**:_____(Required)** (Note: Please include a brief description of the equipment, method of control, and electrical properties of the equipment) If the equipment uses gas, is medically related, or contains any materials than meet hazardous notification requirements include this information MET may contact you for additional information) Please use the attached for multiple items.	
Other Comments or Information Related to the Inspection:	
I have read and understood the terms and conditions for MET's Field Evaluation Program Signature of Applicant:	

Date:

Attachment if needed:

Equipment Requiring Inspection:

Equipment Requiring Inspection (If not equipment, what requires inspection)   (Note: Please include a brief description of the equipment, method of control, and electrical properties of the equipment) If the equipment uses gas is medically related, or contains any materials than meet hazardous notification requirements include this information MET may contact you for additional information)
Equipment Requiring Inspection (If not equipment, what requires inspection)   (Note: Please include a brief description of the equipment, method of control, and electrical properties of the equipment) If the equipment uses gas is medically related, or contains any materials than meet hazardous notification requirements include this information MET may contact you for additional information)
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Terms and Conditions

Applicants: Name_____
Project:_____

Terms and Conditions for Product Safety Field Labeling Program

- **Payment Terms** - ☒ Your authorized purchase order indicating engineering/ inspection totals + estimated expenses (If applicable) with net 30 days terms (subject to credit approval for the specific project scope, and based on previous payment history). Please provide 3 business trade references. ☐ Unless otherwise indicated, all quotes are valid for 60 days. Where deposit is required, or no credit has been established we will need to have your payment received prior to our inspection. ☐ Urgent Options may require 100% Deposit by credit card..
- Scheduling will be confirmed with the receipt of a deposit or purchase order as noted above. It is understood cancellation should be made at least 48 hours in advance of scheduled start date to avoid cancellation fees. Partial billing may be issued as related job tasks are performed.
- It is understood that this project anticipates a compliant product utilizing previously certified components suitable for the application (or adequate details showing compliance with the particular component requirements). An investigation of critical component(s) is not anticipated under the scope of this project or estimated man-days. All components that function to reliably control hazardous conditions (i.e. temperature limiting/regulating, flame detect, explosion proof, etc.), must bear the certification mark of a Nationally Recognized Testing Laboratory, be replaced, or be further evaluated for reliability.
- It is understood the applicant will be responsible for supplying the Equipment Under Test (EUT) with all accessories typical of normal operation and for assuring that the EUT is readily accessible and properly installed for the review and required testing. Any required site Personal Protective Equipment (PPE) is to be specified in advance in writing or be provided by the applicant. Any special access conditions or hardware will need to be provided for MET engineering staff. It is understood that if any site-specific training is required for access of the equipment, if not specifically arranged for in advance may increase the scope of the work and/or delay project completion.
- It is understood this proposal assumes an Indoor Ordinary Location installation, per the NEC/CEC. No lasers are anticipated in this project unless specifically referenced in the proposal.
- It is understood that this Evaluation is limited to the electric fire and shock hazard under the scope of the Standard noted above and the Field Labeling Program only for specific equipment listed in the proposal. If guards installed by the manufacturer have been removed or altered, they will need to be restored to their original condition in advance of our visit.
- It is understood that if review and/or testing is requested in order to determine compliance, MET can not be held responsible for the operation of the product after testing. MET does not monitor the shipping and handling of equipment to and from the lab and may not verify product operation. Although most tests are designed to be non-destructive, by requesting special testing, The applicant understands that special tests could affect equipment operation.
- It is understood MET does not take responsibility for the accuracy of information supplied by the customer.
- MET does not assume any responsibility for the condition of the product after testing, evaluation, shipping or storage. Due care of the product tested will be exercised to assure the product is maintained in it's original condition in the process of Field Labeling.
- It is understood MET cannot guarantee that a product will comply with a standard or qualify for a certification. The customer will be responsible to pay for work performed by MET even if compliance is not achieved. It is further understood that if MET is requested to close or cancel the project, MET is required to issue a final non-compliant report to you and any Authority Having Jurisdiction involved in the project.
- It is understood MET may be required to make subjective opinions or interpretations, based upon MET's judgment and interpretation of the applicable standards. In those cases, MET does not warrant or guarantee its opinions or that there will be universal acceptance of its findings. Furthermore, MET does not undertake to discharge or assume any responsibility of the Customer or any third party.
- MET recognizes the confidential nature of the product and the associated documentation. Except as necessary in accordance with the defined project, MET will not voluntarily disclose any information regarding the Customer's product without prior authorization. If desired by the Customer, an additional level of confidentiality can be provided by MET.

