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USACE / NAVFAC / AFCEC **UFGS-23 74 33 (May 2024)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2024
****

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05/24

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SECTION 23 74 33

DEDICATED OUTDOOR AIR SYSTEMS (DOAS)
05/24

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NOTE: This guide specification covers the requirements for dedicated outdoor air systems (DOAS) where ventilation airflow exceeds 354 L/S 750 cfm per UFC 3-410-01, as calculated by ASHRAE 62.1 and/or air balance requirements. "DOAS" in this specification refers to the air handling piece of equipment and internal components only. Other components such as ductwork and sensors should be specified elsewhere.

Show cooling and dehumidification requirements, capacity, mounting details, power connections, etc. on drawings or schedule.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This note applies to this whole specification section. Refer to applicable UFCs for requirements on how to size and design DOAS and all components; including but not limited to UFC 3-400-02 Design: Engineering Weather Data, UFC 3-401-01 Mechanical Engineering, UFC 3-410-01 Heating, Ventilating, and

Air Conditioning Systems, and UFC 3-410-02 Direct Digital Control for HVAC and Other Building Control Systems.

****

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NOTE: This specification uses tailoring options to select the required protocol for control system interfaces for equipment. These tailoring options are:

1. BACnet Only
2. LonWorks Only
3. BACnet or LonWorks (this will require the unit match the building control system)

DESELECT all three if not requiring control system interfaces. Otherwise SELECT exactly ONE of these tailoring options.

You have currently SELECTED the following option:

BACnet Only
LonWorks Only
BACnet or LonWorks

If more than one item appears between the dashes above, you have included more than one control system interface tailoring option and need to DESELECT all but one. If there is no text between the dashes above, you have not included any control system interface tailoring option. Select ONE of the control system interface tailoring options for inclusion.

Service Tailoring Option

This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "NAVY ACCEPTANCE ENGINEER" tailoring option that is used on Navy projects which have an Acceptance Engineer. There is a "Service Generic" tailoring option that can also be used when none of the other services tailoring options apply. Only ONE of the five tailoring options related to the services should be used. You have currently included the following option:

AIR FORCE
ARMY
NAVY
NAVY WITH ACCEPTANCE ENGINEER
SERVICE GENERIC

If more than one item appears between the dashes above, you have included more than one service tailoring option and need to DESELECT all but one. If there is no text between the dashes above, you

have not included any service tailoring option. Select ONE of the service tailoring options for inclusion.

****

PART 1 GENERAL

****

NOTE: Coordinate the use of this specification with other sections, as appropriate, in order to specify a complete HVAC built-up system.

****

Submit equipment and performance data for each DOAS consisting of use life, total static pressure, all entering and leaving temperatures of each component, fan curves, provide psychrometric chart with processes shown for both summer and winter conditions, power ratings, capacity ranges, face area classifications, rotational velocities, controls instrument locations [with recommended installation locations], [and][all information shown on the equipment schedule on the design drawings][and][_____].

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

[Design and construction must comply with current applicable Host Nation codes and standards. In case of conflicting U.S. and H.N. codes and standards, the most stringent must apply, unless otherwise specified by the applicable Bilateral U.S./H.N. Agreements.

] AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99 (2016) Standards Handbook

AMCA 201 (2002; R 2011) Fans and Systems

AMCA 204	(2005; R 2012) Balance Quality and Vibration Levels for Fans
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 540	(2015) Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units
AHRI 920 I-P	(2020) Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units
AHRI 921 SI	(2020) Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units
AHRI 1060 I-P	(2014) Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 370	(2015; Addendum 1 2016) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 640	(2005) Performance Rating of Commercial and Industrial Humidifiers

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2022) Ventilation for Acceptable Indoor Air Quality
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers
ASHRAE 84	(2024) Method of Testing Air-to-Air Heat/Energy Exchangers

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1884	(2003) Fibrous Glass Duct Construction Standards, 7th Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-01	(2022; with Change 3, 2024) DoD Building Code
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Sep 2024) UL Standard for Safety Power Ventilators
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Compressor; G, [_____]

Coils; G, [_____]

Controls; G, [_____]

Unit Cabinet; G, [_____]

Casing; G, [_____]

Air-Cooled Condenser; G, [_____]

Evaporative Condenser; G, [_____]

Installation Drawings; G, [_____]

SD-03 Product Data

Equipment and Performance Data; G, [_____]

Air-Conditioning Systems; G, [_____]

Compressor; G, [_____]

Coils; G, [_____]

Fans; G, [_____]

Controls; G, [_____]

Unit Cabinet; G, [_____]

Casing; G, [_____]

Air Filters; G, [_____]

Air-Cooled Condenser; G, [_____]

Evaporative Condenser; G, [_____]

Energy Recovery Devices; G, [_____]

[Humidifier; G, [_____]

] SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G, [_____]

System Performance Tests; G, [_____]

SD-07 Certificates

List of Product Installations

Manufacturer's Warranty; G, [_____]

[Coil Coating Warranty; G, [_____]

] SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

****
Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).
****

Operation and Maintenance Manuals, Data Package 2

1.3 RELATED DOCUMENTS

****
NOTE: If the following sections are not included in the project specification, insert applicable requirements and delete the following paragraphs as needed.
****

[Section 01 45 00 QUALITY CONTROL applies to work specified in this section.

][Section 01 91 00.15 BUILDING COMMISSIONING applies to work specified in this section.

][Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT applies to work specified in this section.

][Section 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL applies to work specified in this section.

][Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC applies to work specified in this section.

][Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC applies to work specified in this section.

][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC applies to work specified in this section

][Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC applies to work specified in this section.

][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS applies to work specified in this section.

][Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS applies to work specified in this section.

][Section 23 23 00 REFRIGERANT PIPING applies to work specified in this section.

][Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in

this section.

][Section 23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT applies to work specified in this section.

][Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to work specified in this section.

]1.4 QUALITY CONTROL

Submit a list of product installations of each DOAS showing a minimum of five installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Provide a list that includes the purchaser, address of installation, service organization, and date of installation.

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5 year period.

1.4.2 Service Support

The equipment items must be supported by service organizations. Submit a certified list of a minimum of three qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract within [24][48][_____] hours.

1.4.3 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer. "Authority having jurisdiction" must be in accordance with the applicable year of UFC 1-200-01 DOD BUILDING CODE.

1.4.5 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned

property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.4.6 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE AND HANDLING

Handle, store, and protect equipment and materials to prevent damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Additionally, cap or plug all pipes until installed. Replace damaged or defective items.

1.6 ELECTRICAL WORK

****

NOTE: Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting interferes with other electrical equipment and circuits and when recommenced by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 INTERIOR ELECTRICAL SYSTEMS.

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type,

fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

****
NOTE: Coordinate this with paragraph OPERATION AND MAINTENANCE TRAINING.
****

Furnish the services of competent instructors to give full video recorded instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section.[When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.]

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

****
NOTE: The following requirement is intended to

solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors. Contractor and manufacturer are responsible for verifying equipment, including any additional parts such as controls devices and other equipment requiring access, fits in the space provided. The Government review does not relieve contractor from delivering the product that meets minimum capacity and mandatory efficiency requirements to meet all codes and standards.

1.9 WARRANTY

Submit the manufacturer's warranty for the unit.

[Submit the coil coating warranty.] Provide unit with the [Manufacturer's Standard Warranty.][[1 year][2 year][5 year][10 year][_____ year]manufacturer's warranty.][Provide [compressors][and][gas heat exchangers] with the[Manufacturer's Standard Warranty.][[1 year][2 year][5 year][10 year][_____ year]manufacturer's warranty.]]

PART 2 PRODUCTS

2.1 TYPES

****

NOTE: Designer must, at a minimum, comply with applicable year of ASHRAE 90.1 and ASHRAE 55 for equipment efficiencies, energy recovery effectiveness, thermal comfort, etc. All applicable design requirements should be incorporated by the designer into the contract documents.

****

****

NOTE: Coordinate with paragraph FANS and paragraph COILS.