I have read and understand the terms of MET's Field Labeling Program. Signature below acknowledges terms and conditions for products reviewed under the Field Labeling Program:

_____	_____	_____
Name Printed	**Authorized Signature**	**Date**

HMH AHU Specification Check List Revised 9-21-18 BLF

Acceptable Manufacturers:

Acceptability of any listed or non-listed manufacturer's is based on meeting the HMH Design Criteria, and Master Specifications, as well as meeting or exceeding the scheduled unit capacities & other noted required criteria & accessories. Verification of Dimensional fit within the MER space allocated and/or available to install the AHU unit within. The units may require shipping splits or complete take down to be able to be installed. Verify in writing with HMH Design Engineer and FMS prior to start if design and release for contractor bidding. Document in the D&C decision Tree. Be aware that you as the Vendor have to meet or exceed the specified requirements and scheduled capacities. Leaking access doors, exterior atmospheric condensation and displaced fan isolation bases are the full and sole responsibility of the manufacturer. The factory has to supervise the installation of the unit components when shipped in modular shipping splits and perform final inspection to certify in writing that the units have been correctly installed and set up by the installing contractor and provide the signed factory Start-up AHU checklist for each unit.

General Duty:

Interior unit construction Draw-Thru or Blow Thru with mixing box, filters, coils, access sections, fans, pre and final filters, discharge plenum, 6" or higher base rail selected in accordance with the unit design TSP "WG must be coordinated with base rail concrete housekeeping pad and unit duct connections, and overall height of unit within indoor space. The overall height of the base rail and concrete housekeeping pad must be coordinated to achieve sufficient height for the cooling coil condensate drain pan air trap overall height based on the unit positive or negative static experienced at the cooling coil drain pan and fan cabinet section.

Exterior unit construction with mixing box, filters, coils, access sections, fans, pre and final filters, discharge plenum, weather tight piping vestibules for each exterior piping connection e.g., pre-heat, cooling or reheat coil and/or humidifier connections, 14"high insulated roof curb, weatherized construction with sloped roof and drip lip edges, rain tight doors, OA intake hood with bird screen, mist eliminators, modulating dampers, weatherproof electrical components and conduit, Unless Noted Otherwise; Specification notes for interior units apply to exterior units.

Cabinet Specifications

- Double Wall construction
  - External Casing Metal Gauge:
    - ☐ 20 Gauge
    - ☐ 18 Gauge
    - ☒ 16 Gauge (Typical)
    - ☐ 14 Gauge
  - External Casing Metal Material: (Select One)
    - ☐ G-90 Galvanized (Typical Indoor Unit)
    - ☒ Painted – Minimum of 2500 Hour Salt Spray Rated (Typical Outdoor Unit Factory Color)
    - ☐ Stainless -304
    - ☐ Stainless -316
    - ☐ Aluminum
    - ☐ Custom Color or Coatings (Heresite or Ameron)
  - Internal Casing Metal Gauge: (Select gauge and finish)
    - ☒ 16 Gauge (Typical)
    - ☐ Solid Panel 20 Gauge

☐ Perforated Finish 22 Gauge (Requires Tedlar or Steriloc Separation of Fiberglass insulation or fire rated foam insulation) on sound sensitive units

- Internal Casing Metal Material: (Select gauge and finish)
  - ☒ G-90 Galvanized (Typical)
  - ☐ Painted - Minimum of 2500 Hour Salt Spray Rated
  - ☐ Stainless -304 (Wet Cooling Coil Section)
  - ☐ Stainless -316 (Wet Coastal Corrosive)
  - ☐ Aluminum
  - ☐ Custom Color or Coatings (Heresite or Ameron)

- Casing Penetrations and Access Doors: (The minimum, opening dimension of the access doors shall be 18" that generally means the overall access section length will be approximately 24")
  - ☐ Field Cut by Others (Field cut holes are not acceptable)
  - ☒ Factory Bulkhead Fitting (with 1" Conduit and mounted J-Boxes Minimum one per section minor cost add)
  - ☒ Access Doors all sections (minimum one side of unit to open in on positive pressure sections and open out for negative pressure sections)
  - ☐ Access Doors all sections (both sides of unit to open in on positive pressure sections and open out for negative pressure sections)
  - ☒ Access Doors view ports (UV rated glass with wire mesh) Doors on one side of unit with view ports where applicable)

- Factory Casing Constructed (Select One) (Acceptability of any listed or non-listed manufacturer's is based on meeting the HMH Design Criteria, and Master Specifications, as well as meeting or exceeding the scheduled unit capacities & other noted required criteria & accessories. Verification of Dimensional fit within the MER space allocated and/or available to install the AHU unit within. The units may require shipping splits or complete take down to be able to be installed. Verify in writing with HNM+MH Design Engineer prior to start if design and release for contractor bidding. Document in the D&C decision Tree.)
  - ☒ STD Factory Assembled and shipped
  - ☐ Shipping splits dimensionally coordinated for Size and weight capacity of freight elevator, corridor ceiling heights and door access into Existing MER (Partial Knock Down for Field Disassembly & Reassembly Electrical & Mechanical Contractor to provide manpower & Time)
  - ☐ Full Knock Down for Palletized Field Assembly (Electrical & Mechanical Contractor to provide manpower & Time)

- Panel Deflection (Max): (Select One)
- ☐ L/240 (Typical Standard for up to 6" TSP)
- ☐ L/200 (Typical for 8" TSP)
- ☐ L/240 @ 10" of total static pressure

Drain Pans

- Drain Pans to be provided in the Following Sections:
  - ☐ Filter Sections
  - ☒ Heating Coil
  - ☒ Cooling Coils
  - ☐ Fan Section (Not applicable as units are "Blow Thru" design)

- Drain Pans Minimum Gauge:
  - ☒ 16 Gauge (Typical Modular Factory AHUs)
  - ☐ 14 Gauge
  - ☐ Galvanized
  - ☐ 304 Stainless Steel
  - ☒ 316 Stainless Steel

- 316 Stainless Steel Drain Pan Length Downstream of Coil Face: (Select One)
  - ☐ 6”
  - ☐ 12”
  - ☒ 18” (Generally does not add to overall unit airstream length because of Fan distance to coil face requirements)
- Drain Pan options and accessories
  - ☒ Double Wall Construction (Foam Injected and sealed)
  - ☐ Insulate Intermediate Drain pans
  - ☐ Condensate connections on both sides of drain pan (Units with CFM over 50,000)
  - ☐ Wash Down interface with interior wall construction (Might consider for OR’s)
  - ☒ Industrial Fiberglass Non-Skid Industrial grating for walk on access section where walk-in is required (Typical 1” x1” x 1” on support rail to keep grid out of condensate pan water)

- Thermal Break: (Details to Follow)
  - ☐ Option 1 (None) (Standard Modular Factory AHUs)
  - ☒ Option 2 (Gasketed Thermal Break) (Typical Semi-Custom AHUs)
  - ☐ Option 3 (Full Thermal Break with High Density Polymer Block Fillers) (Costly Less Common Full Custom AHUs)

- Insulation: (Select One)(Foam filled wall thickness preferred by HMH; Depends on the required wall thickness and whether or not outdoor mounted unit)
  - ☐ Fiberglass Bats, R-8.4, 2” Thick, 3lb. density (Do not want, requires heavier gauge panels construction)
  - ☐ Fiberglass Bats, R-12.6, 3” Thick, 3lb. density (Do not want, requires heavier gauge panels construction)
  - ☐ Fiberglass Bats, R-16.8, 4” Thick, 3lb. density (Do not want, requires heavier gauge panels construction)
  - ☒ Foam Filled R-13.5, 2” Thick, 3 lb. density, Injected Foam UL 94 HV1 “Fire Rated” (Typical)
  - ☒ Foam Filled R-20, 3” Thick, 3 lb. density, Injected Foam UL 94 HV1 “Fire Rated” (Cost Break Point)
  - ☒ Foam Filled R-26, 4” Thick, 3 lb. density, Injected Foam UL 94 HV1 “Fire Rated” (Semi-Custom)