****

Provide [single-zone draw-through type][or][single-zone blow-through type][or][multizone blow-through type][blow-through double-deck type][blow-through triple deck type] units as indicated. Units must include fans, coils, airtight insulated casing,[energy recovery devices,][required controls devices for temperature and humidity control,][prefilters,][secondary filter sections,][and][diffuser sections where indicated,][air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated,[mixing box][combination sectional filter-mixing box,][[pan][drysteam][spray type] humidifier,] vibration-isolators, and

appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity and efficiencies indicated. Provide air handling unit that is rated in accordance with [AHRI 920 I-P] [AHRI 921 SI] [AHRI 430] [_____] and AHRI certified for cooling.[Protect outdoor air coils from incidental contact to coil fins by a coil guard. Coil guard must be constructed of cross wire welded steel with PVC coating.]

2.2 UNIT CONSTRUCTION

2.2.1 Unit Cabinet

Units must have a leakage rate not to exceed 1 percent of supply air volume to [2][2.5][_____] kPa [8][10][_____] inches water gauge static pressure in either positive or negative pressure tests. Manufacturer must provide test data confirming cabinet construction can meet the requirement. Indoor cabinets must be suitable for the specified indoor service and enclose all unit components. Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

****
NOTE:
Class A total static pressure to 750 pascals 3 inches water gauge.

Class B total static pressure of 750 to 1375 pascals 3 to 5.5 inches water gauge.

Class C total static pressure over 1375 pascals 5.5 inches water gauge.
****

2.2.1.1 Class A and Class B Cabinets

****
NOTE: Select the following paragraph for AMCA Class A and Class B cabinets.
****

Provide an AHU cabinet suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span before acceptance. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Fabricate the enclosure from continuous hot-dipped-galvanized steel no lighter than 0.91 millimeter 20 gauge thickness, to match the industry standard. Provide mill-galvanized sheet-metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural-steel that is hot-dip-galvanized or primed and painted. Corrosion-protect cut edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make entire cabinet floor and ceiling hot-dipped-galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.1.2 Class C Cabinets

****
NOTE: Select the following paragraph for AMCA Class C cabinets.
****

Provide an AHU cabinet that is suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when the fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span before acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Provide the enclosure that is fabricated from mill-galvanized or primed and painted carbon sheet steel. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion-protect edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make the entire cabinet floor and ceiling hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.2 Casing

Provide the following:

a. [Casing sections[[single][50 mm 2 inch double] wall type][as indicated], constructed of a minimum 1.3 mm 18 gauge galvanized steel, or 1.3 mm 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.][Inner casing of double-wall units that are a minimum one mm 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304.]Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.

b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.

c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 1.3 mm 18 gauge outer and one mm 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet

steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 300 mm 12 inches wide by 300 mm 12 inches high. Access doors must be a minimum 600 mm 24 inches wide, the full height of the unit casing or a minimum of 1800 mm 6 foot, whichever is less.[Install a minimum 200 by 200 mm 8 by 8 inches sealed glass window suitable for the intended application, in all access doors.]

Access doors must be installed to open against the greatest pressure relative to air pressure on each side of access door. Provide 25 mm 1 inch diameter test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement across internal components to limit unnecessary or unauthorized access inside the unit.

d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 1.4 mm 16 gauge[stainless steel][corrosion resisting sheet steel conforming to ASTM A167, Type 304], conforming to ASHRAE 62.1. Galvanized steel pans are not acceptable. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage.[When two or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover.] Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing. Provide[40 mm 1.5 inch][_____] minimum drain pan connection[as indicated].

e. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 25 mm 1 inch thick, 24 kg/cubic meter 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 50 mm 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.

f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors [and casing sections].

g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.

h. A latched and hinged inspection door, in the fan, filter and coil sections. Plus additional inspection doors, access doors and access sections [_____][where indicated].

2.2.3 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.2.4 Diffuser Sections

Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [2][_____] kPa [8][_____] inches water gauge and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream[coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.2.5 Roof Curb

****
NOTE: Roof curb must be in accordance with the Hurricane, Seismic and Wind requirements associated with the site.
****

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The roof curb must be a minimum of [_____] mm inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.2.6 Corrosion Protection

****
NOTE: Higher Corrosion Protection is required in high-humidity locations and coastal environments.
****

****
NOTE: Refer to UFC 1-200-01 DoD Building Code, Chapter 4 for additional requirements for corrosion protection.
****

Provide the interior of the unit with corrosion protection which must be capable of withstanding at least 3000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with

ASTM B117 test procedure. Air tunnel, fans and dampers must all include the corrosion protection. Provide all coils in contact with outside air a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Confirm corrosion durability through testing to no less than 3000 hours salt spray per ASTM B117. Coated coil must receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating is not required on coils utilizing copper tubes and copper fins.

2.2.6.1 Remote Outdoor Condenser Coils

Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprised of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. Maintain the coating thickness between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, treat to permeate immersion rinse and spray. Where the coils are subject to UV exposure, apply UV protection spray treatment comprising of UV-resistant urethane mastic topcoat. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process must be such that uniform coating thickness is maintained at the fin edges. Comply with the applicable ASTM Standards for the following:

a. Salt Spray Resistance: [500][1,000][3,000][6,000][10,000][_____] hours (ASTM B117)

b. Humidity Resistance (Minimum 1,000 Hours)

c. Water Immersion (Minimum 260 Hours)

d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)

e. Impact Resistance (Up to 160 Inch/Pound)

2.2.6.2 Exposed Outdoor Cabinet

****
NOTE: Recommend minimum salt-spray resistance of 3,000 hours unless specifically not required.
****

Casing Surfaces (Exterior and Interior): Protect all exposed and accessible metal surfaces with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness must be 2-4 mils and provide minimum salt-spray resistance of [500][1,000][3,000][6,000][10,000][_____] hours (ASTM B117) and [500][1,000][_____] hours UV resistance (ASTM D4587).

Provide outdoor cabinets with a roof panels sloped at a minimum pitch of 2 percent 1/4 inch per foot. The roof must overhang side and end panels by a minimum of 50 mm 2 inches.

2.2.6.3 Corrosion Protection for Coastal Installations

****
NOTE: Use this paragraph for Navy projects only.

Specify corrosion protection for exterior HVAC

equipment, including air handling units, heat exchanger coil surfaces, equipment casings, air-cooled water chiller coils, heat pumps, and air conditioning units, that is exposed to the weather within 8 km 5 miles of a sea (salt) water coast.

At these coastal locations, this corrosion protection is also required on HVAC equipment within buildings that are subject to the outside weather conditions. Specifically, equipment requiring protection is defined as the first HVAC equipment (excluding louvers) met by the outside air in the supply air ductwork system.

Specifier will survey the HVAC equipment market place, find and specify the manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations. Specify the various systems (utilizing the word "or") offered by three competitive equipment selections. This approach is by far less costly than specifying custom corrosion protection.

Manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations also vary with type and size of HVAC equipment.

After thorough investigation of the commercial market, determines manufacturer's standard off-the-shelve anti-corrosion options are not available for the selected equipment, contact the Mechanical Design Branch, NAVFAC LANT for consultation if the need for this protection is considered mandatory by the station.

For installations at MCAS Cherry Point and MCB Camp LeJeune, including New River, and installations at NAS Oceana including Dam Neck, specify corrosion protection for all outside, and specific inside HVAC equipment exposed to the weather. Follow the guidance specified in the criteria NOTE above.

****

[_____]

2.3 FANS

****

NOTE: Refer to UFC 3-450-01, Noise and Vibration Control for vibration criteria. Detail vibration isolation required on the drawings and include it in the appropriate schedule. Include any applicable noise criteria in appropriate equipment schedule on the drawings.

Design and detail ductwork near air moving devices to minimize system effect on the fans in accordance

with AMCA 201. Add system effect to the duct friction loss and indicate fan static pressure on drawings for the designed ductwork configuration.

Indicate the location of each duct smoke detector in the HVAC system and include the detectors on the schematic and associated ladder diagram. Provide duct smoke detectors according to NFPA 90A. Duct detectors are intended to shut associated air distribution fans and smoke dampers, if provided. Duct smoke detectors are not for use inside ducts where ambient temperatures exceeds 38 degrees C 100 degrees F.

When the building is equipped with a fire alarm system, connect the duct smoke detectors to the fire alarm control panel (FACP) for alarm initiation. Show wiring to the FACP for either new or existing fire alarm systems.

Fans with motors greater than 0.5 kW 3/4 hp must have automatic controls capable of shutting off fans when not required.