Fans

- Configuration/Arrangement (Depending on Project Requirements)
  - ☒ Draw-Thru
  - ☒ Blow-Thru
  - ☒ Single Fan only allowed on units less than 2500 cfm
  - ☒ Multiple Fan (Fan Array or Fan Wall) (Need separate motor overloads and disconnects to be provided by the VFD manufacturer per specifications)
  - ☒ Direct Drive (Preferred plenum fans, utilize 2 or more FanWalls with premium plus high efficiency TEFC or TEAO invertor rated motors, with ECMs or VFDs

☐ Belt Drive (HMH Criteria Eliminates belt drive fans if direct drives are available with VFD or ECM)

☒ Plenum Fan (Fan Wall) (Need separate Overloads, current sensing relays and motor disconnects for each fan)

☐ Housed Fan

- Fan Redundancy
  - ☐ None (Single Fan)
  - ☒ Multiple Fans
  - ☒ N-1 (Multiple Fans with Redundant capacity; N fans are selected to meet Design airflow and "WG TSP; fans are selected to operate in N-1 Mode and will ramp up RPM to meet the Design airflow and "WG TSP. Fan motor size and VFD size is determined by the BHP required at the N-1 selection operating point.)

- Fan Wheel Class (Select One) (ECM fans have some "WG TSP limitations, (4 to 5 "WG limited TSP polymeric wheel ECMs design which are rated by the fan manufacturer to withstand UVC light are acceptable; if not rated by fan manufacturer for UVC light then GPS I-Bar NPI System shall be used to keep CH coil clean of microbiological materials. Note the 6" and Higher " WG TSP ECM fans are generally made of welded aluminum. All direct drive variable speed fans must have the following included in the submittal each type of fan motor included with number of poles and nominal rated RPM, Minimum and maximum rated motor RPM, maximum rated fan blade - wheel RPM, design fan wheel Minimum and Maximum RPM vs BHP and a Completed Fan schedule that shows what each fan of N fans each are doing SA CFM airflow, "WG TSP, BHP and RPM as well as what N-1 fans are doing SA CFM airflow, "WG TSP, BHP and RPM.)
  - ☐ Class 1 (Typical FC Modular Factory AHU Low Pressure Units up to 2.5" TSP; steel riveted wheel and blades)
  - ☐ Class 2 (Typical BI or AF Metal wheel not necessarily welded)
  - ☒ Class 3 (Typical Aluminum Welded or Molded Composite Material Fan Wall)

- Fan Wheel Construction
  - ☐ Galvanized with mechanical fasteners holding the blades
  - ☐ Galvanized with mechanical fasteners holding the blades and "Coated"
  - ☒ Aluminum with welded blades
  - ☐ Steel with welded blades
  - ☒ Polymer Wheels with UV Rated Materials Fan manufacturer must furnish letter stating the fans polymeric components are UVC impervious and warranty the fans lifetime against UVC failure)
  - ☐ Class 3 (Typical Aluminum or steel Welded or Molded Composite Material Fan Array or FanWall)

- Fan Isolation
  - ☒ Rubber Pads (for applications with FanWall) + Fan balance to AMCA 204-96 Category BV-5 (Provided by the Mechanical Contractor)
  - ☐ 1 to 2" deflection Spring Isolators + Fan balance to AMCA 204-96 Category BV-3 (Requires Thrust restraint and flexible connectors)

- Fan Accessories
  - ☐ Inlet Screens (Inexpensive Good Idea, do not need if BDDs are used)
  - ☒ Powder Coated or Aluminum Inlet cones/bells on all fans (Galvanized or Painted are not acceptable)
  - ☒ Gravity Automatic Backdraft Dampers (Net Zero System Effect)

☒ Motor removal rails (Typical all units excluding Hoist on units with fans over 15 HP or 100 Pounds of weight)

☒ Integral fan discharge silencer (Typical for FanWall units)

Coils

- Cooling Coil Casing
  - ☐ Galvanized Casing 16ga
  - ☐ 304 Stainless Steel 16ga (Typical)
  - ☒ 316 Stainless Steel 16ga (Coastal)
  - ☐ 304 Stainless Steel 14ga Cost Break Point
  - ☐ 316 Stainless Steel 14ga

Heating Coil Casing
- ☐ Galvanized Casing 16ga
- ☐ 304 Stainless Steel 16ga
- ☒ 316 Stainless Steel 16ga
- ☐ 304 Stainless Steel 14ga
- ☐ 316 Stainless Steel 14ga