HVAC systems having a total fan system power exceeding 3.7 kW 5 hp must meet the provisions of ASHRAE 90.1. These include ASHRAE 90.1, Table 6.5.3.1, Fan Power Limitation:

For supply air volumes less than 9,400 L/s 20,000 cfm the allowable nameplate motor power for a constant volume fan is 1.9 kW/1000 L/s 1.2 hp/1000 cfm and for a variable volume fan is 2.7 kW/1000 L/s 1.7 hp/1000 cfm.

For supply air volumes of 9,400 L/s 20,000 cfm and greater the allowable nameplate motor power for a constant volume fan is 1.7 kW/1000 L/s 1.1 hp/1000 cfm and for a variable volume fan is 2.4 kW/1000 L/s 1.5 hp/1000 cfm.

****

a. Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150][140][120] percent of the connected driving capacity. Provide variable pitch motor sheaves for 11 kW 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed

pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

b. Each fan/motor assembly must be factory balanced to AMCA 204, [BV-5, Balance Quality Grade G1.0][BV-4, Balance Quality Grade G2.5][BV-3, Balance Quality Grade G6.3][Balance Quality Grade indicated on Drawings][_____] or better through entire operating speed range from minimum speed to maximum speed.

c. Mount fan/motor on [aluminum][galvanized-steel][or][powder-coated steel]base. Include base and vibration isolators in accordance with requirements indicated. Weld structural members to form a rigid base. Size and design the base construction to withstand the rigors of shipping and rigging. Include the base with lifting lugs or holes.

d. Each fan/motor assembly must be capable of lock-out/tag-out procedure without interrupting operation of other fans in air-handling unit. Fan wheel/motor assembly must pass through the air-handling unit access door servicing fans. Design and incorporate features to permit safe, rapid, and economical maintenance.

e. Include easily removable safety screens where fan inlet and outlet are exposed to maintenance personnel, including walk-in air-handling unit plenums.[Safety screens are not required on fan inlets and outlets with backdraft dampers.] Safety screens must be expanded-metal or wire screens, fastened to a flat bar perimeter frame. Screens must comply with OSHA requirements. Screens and frame must be constructed of aluminum, stainless steel, or powder-coated steel. Fasten screens to fan using removable and reusable hardware designed for easy removal by maintenance personnel.

2.3.1 Centrifugal Fan Arrays

****
NOTE: Determine sizing, number of fans, and redundancy requirements based on project needs.
****

Fan arrangement within fan array must produce a uniform airflow and velocity profile across air-handling unit air tunnel when measured[300 mm 12 inches][_____] upstream of fan inlet and[1200 mm 48 inches][_____] downstream of fan inlet. Remaining fans in array must continue to operate with one or multiple failed fans. A single mechanical, electrical, and control device failure must not result in a fan array available capacity of less than [33][_____] percent of air-handling unit total scheduled airflow capacity.

Each fan/motor assembly must be controlled through a variable-frequency controller, except for fans with electronically commutated (EC) motors having integral motor controls.[Include a dedicated variable-frequency controller for each fan/motor assembly in the fan array.][If fan array is served from a single variable-frequency controller, include a redundant variable-frequency controller with automatic switchover in event of primary variable-frequency controller failure.]

[2.3.1.1 Airflow Measurement

****
NOTE: Retain paragraph below to include airflow measurement as integral part of air-handling unit.
****

Each fan within fan array must include airflow measurement indication in L/s cfm. Include airflow totalization of all operating fans in fan array. Airflow measurement instrumentation must not restrict or deflect air travel through fan and must not impact fan air and sound performance. Include digital display of individual fan airflow and total fan array airflow on face of fan control panel. Include a 4- to 20-mA output signal for remote monitoring of total fan array airflow.

]2.3.1.2 Fan Array Control

****
NOTE: Retain one of the two paragraphs below.
****

[Include fan control panel with operator interface to control fan array locally through the fan control panel and to switch to control of fan array through a remote-control source. Local control must include on/off operation [and speed adjustment]for entire fan array and each individual fan/motor in fan array.

a. The component panel functional intent is manual operation of the fan array which is independent from the building automation system and automated control for the VFD / ECM motor by the building automation system. The component panel must provide all life safety and HVAC equipment safeties AHU shutdown interlocks wired to termination blocks.

b. The component panel must be designed using only ladder logic hard wired methods and must not execute any programmed logic specified in the sequence of operation which cannot be submitted in a ladder wiring diagram. The component panel must provide all relevant inputs and outputs necessary for the building automation system to execute the specified sequence of operation.

c. Coordinate component panel design with Division 25. Submit design for approval prior to construction of component panel. Laminate final approved as-built ladder wiring diagram and mount inside component panel door.

][Include fan control panel with control interface for remote control. Fan array on/off operation must be remotely controlled through a single hardwired digital output signal. Fan array speed must be remotely controlled through a single hardwired analog (4- to 20-mA) output signal.

]2.3.1.3 Fan Array Construction

Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of fan blades. Inlet cone must be a smooth hyperbolic shape. Inlet cone must be a single piece, constructed of aluminum or powder-coated steel. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable. Fan blades must be a true hollow airfoil shape, welded to backplate and wheel cone. Construct blades of aluminum, reinforced for AMCA fan class. Design blades to provide smooth airflow over all surfaces of blade. Construct fan hubs of aluminum with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or any other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Hubs must be keyed and setscrewed to motor shaft for positive attachment. Construct wheel backplates of aluminum. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum speed in AMCA fan class.

Fan must be direct drive, arrangement 4 in accordance with AMCA 99. Adjust wheel width and diameter to match motor speed while providing performance scheduled. Fasten fan wheel directly to motor shaft using a key in motor shaft and setscrew. Construct motor base and pedestal supports of [aluminum][galvanized steel][or][powder-coated steel].

2.3.1.4 Fan Array Motors

****
NOTE: Retain one of two bracketed paragraphs below and coordinate with Fan Motors paragraph.
****

[See Fan Motors for more information.

][Provide Electronically Commutated (EC), variable-speed, dc, programmable brushless motor with integral controller/inverter that operates a wound stator and senses rotor position to electronically commutate the stator. Controller must control motor speed either through manual adjustment locally at fan array control panel or through a remote 0- to 10-V-dc control signal. Coordinate motor mounting with driven equipment. Motor must be suitable for mounting with motor shaft in either horizontal or vertical position. Motor must be suitable for operation at site altitude and ambient temperature range. Electrical characteristics must be suitable for operation with field power source. Coordinate with electrical installer. Motor efficiency must comply with governing energy codes; [80][_____] percent or higher maintained throughout entire operating range. Power Factor must be [0.9][_____] or higher at full load. Service Factor must be 1.0 or higher.

a. Provide with zero to 100 percent variable speed control. Controller must be capable of synchronous speed rotation with no slip losses, gradual ramp-up to set point upon receiving a start signal, soft speed change ramps, overcoming reverse rotation without impact, and controlling airflow within 5 percent of set point regardless of static pressure.

b. Provide with thermal protection to automatically break electrical power to motor when temperature exceeds a safe value and automatically resets and restores power when temperature returns to normal range.

c. Bearings must be sealed and permanently lubricated ball bearings. Enclosure must be ODP or TEFC. Insulation must be Class B or Class F. Rotor must be permanent magnet with near zero rotor losses that operates independent of motor current.

d. Enclosure and Frame must be constructed of aluminum, painted steel, or stainless steel. End brackets must be cast aluminum. Shaft must be steel or stainless steel. Motor leads must be Pin or screw terminals. Provide with manufacturer's standard nameplates and paint.

]2.3.1.5 Fan Array Discharge

****
NOTE: Retain paragraph below to add fan discharge enclosure for physical separation between operating fans without sound attenuation.
****

[Include each fan in fan array with integral single-wall enclosure constructed of solid [aluminum][galvanized-steel][or][powder-coated steel]sheet. Enclosure must not increase fan array length beyond size indicated on Drawings. Enclosure must not add static pressure loss. Enclosure must provide a physical separation between operating adjacent fans to prevent negative performance.