Tube wall and fin thickness with AHU Manufacturer for best selections. (all units shall have a minimum of 8 row 8 FPI Cooling Coils with out exception)

- Cooling Coil Fins (Max 8 R 10FPI single coil)
  - ☒ 0.008" Fin Thickness Aluminum
  - ☐ 0.010" Fin Thickness Aluminum
  - ☐ 0.006" Fin Thickness Copper
  - ☐ 0.080" Fin Thickness Copper
  - ☐ 0.060" Fin Thickness Copper (1/2" tube)

Heating Coil Fins
- ☒ 0.008" Fin Thickness Aluminum
- ☐ 0.010" Fin Thickness Aluminum
- ☐ 0.006" Fin Thickness Copper
- ☐ 0.080" Fin Thickness Copper
- ☐ 0.060" Fin Thickness Copper (1/2" tube)

Tube wall and fin thickness with AHU Manufacturer for best selections

- Coil Tubes
  - ☐ ½" Diameter, 0.017" Tube Wall Thickness
  - ☐ ½" Diameter, 0.025" Tube Wall Thickness
  - ☐ 5/8" Diameter, 0.020" Tube Wall Thickness
  - ☒ 5/8" Diameter, 0.025" Tube Wall Thickness
  - ☐ 5/8" Diameter, 0.035" Tube Wall Thickness
  - ☐ 5/8" Diameter, 0.049" Tube Wall Thickness
  - ☐ Least expensive that meets the scheduled performance

- Coil Accessories
  - ☐ Heresite Coatings (OA or Corrosive)
  - ☐ Epoxy Coatings (OA or Corrosive)
  - ☐ Balance and Shut-Off Piping Package (Not Common, added Cost Point)
  - ☒ Fresh-Aire APCO UV Lights on downstream side of cooling coil only Teflon coated 2-year UV lamps with multi-voltage life time warranty power supply. Where more than 8 row coil or more than 10 FPI used provide on both sides of the cooling coil
  - ☐ GPS I-Bar Needle Point Ionization System on upstream side of cooling coil only High VOC Applications
  - ☐ GPS I-Bar Needle Point Ionization System on upstream side of Carbon Filters Only High VOC applications
  - ☐ Leaving Air Temperature averaging sensor (factory installed, or contractor installed)
  - ☐ Drain and Vent connections on coil header (Needed to drain and vent air and water from coils)
  - ☐ Type K Copper Headers

Motors

- Motors
  - ☐ Premium Efficiency (Inverter Duty)

- ☒ VFD Rated, Premium Plus High Efficiency larger than 3 HP
- ☒ Totally Enclosed Air-Over (TEAO) or (TEFC)
- ☒ External motor Shaft & Bearing Grounding System Brush accessible without motor disassembly Typical for VFD units with colloidal silver conductance rings on motor shaft
- ☒ ECMi Motor (ECMi motor/fan/controller units must be stocked in sizes for quick ship replacement within 3 working Days). ECMI fan/motor/controller unit must be individually mapped via dynamometer for the systems to work properly and their BHP at design conditions must be known and included in the scheduled submittals along with fan curves. ECMi three phase and single phase motors have permanent magnet poles and the rotor winding give the electronic controllers and sensors the ability to converts the) to 10 VDC potentiaometer signal for speed control via built in sensors and algorithms to sense and control rotor RPMs Torques, FLA, etc. required to operate the DC voltage motor and provide with 5% plus or minus accuracy CFM Air Flow. The ECMi fan motor manufacture must provide the algorithm to the DDC BAS in order for the translation of this into usable input to BAS. Some ECM I motor manufacturers have developed Modbus, LON or BACnet translators that make this easier to provide feedback info to BAS.

Variable Frequency Drives (VFD's) are to be provided by Mechanical Contractor with installation by Electrical Contractor with factory startup. ECMi fan/motor/controllers must have the Modbus, LON or BACnet translator or the manufacturer must furnish the algorithm information to DDC BAS contractor for incorporation of required feedback to BASs

Fans shall be direct drive variable speed generally BI or AF SWSI plenum fans to the greatest extent possible. The decision to go with VFD or ECMi motors is significant and must be approved in writing by HMH Engineering and FMS prior to start of selection and documented in the project Decision Tree by the EOR.