] **********
NOTE: Retain paragraph below to add fan discharge sound attenuation. Consult manufacturers about expected sound attenuating performance.
****

[Include each fan of fan array with integral sound silencer enclosure to reduce the bare fan discharge sound levels by at least [8][15][_____] dBs through octave band frequencies from 125 to 8000 Hz. Enclosure must not increase the fan array length beyond size indicated on Drawings. Silencing enclosure must not add static pressure loss. Double-wall construction consisting of sound-absorbing insulation sandwiched between a solid metal outer skin and perforated metal inner skin. Outer skin material must be[Aluminum][Galvanized steel][Powder-coated steel]. Inner skin material must be [Aluminum][Galvanized steel][Powder-coated steel]. Insulation must be [Mineral fiber][mineral fiber wrapped in a tight woven fiberglass cloth or polymer sheet][or][fiber free]. Enclosure must provide a physical separation between operating adjacent fans to prevent a negative performance.

]2.3.1.6 Fan Array Accessories

****
NOTE: Retain paragraph below to include backdraft dampers on fans.
****

[Include each fan in the fan array with a backdraft damper at the fan [inlet][or][outlet] to prevent air circulation through a fan that is not

operating. Open backdraft damper when fan is operating and close when fan is not operating. Design backdraft damper assembly to operate with little to no static pressure loss with fan operating throughout entire operating range from design to minimum airflow. Add damper pressure loss to fan scheduled total static pressure. If pressure loss requires a change field electrical power, air-handling unit manufacturer must be responsible for associated cost of change. Fasten backdraft damper assembly to fan panel or enclosure using hardware designed for easy removal by maintenance personnel. Dampers must not create measurable additional noise above the sound level of fan. Dampers must not vibrate or rattle. Construct dampers of extruded aluminum, stainless steel, or powder-coated steel.

] **********

NOTE: Retain paragraph below to include blank-off panels to prevent bypass airflow through individual fans that are not operating. Coordinate with backdraft paragraph above. Fan arrays with backdraft dampers do not require blank-off panels.

****

[Include[one][two][10 percent of][_____] blank-off panel(s) with each air-handling unit fan array for use by operators in the field to prevent air circulation through any of the fans in fan array that are not operating. Design blank-off panels for attachment to fan panels using easily removable and reusable hardware. Construct blank-offs of aluminum, stainless steel, or powder-coated steel sheets, not less than[1.8 mm 0.07 inch][_____] thick. Mount fan blank-off panels in the fan inlet access section for convenient operator access and use in the future.

]2.3.2 Centrifugal Plenum Fans

a. Construct fan panel of aluminum or powder-coated steel. Support fan wheel and bearings from a structural aluminum or powder-coated steel framework. Reinforce and brace fan panel to prevent vibration and pulsation. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.

b. Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of blades. Inlet and wheel cones must be hyperbolic. Inlet cone must be a single piece, constructed of aluminum or powder-coated carbon steel. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable. Inlet cones that are held in place using retaining clips are unacceptable.

c. Fan blades must be a true hollow airfoil shape,[continuously] welded to backplate and wheel cone. Construct blades of aluminum, reinforced for AMCA fan class and operating conditions scheduled. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade. Construct fan hubs of cast aluminum or cast iron, ASTM A48/A48M Class 20A and better, with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Hubs must be keyed and set-screwed to shaft for positive attachment. Construct the

wheel backplates of aluminum. Statically and dynamically balance fan wheel before fan is assembled. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum AMCA class speed.

****
NOTE: Only direct drives are indicated. If applications require belt-drive plenums fans, copy requirements for belt drives indicated in HOUSED CENTRIFUGAL FANS paragraph and revise to suit application.
****

d. Fans must be direct drive, arrangement 4 in accordance with AMCA 99 for single-width, single-inlet fans. Adjust wheel width and diameter to match motor speed while providing performance scheduled. Fasten fan wheel directly to motor shaft using a key and setscrew as previously specified. Construct motor base and pedestal of aluminum or powder-coated carbon-steel plate.

2.3.3 Housed Centrifugal Fans

Continuously weld housing constructed of [aluminum][carbon-steel][or][stainless steel]sheets, plates, and structural shapes. Support fan housing and shaft bearings from a rigid structural framework. Brace fan housing to prevent vibration and pulsation with external stiffeners to form a rigid housing that is free of operating resonance. Extend fan housing side sheets not more than[13 mm 1/2 inch][_____] past fan scroll. Fan Cut-off: Designed for pressure distribution required by the application. Fan Blast Area: At least [80][_____] percent of fan outlet area. Wheel Removal: Construct fan housing for fan wheel(s) removal through the inlet opening when the inlet cone is removed.

2.3.3.1 Housed Centrifugal Fan Construction

****
NOTE: Retain the following subparagraphs below as needed for the indicated items. These include requirements for:

a. Split housings on large fans for enhanced access.
b. Access doors for enhanced access.
c. Drains on fans capable of accumulating moisture.
d. Fans with flanged discharge connections.
e. Fans with flanged inlet connections.
****

[a. For fans with wheel diameters nominal[1225 mm 49 inches][_____] and larger, include diagonally flanged, gasketed, and bolted split housings.

][b. Provide access doors with quick-opening, gasketed, with heavy-duty latches. Conform to housing contour. Locate in 5 o'clock or 7 o'clock position about the end of the shaft and position to gain internal access. Maximize size of square access door up to[600 mm 24 inches][_____].

][c. Provide[DN 25 NPS 1][_____] female NPT threaded half coupling welded

to lowest point of fan housing. Position the drain connection to accommodate field-installed drain piping. Include each drain coupling with a stainless steel threaded plug.

][d. Provide welded flanged discharge with a matching companion flange having evenly spaced holes for threaded hardware.

][e. Provide welded flanged inlet with a matching companion flange having evenly spaced holes for threaded hardware.

] f. Include precision-spun or die-formed, matched inlet and wheel cones with hyperbolic shape to ensure streamlined airflow into the wheel and fully load the blades for efficient aerodynamic performance. Inlet cone must be a single piece, constructed of[aluminum][carbon steel][or][stainless steel]. Fasten inlet cone to fan housing using bolts, nuts, and washers to provide a positive and secure attachment that can be removed and replaced in the field.

Provide fan blades with true hollow airfoil shape, continuously welded to backplate or centerplate and wheel cone(s). Construct blades of[aluminum][carbon steel][or][stainless steel], reinforced for AMCA fan class. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade. Construct fan hubs of[cast aluminum][cast iron, ASTM A48/A48M Class 20A and better][or][stainless steel], with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Key and setscrew hubs to shaft for positive attachment. Construct wheel backplates or centerplates of[aluminum][carbon steel][or][stainless steel]. Statically and dynamically balance fan wheel before fan is assembled. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum AMCA class speed.

[2.3.3.2 Housed Centrifugal Fan Drive

****
NOTE: Retain paragraph below for belt-drive fan applications and for direct-drive fan applications with a drive coupling. Paragraph is not required for applications where fan wheel is directly connected to motor shaft.
****

Fan shaft must be one piece, solid [carbon][or][stainless] steel, accurately turned, ground, polished, and inspected. Polish shafts at the point of bearing contact to comply with bearing manufacturer's recommended tolerances. Inspect shafts for straightness after the keyways are cut. Coat carbon-steel shafts with a rust-inhibitive coating. Fan bearings must be foot-mounted type, bolted on a rigid welded steel framework that is integral with, or independent of, the housing. Size bearings for L-10 life of at least [200,000][_____] hours, a DN factor less than [200,000][_____] and a load factor less than [2,700,000][_____] at the maximum fan class load limit horsepower, including belt pull. Select bearings in accordance with [ABMA 9][and][or][ABMA 11].

Bearings for Fans with Motor Horsepower up to[7.5 kW 10 HP][_____]: Single-row ball or spherical bearings, self-aligning, grease lubricated, and housed in a pillow block housing. Bearings for Larger-Size Fans: Double-row spherical, self-aligning, grease lubricated, and housed in a horizontally split pillow block housing. Extend [copper][or][plastic] grease lines to an accessible location within sight of bearing for greasing the bearings without removing guards, inlet screens, linkages, and other appurtenances. Terminate bearings and extended grease lines with grease gun fittings.

[2.3.3.2.1 Direct Drive

****
NOTE: Retain subparagraph below for direct-drive fan applications.
****

Fans must be direct drive Double-Width, Double-Inlet: Arrangement 7 in accordance with AMCA 99. Single-Width, Single-Inlet: Arrangement [4][or][5] in accordance with AMCA 99. For AMCA arrangements 4 and 5, fasten fan wheel directly to motor shaft using a key and setscrew indicated. Construct motor base and pedestal for AMCA arrangement 4 and 7 fans of[aluminum][carbon-steel][stainless steel] plate.

][2.3.3.2.2 Belt Drive

****
Retain paragraphs below for belt-drive fan applications.
****

Fans must be Multiple V-Belt Design. Size two belt drives for at least [2.0][_____] times the fan motor horsepower. Size belt drives with more than two belts, for at least [1.5][_____] times the fan motor horsepower. Coordinate, with motor manufacturer, the size and location of motor sheave required to satisfy motor L-10 bearing life using motor manufacturer's written instructions.

]]2.3.3.3 Additional Fan Requirements

****
NOTE: Retain paragraphs below for belt-drive fan applications.
****

[a. Sheave and V-belt selections must be in accordance with manufacturer's published data. For constant-Speed Applications, utilize fixed or variable sheaves for applications up to[4 kW 5 hp][_____] and fixed sheaves for applications with larger horsepower. For variable-speed applications, utilize fixed sheaves. Sheave profile must be machined to Mechanical Power Transmission Association Standards. Construct sheaves of high-strength cast iron having a minimum tensile strength of[172.4 MPa 25,000 psi][_____]. Sheave rim speeds must not exceed[25.4 m/s 5000 fpm][_____]. Sheave side wobble and runout, and eccentricity must be within Mechanical Power Transmission Association and Rubber Manufacturers Association (RMA) tolerances. Balance sheaves to satisfy vibration performance requirements. Mount sheaves on the shaft using a taperlock split and keyed bushing or an integral keyed bushing. V-belts must be oil resistant, non-static conducting,

and high quality in accordance with RMA standards. Classic A, B, C, D, and E, non-cogged, cross sections. Multiple belt drives must be a matched set with belt tolerances in accordance with RMA standards. Tension belts in accordance with manufacturer's written instructions.

b. Furnish and factory install fan drive guard(s) for bearing assemblies, rotating shafts, sheaves, belts, couplings, and heat slingers. Arrangement 3 fans do not require guards for bearings on the side opposite the drive. Make provision for motor and fan rpm measurement without removing the guard. Construct the guard of flattened expanded aluminum or steel wrapped around a channel frame, suitably braced to prevent vibration. Paint guards using the same coating as fan, except color must be safety yellow. Design attachment to fan for easy removal by maintenance personnel using a clamp and latch.

] **********

NOTE: Retain paragraph below for exhaust applications requiring a seal to minimize leakage.

****

[c. Provide single-width, single-inlet fans with shaft seal(s) where indicated on Drawings. Shaft seal(s) must minimize fan leakage when operating and not operating. Construct shaft seal of an aluminum or split stainless steel plate with non-asbestos material fitted under the split metal plate and seated around the shaft. Secure split plates to housing using threaded hex-head hardware. Shaft seals must be replaceable from outside the housing without disturbing the shaft or bearings. Select shaft seal clearances and materials for operating temperature, pressure, and air quality encountered. Shaft seals, including labyrinth, floating bushing, or close clearance annulus, are acceptable alternatives.

][d. Piezometer Ring: Mount piezometer ring at fan inlet cone for airflow measurement.

]2.3.4 Special Fan Construction

Where indicated on Drawings, construct individual fans with the following additional features.

2.3.4.1 Spark-Resistant Construction

Construct fans in accordance with AMCA 99[Type A][Type B][Type C] spark-resistant construction[where indicated on Drawings].

2.3.4.2 Heat Slinger

Provide for fans handling air with temperatures exceeding[65 deg C 150 deg F][_____]. Provide a cast aluminum, split-design, internally-finned rotor to create a strong circulation of air over the shaft and inboard bearing, and reduce heat conduction along the shaft to bearings. Secure the split halves together using at least two stainless steel bolts and use a setscrew to secure the assembly to fan shaft.

2.3.4.3 Corrosion-Resistant Coating

Provide Baked phenolic[, equal to Heresite's "P-4403 Brown Baked Phenolic Coating."] <Insert manufacturer's name and product name or designation.> Total Dry Film Thickness: [7][_____] mils. Application in accordance with

manufacturer's written instructions. Mist bonding pass and allow to flash off for several minutes, but not long enough to allow film to completely dry. Not less than three crisscross multipasses maintaining a wet-appearing film. Air dry approximately 45 to 60 minutes with ventilation before applying heat. After air dry period has elapsed, raise temperature in recommended increments of 30 minutes until desired temperature is reached. Bake intermediate coats at approximately half the final temperature for 10 to 20 minutes. Final Bake: [205 deg C 400 deg F][_____] for 1-1/2 hours.

2.3.5 Fan Motors

a. Comply with NEMA MG 1 unless more stringent requirements are indicated. NEMA MG 1, [Design B][_____], as required to comply with capacity and torque characteristics; medium-induction motor.

b. Capacity and torque must be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor. Provide NEMA Premium Efficiency rating complying with NEMA MG 1. Motor must operate fan under all conditions indicated without exceeding motor nameplate and without use of motor service factor. Comply with minimum requirements of Class F or Class H insulation, suitable for "inverter-duty" or "drive-duty" applications in accordance with NEMA MG 1. Motor operation through a variable-frequency controller must not adversely affect the motor performance, operation, useful life, and warranty. Motor Service Factor must be [1.15][_____]. Enclosure Type: must be [ODP][or][TEFC].

c. Provide Shaft grounding system to protect bearings from induced voltage. Shaft grounding system must have low drag (less than 0.05 percent of motor horsepower), and must operate for a minimum of 3 years without periodic maintenance or adjustments. Shaft grounding system must be mounted external [or internal] to motor enclosure. Provide frames with integrally cast feet unless other requirements of driven equipment require a different arrangement. Frame, front and back end brackets, and front and back end bearing intercaps constructed of cast iron, ASTM A48/A48M, Class 25 or better. Fabricate rotor frame from die-cast aluminum, copper, or associated alloys. Key rotors to motor shaft. Rotating assembly must be dynamically balanced to within limits defined in NEMA MG 1. Motors must have the entire rotating assembly between bearing inner caps coated with a corrosion-resistant coating.

d. Copper windings must be spike resistant to withstand 1600 peak V. Entire wound and insulated stator coated with a coating to protect against moisture and corrosion.

e. Solid shaft fabricated of[carbon][Type 304 stainless][Type 316 stainless][Type 416 stainless] steel, accurately turned, ground and polished, and inspected for accuracy. End of shaft with drilled hole for use in field measurements.

f. Grease-lubricated ball or roller bearings. ABMA 11 L-10 motor bearing life of [100,000][_____] hours. Factory lubricate motor bearings using a premium moisture-resistant polyurea thickened grease with rust inhibitors suitable for extreme operating temperatures encountered. Coordinate special requirements that may impact lubrication and

include appropriate lubrication.

g. Equip each bearing housing with an easily accessible grease inlet. Fit grease inlets with a grease fitting and protective fitting cap. Equip inlets with an automatic grease relief fitting to prevent excessive greasing. Equip each bearing housing with grease drain and threaded plug.

h. Conduit box material must be the same as frame. For motor frames 365T and below, furnish conduit boxes sized with internal volumes in accordance with NEMA MG 1. For motor frames larger than 365T, furnish conduit boxes one size larger than NEMA MG 1. Coordinate the location and mounting of conduit box with driven equipment manufacturer. Factory mount conduit box on motor. Provide NRTL-listed clamp-type grounding lug mounted in conduit box.

i. Motor leads must be non-wicking type, Class F temperature rating or better, and permanently numbered over entire length for identification. Lead terminals must be manufacturer's standard.

j. Provide motor with drain holes at the lowest point for drainage of condensate. Each drain hole with a threaded removable plug.

[k. TEFC Motor Fans must be corrosion-resistant construction, non-sparking, metallic or non-metallic, bi-directional, and keyed to shaft. Motor Fan Cover must be[Steel][Same material as frame].