1. Fans shall be single fan double width, double inlet, backward-inclined or airfoil type centrifugal fan wheel plenum plug direct drive fans with VFDs. VFDs will be furnished with multiple contactor manual bypass where single fan units are furnished. Fan wheels shall be backward inclined airfoil blades as indicated on the Drawings. All plenum type plug fans with direct drive provide matching VFDs as specified herein. All fans that require thrust restraint springs and adjustments shall have dual springs and adjustable all thread rods and spring locations.
2. Critical AHU's defined as units having HEPA final filtration shall have "Fan Wall" or multiple Fan Arrays with two to four or more plenum type plug fans with direct drive provided with matching VFD's as specified herein. Fan selection shall be such that all Fans/Motors/VFDs will run during normal unit operation to meet unit scheduled design airflow CFM @ required unit TSP " WG, but in the case of a Fan/Motor/VFD failure the fan motorized isolation back-draft dampers shall close and the other remaining Fans/Motors/VFDs shall ramp up to meet unit scheduled design airflow CFM @ required unit TSP "WG, Maximum fan hertz overdrive operation shall be limited to 85 hertz, unless written permission is obtained prior to selection of the unit. Where fan motors normal operation point requires higher than 55 to 60 hertz at normal design operation airflow CFM @ design TSP "WG, then each of the multiple fan motors must be provided with a separate VFD. Where fan arrays (More than 1 one fan) are utilized an internal integral monorail lift system shall be provided to change out the motor and fan wheel assemblies. Fan arrays shall have a motorized inlet isolation backdraft air damper with ultra-low leakage characteristics furnished and installed for each fan wheel.
3. Exact configuration of VFD with or without 3 contactor manual bypass and or use of ECMs shall be verified in writing with HMH Design Engineer before pricing is released to Contractors for bid purposes prior to start of design and shall be documented in the FMS D&C Coordination Checklist Decision Tree.
    - VFD's Yaskawa Z-1000U only
        - ☐ Unit Mounted By-Pass Switch
        - ☒ Unit Mounted Rectifiers
        - ☒ BAS Communication Card (BACnet)
        - ☐ Line Filters
        - ☐ Single VFD per Fan Array

- ☐ Dual VFD's per Fan Array
  - ☐ (2) @ 100% rated VFD's
  - ☐ (2) @ 50% rated VFD's
- ☐ Dual VFD's per air handler with integral auto change over panel (Costly)
- ☒ Single VFD per motor (one for every motor/fan assembly)
- ☐ Factory mounted and wired
- ☐ Field mounted and wired
- ☐ Start-up service and 1 year labor warranty
- ☐ Single Fan J-Box
- ☐ Multiple Fan Motor Overload Panel with Individual Disconnects and HOA Rotary (Typical for FanWall)
  - ☐ Current Sensors with Status Indication
  - ☒ Current Sensors with remote output signal (Typical for FanWall)

Filters

1. FMS Operations utilizes a specific filter replacement service that is contracted to supply all required filters, filter leakage, filter loading (pressure drop) monitoring, testing and replacement for all Air Handling Units (AHU), Fan Coil Units (FCU), Computer Room Air Conditioning Units (CRAC) and Fan Powered Box (FPB) VAV/CAV Terminals.
2. FMS Operations Manager must be notified in writing about the specific filters required for each project by the design engineer and then confirmed by the Mechanical Contractors approved equipment manufacturers for equipment being furnished. See the itemized cost schedule form that breaks down the pre-filter and final filter requirements, % efficiency, number and size of filters required for each type of unit specified within the project.
3. Contractor shall include in this project the "Basis of Design" bid cost using the of the quantity and number of the various types of filters at the Filter Service replacement company listed cost and shall include all freight for delivery of the filters to the job site in a timely manner.
4. Contractor furnished construction filters of proper type, size and edge sealing characteristics shall be in place prior to start-up and operation of HVAC systems, clean new filters of specified type shall be installed just prior to TAB and final Commissioning work as required by specifications.
5. If filter loading as determined by the filter replacement service company that is contracted to supply all required filters exceeds permissible design levels at time of substantial completion and acceptance, then the Contractor will pay the filter service company to furnish and install new clean filters at no additional charge to the Owner.
6. Approved Vendor: Filter Technology Company, Inc. Contact Jerry Wittman @ Phone 713-910-1395, Fax 713-910-0071, 1-800-874-1045, Cell 832-643-1395, e-mail: jwittman@filtertexas.com.
7. Contractor must submit a cost for the Basis of Design Filters before being allowed to submit an alternate filter manufacturer alternate proposal. Owner reserves the right to accept or refuse all alternate proposals. The contractor may submit an alternate proposal for filters with an itemized cost schedule form that breaks down the pre-filter and final filter requirements, % efficiency, number and size of filters required for each type of unit specified within the project. Minimum number of two sets of all types of filters, except HEPA filters will be required.