] l. Motor hardware must be hex-head, high-strength, zinc-plated carbon steel or stainless steel.

m. Provide lifting eyebolts threaded into frame receptacle and designed to prevent moisture and other foreign material from entering motor cavity when eyebolt is removed.

n. Construct nameplates of aluminum or stainless steel and attach to motor frame with aluminum, stainless steel, or brass drive pins. Engrave or stamp data on the nameplate. At a minimum, include nameplate data in accordance with NEMA MG 1.[Also include ABMA bearing designation for the drive and opposite end bearing.]

o. Motor must successfully pass[500][1000][2000][_____]-hour salt spray test for corrosion in accordance with ASTM B117.

2.4 COILS

****

NOTE: Refer to UFC 1-200-01 DoD Building Code, Chapter 4 for additional requirements for corrosion protection and coordinate with CORROSION PROTECTION sub-paragraph. Research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, rewrite the specification for coils and fins for these specific conditions. Consider the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Provide either phenolic, vinyl or epoxy/electrodeposition coating. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic or epoxy/electrodeposition coating is preferred, as these have less tendency to bridge across the fins than vinyl, better thermal conductivity than vinyl and in many conditions weathers better than vinyl.

****

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.406][0.508][0.6096] mm [0.016][0.020][0.024] inches.][Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm [0.035] [0.049] inches.][Provide aluminum fins that are [0.14][0.19] mm [0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.114 mm 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.[Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.]

2.4.1 Direct-Expansion Coils

****

NOTE: Use this paragraph for Army and Air Force projects only.

****

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with UL 1995.

2.4.2 Water Coils

Install water coils with a pitch of not less than 10 mm/m 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and

drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.4.3 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 13 mm 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure testcoils in accordance with UL 1995.

2.4.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 25 mm 1 inch outside diameter for tube lengths 1.5 m 60 inches and over and 13 mm 1/2 inch outside diameter for tube lengths under 1.5 m 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 15 mm 5/8 inch outside diameter for tube lengths 1.5 m 60 inches and over and 10 mm 3/8 inch outside diameter for tube lengths under 1.5 m 60 inches with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 3.66 m 144 inches. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.4.5 Electric Heating Coil

****
NOTE: Use this paragraph for Navy projects only. Choose the second set of brackets if an air-conditioning unit for EDP is specified.
****

Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide[nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.4.6 Eliminators

****
NOTE: Use this paragraph for Navy projects only.
****

Equip each cooling coil having an air velocity of over 2 m/s 400 fpm through the net face area with moisture eliminators, unless the coil manufacturer guarantees, over the signature of a responsible company official, that no moisture can be carried beyond the drip pans under actual conditions of operation. Construct of minimum 24 gage[zinc-coated steel][copper][copper nickel][or][stainless steel], removable through the nearest access door in the casing or ductwork. Provide eliminators that have not less than two bends at 45 degrees and are spaced not more than 63 mm 2-1/2 inches center-to-center on face. Provide each bend with an integrally formed hook as indicated in the SMACNA 1884.

2.4.7 Sprayed Coil Dehumidifiers

****

NOTE: Sprayed coil dehumidifiers are not recommended due to additional maintenance and the potential of mold and mildew, only use when another option is not feasible. Consider weather impacts when deciding to use this or not.

****

Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers, adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed connection.

2.5 REFRIGERATION

****

NOTE: Designer must at a minimum comply with applicable year of ASHRAE 90.1 for equipment efficiencies and indicate required efficiencies on the equipment schedules on the drawings.

****

2.5.1 Air-to-Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive or coastal environments.

****

Provide air-to-refrigerant coils with [seamless copper][or][aluminum] tubes of 8 mm 5/16 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel][or][aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Factory pressure and leak test each coil.

a. Provide separate expansion devices for each compressor circuit. Condensate drain pans must be removable and double-sloped.

b. Dual compressor units must have intermingled evaporator coils.

c. Condensate drain pans must be removable and double-sloped.

[d. Provide condenser coils with hail protection guards.

] e. Coat[condenser][evaporator][condenser and evaporator] coil with a uniformly applied[epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.5.2 Compressor

Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Equip compressors of 35 kW 10 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start compressors in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,][high][high and low] pressure safety cutoffs and protection against short cycling.

2.5.3 Refrigeration Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant lines with service pressure tap ports and refrigerant line filter.

2.5.4 Remote Condenser or Condensing Unit

****
NOTE: Delete the sound requirements unless the unit is located in a sound-sensitive area.
****

Units with capacities 39.5 kW 135,000 Btuh or greater must produce a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 370. Fit each remote condenser coil with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 49 degrees C 120 degrees F at 40 degrees C 95 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [-6][13][_____] degrees C [20][55][_____] degrees F. Provide fan and cabinet construction must be provided as specified in paragraph UNIT CONSTRUCTION. Fan and condenser motors must have[open][dripproof][totally enclosed][explosion proof] enclosures.[Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.][Provide outdoor unit with louvered, weather-proof enclosure for protection of integral elements.]

2.5.4.1 Air-Cooled Condenser

Provide unit rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Unit must be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

a. Provide interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit as required and as indicated. Provide electrical and refrigeration piping terminal connections between[condenser][condensing unit] and evaporator units.

b. Low ambient control for multi-circuited units serving more than one evaporator coil must provide independent condenser pressure controls for each refrigerant circuit. Set controls to produce a minimum of 40 degrees C 95 degrees F saturated refrigerant condensing temperature. Provide unit with a liquid subcooling circuit that ensures proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit must be provided with[manufacturer's standard][not less than [4][_____] degrees C [8][_____] degrees F] liquid subcooling. Liquid seal the subcooling circuit.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Coils must have[nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COILS.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide separate expansion devices for each compressor circuit.

d. Provide a complete control system with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Construct unit mounted control panels or enclosures in accordance with applicable requirements of NFPA 70 and house in NEMA ICS 6, Class 1 or 3A enclosures. Controls must include[control transformer,][fan motor[starters],][solid-state speed control,][electric heat tracing controls,][time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.5.4.2 Evaporative Condenser

****

NOTE: Evaporative condensers are only used in dry

climates due to problems with condensate scaling and algaie formation in other climates. Verify with the user that their environmental conditions support the installation or evaporative condensers.

****

[Provide a counter-flow blow-through design, with single-side air entry.]The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section and the cabinet must not be lighter than 1.6 mm 16-gauge steel, protected against corrosion by a zinc coating. Conform the zinc coating ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 0.76 kg/square meter 2.5 ounces/square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Unit must be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

a. Provide a watertight pan complete with drain, overflow, and make-up water connections. Provide standard pan accessories to include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

b. Provide a direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fan. Do not locate fan and fan motor in the discharge airstream of the unit. Enclose motors in[open][splashproof][totally enclosed] enclosure that is suitable for the indicated service. Design the condensing unit design to prevent water from entering into the fan section.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Provide condensing coils with[nonferrous][copper][or][aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Protect coil in accordance with paragraph COILS.] Provide [galvanized steel][or][aluminum] casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil][or][a holding charge].[Field charge unit shipped with a holding charge with refrigerant and oil.]

d. Provide a water distribution system that distributes water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide[brass,][stainless steel,][or][high-impact plastic] spray nozzles that are the cleanable, non-clogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

e. Provide [a][two] bronze-fitted [centrifugal][or][turbine] type water pump[s] that may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast-iron casings. Impellers must be bronze, and shafts stainless steel with bronze casing wearing rings. Use mechanical type shaft seals. Factory coat the pump casing with epoxy paint. Pump motors

must have[open][drip proof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge pump suction and provide with a [galvanized steel][or][monel] screened inlet.

f. Provide drift eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of [zinc-coated steel][or][polyvinyl chloride (PVC)]. Eliminators must prevent carry over into the unit's fan section.

g. Provide the evaporative condenser unit with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers must modulate to reduce the airflow through the evaporative condenser. Controls must include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycle a fan motor on and off in accordance with the manufacturer's instructions.

[2.5.4.3 Compressor

****
NOTE: Delete this paragraph if only a remote condenser is required.
****

Provide compressor rated in accordance with AHRI 540. Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide units 35 kW 120,000 Btuh and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor must have an independent refrigeration circuit through the condenser and evaporator. Each compressor must start in the unloaded position. Provide each compressor with vibration isolators, crankcase heater,[lubrication pump,] thermal overloads, and[high][high and low] pressure safety cutoffs and protection against short cycling.

]2.5.4.4 Fans

Provide fan wheel shafts supported by either maintenance-accessible grease lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Mount fan motor and fan assembly on a common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire fan motor and fan assembly must be completely vibrationally isolated from the unit. Select unit fans to produce the airflow required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a[n][open drip-proof][totally enclosed][explosion proof] enclosure. Provide [manual][or][automatic-reset] type thermal overload protection. Construct fan wheels of [aluminum][or][galvanized steel]. Provide centrifugal fan wheel housings of galvanized steel, and construct centrifugal fan casings of [aluminum][or][galvanized steel]. Steel elements of fans, except fan shafts, must be [hot-dipped galvanized after fabrication][or][fabricated of mill galvanized steel]. Recoat

mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Statically and dynamically balance [fan wheels][or][propellers]. Provide double inlet[forward-curved][air foil] type fan wheels. Fan must reach rated rpm before the fan shaft passes through the first critical speed. Fans must be belt-driven with adjustable sheaves. Select the sheave size so that the fan speed at the approximate midpoint of the sheave adjustment produces the specified air quantity. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be independent of any other drive. Condenser fans must be propeller type, direct drive, statically balanced with galvanized steel blades and permanently lubricated ball bearings. Protect condenser fan motor drive bearings with water slingers or shields. Fit all belt drives with guards where exposed to contact by personnel.

2.6 GAS-FIRED HEATING SECTION

Construct gas-fired heat exchanger and burner of stainless steel suitable for[natural gas][liquid propane gas] fuel supply. Provide burner with[direct spark][pilot] ignition. Heating section must have modulation with a turn down ratio of at least [4][3] to 1. Provide heating section completely assembled and integral to unit. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction and completely accessible for service. Gas equipment must bear the AGA label for the type of service involved.[Provide burner in accordance with NFPA 54.]

2.6.1 Direct Gas-Fired Heating Section

Direct gas-fired heat module(s) must have a stainless-steel burner with aluminum burner head casting, non-clogging gas ports; spark-ignition intermittent pilot, flame safeguard system with integral flame sensing, air pressure switch and automatic high limit switch set to [85][_____] degrees C [185][_____] degrees F. Burner assembly must be mechanically secured to vestibule panels. The burner combustion must be clean and odorless, with combustion efficiency limiting the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide. The burner profile to be equipped with adjustable profile plates.

2.6.2 Indirect Gas-Fired Heating Section

Heat module must be listed for outdoor installation with a Category IV venting system. Vent connectors provided must be suitable for connection to commercially available PVC pipe. Module must have [2][4][_____]-pass tubular heat exchangers, constructed of[aluminized steel][type 409 stainless steel]. Heat exchanger tubes must be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Module must be encased in a weather-tight metal housing with intake air vents.

2.7 AIR FILTERS

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NOTE: Select filters based on the functional needs of the area served, including indoor air quality. The combination of the extended surface pleated

panel filters and the extended surface nonsupported pocket filters or the cartridge filter of the same efficiency are intended to fulfill the filtration requirements in UFC 3-410-01, Heating, Ventilating, and Air-Conditioning Systems for areas where indoor air quality is of primary concern. Consider limiting the variety of filter sizes required to minimize inventory requirements for system maintenance.

In the event the retention of efficiency values in the specification becomes too cumbersome, revise the requirements by referring to the efficiencies indicated on the drawings, to show for each air handling unit or system the efficiency of the air filters required, and the maximum initial resistance.

****

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.7.1 Extended Surface Pleated Panel Filters

Provide 50 mm 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 2.54 m/s 500 fpm that does not exceed 0.09 kPa 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.7.2 Extended Surface Nonsupported Pocket Filters

Provide [750][_____] mm [30][_____] inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.1125][_____] kPa [0.45][_____] inches water gauge. Provide UL Class 1 filters. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.7.3 Cartridge Type Filters

Provide 305 mm 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.14][_____] kPa [0.56][_____] inches, water gauge. Provide UL class 1 filters, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter[with an extended surface pleated media panel filter as a prefilter] in a factory preassembled side access housing, or a

factory-made sectional frame bank, as indicated.

2.7.4 Sectional Cleanable Filters

****
NOTE: Delete washing and charging racks when not required.
****

Provide [25][50] mm [1][2] inch thick cleanable filters. Provide viscous adhesive in 20 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one L one quart for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and[single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.

2.7.5 Replaceable Media Filters

Provide the[dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that is not less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 1.6 mm 16 gauge galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.5][_____] m/s [300][_____] fpm, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Provide MERV that is not less than [_____] when tested according to ASHRAE 52.2.

2.7.6 Electrostatic Filters

Provide the following:

a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.

b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.

c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells

that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 19.8 m 65 foot lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 62.3 Pa 0.25 inch water gauge at 2.54 m/s 500 fpm face velocity.

d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 125 Pa 0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated.

e. A dry agglomerator/extended surface nonsupported pocket filter section combination with initial air flow resistance, after installation of clean filters, that does not exceed 162 Pa 0.65 inch water gauge at 2.54 m/s 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.

2.7.7 High-Efficiency Particulate Air (HEPA) Filters

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NOTE: Use high-efficiency particulate air filters in CLEAN ROOMS (White Rooms or Dust Controlled Facilities), clean work stations, and for critical areas of hospitals. Show the efficiency of the prefilter on the drawings. Provide efficiency that is sufficient for the anticipated contamination load and the degree of prefiltration required. Reference ASME AG-1 either all or in part when extreme temperature or humidity requirements exist. Ensure that requirements added to text from ASME AG-1 are essential to customer's needs to prevent unnecessary expenses from being added to the project, as this standard is not intended for routine commercial applications. When used, add ASME AG-1 to paragraph REFERENCES.

****

Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than [95][99.97] percent, and an initial resistance at [_____] m/s fpm that does not exceed [_____] Pa inches water gauge. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated

filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the[upstream][downstream] face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are[19 mm 3/4 inch thick exterior grade fire-retardant plywood][cadmium plated steel][galvanized steel] assembled in a rigid manner. Provide overall cell side dimensions that are correct to 2 mm 1/16 inch, and squareness that is maintained to within 3.2 mm 1/8 inch. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter as indicated. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Provide prefilters of the type, construction and efficiency indicated.

2.7.8 Holding Frames

Fabricate frames from not lighter than 1.6 mm 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.7.9 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 98 mm 3-7/8 inches in diameter, with white dials with black figures, and[graduations][graduated in 0.0025 kPa 0.01 inch water gauge,] with a minimum range of 0.25 kPa 1 inch water gauge beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m 5 foot minimum lengths of 6.35 mm 1/4 inch diameter[aluminum][vinyl] tubing, and all hardware and accessories for gauge mounting.

2.8 ENERGY RECOVERY DEVICES

****
NOTE: Designer must comply with applicable year of ASHRAE 90.1 for energy recovery effectiveness, including calculation methodology as part of the calculations submittal package. Include exhaust air transfer ratio (EATR) or outdoor air correction factor (OACF) in the equipment schedule on the drawings as applicable.
****

2.8.1 Energy Recovery Performance

Energy recover equipment must comply with[ASHRAE Design Guide for Dedicated Outdoor Air Systems (DOAS)][ANSI/AHRI Guideline V Calculating the Efficiency of Energy Recovery Ventilation and its Effect on Efficiency and Sizing of Building HVAC Systems][and][ANSI/AHRI Guideline W Selecting, Sizing, and Specifying Packaged Air-to-Air Energy Recovery Ventilation Equipment].

[Energy transfer ratings must be AHRI Certified to AHRI 1060 I-P and bear the AHRI certification seal for AHRI Air-to-Air Energy Recovery Ventilation Equipment Program based on AHRI 1060 I-P.][The manufacturer must provide certified performance data in accordance with ASHRAE 84 and AHRI 1060 I-P. Independent performance test results must be used to rate the product in accordance with the AHRI Air-to-Air Energy Recovery Ventilation Equipment Program.]

2.8.2 Rotary Wheel

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NOTE: Show energy recovery device supply/exhaust filters, preheat coils, backdraft dampers, exhaust dampers, recirculation dampers, face and bypass dampers, drainage provisions, controls and like ancillaries on the drawings and supplement by the specifications as necessary. Select minimum acceptable energy transfer effectiveness and maximum acceptable cross-contamination.