- Pre-Filters 4" thick MERV 11 Filters are HMH Design Standard)
  - ☒ Face Load Filter Racks
  - ☐ Side Load Filter Racks
  - ☐ Merv 8, 2" thick, 30% Pleated Filter with Cardboard Frame
  - ☐ Merv 8, 2" thick, 30% Pleated Filter with Metal Frame and replaceable media
  - ☐ Merv 11, 4" thick, 65% Pleated Filter with Metal Frame, retaining springs and sealing gaskets (Typical HMH Basis of Design Requirement)

☒ Merv 11, 4" thick, 65% Pleated Filter 50% Bonded Carbon/50% Potassium Permanganate with Metal Frame, retaining springs and sealing gaskets (Typical HMH Basis of Design Requirement for TVOC Containment)
☐ Merv 13, 4" thick, 65% Pleated Filter with Plastic Frame

- Final-Filters

☒ Face Load Filter Racks
☐ Crank operated filter clamping mechanism for HEPA shall include pressure bars with pre-loaded springs that exert a sealing force of 1,400 lbs. per full width filter and 1,050 lbs. per half width filter, applied as an even, uniform load along at least 80% of the top and bottom of each filter frame.
☐ Merv 14, 6" thick 65% Cartridge Filter
☐ Merv 14, 6" thick 95% Cartridge Filter
☒ Merv 14, 12" thick 95% Cartridge Filter (Typical HMH Basis of Design Requirement)
☐ Merv 14, 12" thick, 95% Pleated Filter 50% Bonded Carbon/50% Potassium Permanganate with Metal Frame, retaining springs and sealing gaskets (Typical HMH Basis of Design Requirement for TVOC Containment)
☐ Merv 17, 12" thick 99.995% HEPA Filter (Typical HMH Basis of Design Requirement)
☐ Merv 17, 24" thick 99.5% HEPA Filter
☒ Two total sets required (One extra set of media for entire unit) (All filters, except HEPA Filters)

Accessories

☒ Test Ports in access doors
☒ Unit mounted Air Flow Stations (as noted in the schedule)
☐ Smoke Detectors (Not Common Usually duct mounted existing)
☒ Internal Marine LED lights in Coil and Fan access sections only wired to single switch
☒ Electrical wiring harness from all motors to exterior junction box (Typical FanWall)
☒ Empty control wiring conduit factory installed to all sections of unit (Low Cost)
☒ Start-up service with written report per unit and 1-year labor warranty (Typical FanWall) (Required for Green Field Construction)
☐ Factory Testing (Specification to follow) (Units to be field inspected by HMH and Bruce Colborne)
☒ 1st year parts and labor by the manufacture
☐ Full Wash-Down unit construction with sub floor drains
☒ Drain pan walk on grates on units large enough for personnel to stand inside unit (Not costly need elevated grid support points to keep grid out of water)
☒ Filter Gauges across all filter rack with "Digital Readout and Alarm output signal for BAS to pick up"
☐ Single point power connection (Less Common)
☐ Convenience outlet (Less Common unless outdoor or roof mounted)
☒ Field Inspections and Reports by the equipment manufacturer including the following:

a. Housing inspection confirming:
   1. No external holes by contractor or controls installer
   2. Proper assembly and sealing of all joints
   3. Correct adjustment on access door hinges and latches
   4. Proper sealed to supply and return duct connection
b. Unit performance confirming:
   1. Proper condensate trap height
   2. Correct chilled and hot water piping connections
   3. Correct filters installed and sealed
   4. Submittal cross check on components