Delete moisture resistance and chain drive if not required.

****

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible[and latent] heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than [70][85][_____] percent with cross-contamination not in excess of [0.1][1.0][_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.8.3 Run-Around-Coil

****

NOTE: Delete "factory fabricated and tested" if not required.

Coordinate with paragraph GLYCOL SOLUTION in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Glycol is considered a hazardous waste. If the base does not have a used glycol waste program, using glycol can be an expensive maintenance item.

****

Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer

optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of[ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph COILS. Provide related pumps, and piping specialties that conform to requirements of[Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS][Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS][Section23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE] [_____].

2.8.4 Heat Pipe

****

NOTE: Include face air velocity, static pressure drop, temperature requirements for entering and leaving air or exhaust streams on the equipment schedule for heat pipes.

Delete flexible connectors if not required.

****

Provide a device that is a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat[between exhaust and supply streams] and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [15][18][25] mm [1/2][5/8][1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with ANSI/ASHRAE 15 & 34, selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 1.6 mm 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by[system face and bypass dampers and related control system as indicated][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.

2.8.5 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross

leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

2.8.6 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 1 mm 20 gauge G90, galvanized steel, double wall construction with 25 mm one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.8.7 Plate Total Energy Exchanger

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NOTE: Coordinate filter requirements of the DOAS with the plate total energy exchanger.
****

Provide enthalpy plate energy exchanger that must transfer both sensible and latent energy between outgoing and incoming air streams in a cross or counter flow arrangement with no moving parts. The enthalpy plate exchanger media must be [coated with hydrophilic resin][or][impregnated with a polymeric desiccant]. The material must allow the exchange water by direct vapor transfer using molecular transport without the need of condensation. The frame supporting enthalpy matrix must be constructed of G90 Galvanized material with end caps constructed of [1.3][1.6] mm [18][16] gauge galvanized plates. The enthalpy plate exchanger must operate at temperatures between minus 40 degrees C and 60 degrees C minus 40 degrees F and 140 degrees F.[The enthalpy plate exchanger must have a warranty of at least 5 years against manufacturing defects.][The enthalpy plate exchanger manufacturer must have at least 10 years of experience in the manufacturing of energy recovery components.]

The enthalpy plate exchanger must bear the AHRI 1060 Certified Product Seal. Sensible, latent and total effectiveness along with pressure drop, exhaust air transfer ratio (EATR) and outdoor air correction factor (OACF) rating must be clearly documented with performance tests conducted in accordance with ASHRAE 84 and per the official AHRI laboratory. The enthalpy plate exchanger must withstand pressure differentials of minimum 1.25 kPa 5 inches water gauge 2.5 kPa 10 inches water gauge. Following UL 1995, the enthalpy plate exchanger must be a UL Recognized Component and bear the UL Certification Mark (tested under UL723 with success by the UL laboratory). The exchanger must have a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84. The membrane must not promote the growth of mold or bacteria and must have successfully passed ASTM G21 testing. Provide heat exchanger core capable of easy removal from the unit. Enthalpy plate exchangers must be cleanable outside of cabinet.

[2.9 HUMIDIFIER

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NOTE: Designer must decide when to use a humidifier provided by the DOAS manufacturer or to specify separately under a separate specification section. If humidifier is not provided by DOAS manufacturer, remove the entire section.

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Provide humidifiers that meet the requirements of ANSI/AHRI 640.

2.9.1 Electrode Canister Type Humidifier

Provide humidifier of the self-contained steam generating electrode type utilizing a[plastic][disposable] canister with full probes connected to electric power via electrode screw connectors. Construct the electrodes from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream. Water chemistry requirements must be provided with humidifier submittal data.

2.9.2 Ultrasonic Type Humidifier

Provide self-contained ultrasonic type humidifier operating on the principle of ultrasonic nebulization of water. Make the casing of high-quality stainless steel. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Water chemistry requirements must be provided with humidifier submittal data.

2.9.3 Gas-Fired Steam Humidifiers (Stand-Alone)

Provide a stand-alone gas-fired steam humidifier that includes an enclosed cabinet of[powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each burner, capable of modulation at a [5:1][_____] ratio must provide steam production as indicated on the HUMIDIFIER SCHEDULE. Provide burner in accordance with NFPA 54.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.]Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.9.4 Electrically Heated Steam Humidifiers (Stand-Alone)

Provide a stand-alone electrically heated steam humidifier that includes an enclosed cabinet of[powder coated][baked enamel] [14][_____] gauge

steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each humidifier must operate at the voltage and provide steam production as indicated on the HUMIDIFIER SCHEDULE.

c. [Control system must seamlessly interface with temperature control system as specified in[Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.]Ensure that all controls equipment meets the requirements of UFC 4-010-06.

]2.10 CONTROLS

****
NOTE: This paragraph uses tailoring options to select the required protocol for control system interfaces for equipment.

Select Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for use on all USACE and AFCEC projects and for additions or retrofits to existing NAVFAC LonWorks systems. New NAVFAC systems should use Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Also coordinate with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.
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2.10.1 Unit Controls

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NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable.
****

Provide units internally prewired by manufacturer with a 24 volt electromechanical control circuit powered by an internal transformer.

Provide terminal blocks for power wiring and external control wiring. Internally protect unit by [fuses][or][a circuit breaker] in accordance with UL 1995. Units with three-phase power must be equipped with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal.

a. [Provide unit with microprocessor controls to provide all 24V control functions.]Control unit by a[two stage heating /cooling thermostat][one stage heating/cooling thermostat] with[manual][automatic] changeover.[Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Provide unit with[low voltage electric controls][factory supplied DDC control system].

2.10.2 Unit DDC Controller

a. Unit controller must include input, output and self-contained programming as needed for complete control of unit.

b. All program sequences must be stored on board in EEPROM. Batteries cannot be used to retain logic program. Execute all program sequences by controller 10 times per second and must be capable of multiple PID loops for control of multiple devices. Programming of logic controller must be completely modifiable in the field over installed[BACnet LANs][LonWorks LANs].

c. Temperature Control System Interface: Points must be available from the unit controller for service access and display or control.

d. Provide device, either graphical interface or an additional laptop with communication cabling along with the manufacturer’s diagnostic software, to enable the maintenance/service technicians to log directly into the DOAS stand-alone controller for system diagnostics/maintenance.

2.10.3 Control System Interface

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with the manufacturer's installation instructions and manufacturer's recommendations.

Submit installation drawings for each DOAS in accordance with referenced standards in this section. Contractor and manufacturer are responsible for verifying equipment, including any additional parts such as controls devices and other equipment requiring access, fits in the space provided. The Government review does not relieve contractor from delivering the product that meets minimum capacity and mandatory efficiency requirements to meet all codes and standards.

3.2 TESTING

3.2.1 Quality Control

Test and rate components of the air-conditioning systems as a system in accordance with ANSI/AHRI 210/240.

3.2.2 SYSTEM PERFORMANCE TESTS

Before each system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Provide in electronic format.[Also provide with [six][_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets.] The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

a. Submit a schedule, at least [2][_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than [48][_____] hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit [six][_____] copies of the report

provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.

(b) Condensing temperature and pressure.

(c) Suction temperature and pressure.

(d) Ambient, condensing and coolant temperatures.

(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.3 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. Provide in electronic format.[Also provide with [six][_____] copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.]

a. The date the tests were performed.

b. A list of equipment used, with calibration certifications.

c. Initial test summaries.

d. Repairs/adjustments performed.

e. Final test results.

3.3.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.3.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operation and Maintenance Manuals, Data Package 2

Submit [six][_____] manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.4.2 Operation and Maintenance Training

****

NOTE: Determine the number of hours of instruction based on the number and complexity of the systems specified.

****

Conduct a video recorded training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [16][_____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and

Maintenance Manuals and at least 14 days prior to conducting the training course. Provide a copy of the recorded training to the designated operating staff.

3.4.3 Acceptance

With the warranty, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.5 PAINTING OF NEW EQUIPMENT

****
NOTE: For NAVFAC SE projects, delete all painting requirements.
****

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.5.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.5.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of

0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

-- End of Section --