5. Inspection of all accessories

Acceptable Manufacturers

Modular Factory Air Handlers (Acceptability of any listed or non-listed manufacturer's is based on meeting the HMH Design Criteria, and Master Specifications, as well as meeting or exceeding the scheduled unit capacities & other noted required criteria & accessories. Verification of Dimensional fit within the MER space allocated and/or available to install the AHU unit within. The units may require shipping splits or complete take down to be able to be installed. Verify in writing with HMH Design Engineer and FMS prior to start if design and release for contractor bidding. Document in the D&C decision Tree. Be aware that you as the Vendor have to meet or exceed the specified requirements and scheduled capacities. Leaking access doors, exterior atmospheric condensation and displaced fan isolation bases are the full and sole responsibility of the manufacturer. The factory has to supervise the installation of the unit components when shipped in modular shipping splits and perform final inspection to certify in writing that the units have been correctly installed and set up by the installing contractor and provide the signed factory Start-up AHU checklist for each unit.)

- ☒Trane Performance Climate Changer
- ☐ Carrier 39MN Aero Indoor or 39MW Aero Outdoor
- ☐ York Solutions
- ☐ Daikin Vision Plus
- ☐Temtrol

Semi-Custom/Custom Air Handlers (Acceptability of any listed or non-listed manufacturer's is based on meeting the HMH Design Criteria, and Master Specifications, as well as meeting or exceeding the scheduled unit capacities & other noted required criteria & accessories. Verification of Dimensional fit within the MER space allocated and/or available to install the AHU unit within. The units may require shipping splits or complete take down to be able to be installed. Verify in writing with HNM+MH Design Engineer prior to start if design and release for contractor bidding. Document in the D&C decision Tree.)

- ☒ Nortek Air Systems (Temtrol, Governair, Huntair)
- ☐ York Semi-Custom/Custom
- ☐ Energy Labs
- ☐ Haakon
- ☐ Carrier 39 CC Semi-Custom/Custom

VFD's

- ☒ Yaskawa (HMH Z1000Uwith BACnet Card and HMH Standard Setup)

Motors (TEFC or TEAO Premium Plus High Efficiency Invertor Rated over 3 HP)

- ☒Baldor with (External Shaft Grounding Ring or equal)

Dampers (Ultra Low Leakage)

- ☒ Ruskin
- ☒ Arrow
- ☒ Tamco

UV Lights (Use of UVC lights or GPS I-Bar NPI shall be verified in writing by HMH design Engineer prior to start of design and release to bidders for pricing and documented in the D&C Decision Tree.)

- ☒ Fresh-Aire APCO UV Lights on downstream side of cooling coil only Teflon coated 2 year UV lamps with multi-voltage life time warranty power supply. Where more than 8 row coil 10 FPI used provide on both sides of the cooling coil (HMH Design Standard when UVC is utilized) Approved Vendor: Filter Technology Company, Inc. Contact Jerry Wittman @ Phone 713-910-1395, Fax 713-910-0071, 1-800-874-1045, Cell 832-643-1395, e-mail: jwittman@filtertexas.com.
- ☒ GPS I-Bar Needle Point Ionization System on upstream side of cooling coil only High VOC Applications

☐ GPS I-Bar Needle Point Ionization System on upstream side of Carbon Filters only High VOC applications

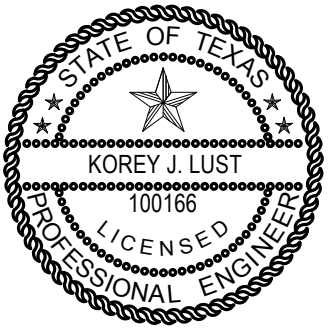
8. GPS I-Bar Needle Point Ionization systems shall be located so as to discharge on the entering face of the cooling coil. Configure system in accordance with the GPS I-Bar Needle Point Ionization manufacturer's recommendations for optimal coverage of the entire cooling coil face.
9. Provide hard-wired on-off switch on unit exterior and identify with permanent signage to distinguish switch from switching for interior light fixture for the GPS I-Bar Needle Point Ionization compartment shall be provided to de-energize the GPS I-Bar Needle Point Ionization. The GPS I-Bar shall be internally wired for complete automatic restart and reset of I-Bar Needle Point Ionization upon loss of power and subsequent restoration of power connection.

Ionization

☐ GPS I-Bar Needle Point Ionization System (HMH Basis of Design)

Air Flow Stations (HMH design Standard)

☒ Ebtron Gold Standard



THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY:

Digitally signed by Korey Lust
Date: 2019.04.30 11:25:23-05'00'

E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068