UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2026
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 81 00

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USACE / NAVFAC / AFCEC **UFGS-23 81 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 81 00 (May 2018)

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SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT
05/24

****

NOTE: This guide specification covers the requirements for unitary (packaged and split systems) air conditioners, heat pumps, and accessories.

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 items(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).
****

****

NOTE: Variable Refrigerant Flow (VRF) systems, also known as Variable Refrigerant Volume (VRV) systems, are not included in this specification due to issues and concerns described in UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems. Do not specify or permit VRF systems which do not meet the requirements of UFC 3-410-01.
****

****

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 options:

BACnet Only
LonWorks Only
BACnet or LonWorks

If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT tailoring options.

****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 23 03 00 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications specified herein.

1.2 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.

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

AMCA 500-D (2018) Laboratory Methods of Testing

	Dampers for Rating
AMCA 500-L	(2015) Laboratory Methods of Testing Louvers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 340/360 I-P	(2015) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
AHRI 350	(2015; R 2021) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI 390	(2003) Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
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 700	(2016) Specifications for Fluorocarbon Refrigerants
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 340/360	(2007; Addendum 1 2010; Addendum 2 2011) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and 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 495	(2005) Performance Rating of Refrigerant Liquid Receivers

ANSI/AHRI 640	(2005) Performance Rating of Commercial and Industrial Humidifiers
ANSI/AHRI/CSA 310/380	(2014) Standard for Packaged Terminal Air-Conditioners and Heat Pumps

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces

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

ANSI/ASHRAE 15 & 34	(2022) ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 15 & 34	(2022) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2025) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 55	(2017) Thermal Environmental Conditions for Human Occupancy
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2023) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding, Cutting and Allied Processes

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

AHAM RAC-1	(1982; R2008) Directory of Certified Room Air Conditioners

ASTM INTERNATIONAL (ASTM)

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 A307	(2023) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2025) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2025) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2025) Standard Specification for Zinc Dust Pigment
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM E84	(2026) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 00001	(2024) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code

NFPA 70	(2026; TIA 26-1; ERTA 26-1; TIA 26-2; TIA 26-3; TIA 26-4; TIA 26-5; TIA 26-6; TIA 26-7; ERTA 26-2; ERTA 26-3) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F; Notice 2 2024) Chemical Conversion Coatings on Aluminum and Aluminum Alloys
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical
UL 484	(2014; Reprint Jun 2022) UL Standard for Room Air Conditioners
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
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

1.3 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-03 Product Data

Spare Parts

Posted Instructions

Coil Corrosion Protection

System Performance Tests

Training; G, [_____]

Inventory

Environmental Data

Supplied Products

Manufacturer's Standard Catalog Data

Humidifier

SD-06 Test Reports

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

System Performance Tests; G, [_____]

SD-07 Certificates

Service Organizations

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Ozone Depleting Substances; S, [_____]

1.4 QUALITY ASSURANCE

Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

h. Equipment schedules

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign matter.

1.6 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain pressure within the building as indicated. Ventilation must meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. Thermal comfort must meet or exceed [ASHRAE 55][AFGM 2016-01].

1.7 WARRANTY

Provide equipment with the [Manufacturer's Standard Warranty.] [[1 year] [2 year] [5 year] [10 year] [____ year] manufacturer's warranty.]

PART 2 PRODUCTS

****

NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each air conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

Projects which include vapor-compression type refrigeration systems will comply with the safety standards defined in ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 & 34 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15 & 34.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new refrigeration equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 Refrigerant.

Step 2. Identify the occupancy classification of the facility which will house the new refrigerant equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new refrigeration equipment. Split system applications are typically considered high-probability systems according to ASHRAE 15 & 34.

Step 4. Estimate the quantity of refrigerant (grams pounds) in the largest single refrigerant circuit of the new equipment. The designer will research catalog data from different manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters cubic feet) of the indoor space which is planned to house the new refrigeration equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 & 34 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements.

ASHRAE 15 & 34 refers to a mechanical room as a machinery room, however the terms are synonymous. On mechanical room design, ASHRAE 15 & 34 touches on criteria concerning equipment placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open-flame devices, pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 & 34 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)

2.1 ENERGY EFFICIENCY REQUIREMENTS

NOTE: Delete this paragraph and references to Energy Star program for all Air Force Projects.

NOTE: 10 CFR 436.42 specifies that ENERGY STAR qualified and FEMP designated products may be assumed to be life-cycle cost effective. Equipment having a lower efficiency may be specified if the designer determines the lower efficiency equipment to be more life-cycle cost effective. In making such a determination, the designer should rely on the life-cycle cost analysis method in 10 CFR 436, Subpart A.

42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at: https://www.energy.gov/femp/search-energy-efficient-products. A list of qualified light commercial products is available at: http://www.energystar.gov/productfinder/product/certified-light-commercial-hvac/result

Submit Material, Equipment, and Fixtures List of all supplied products within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. For product categories covered by the Energy Star program, submit documentation that the product is Energy Star-qualified. For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or exceeds FEMP-designated efficiency requirements.

2.1.1 Room Air Conditioners

Selected room air conditioners are required to meet performance requirements specified by Energy Star. Information on the requirements can be found at: https://www.energystar.gov/products/room_air_conditioners/partners.

2.1.2 Air-Source Heat Pumps

Selected air-source heat pumps are required to meet applicable performance requirements specified by Energy Star. Information on the requirements can be found for residential models (single-phase units of 65,000 BTU/h or less)at:https://www.energystar.gov/products/air_source_heat_pumps/partners. For light commercial models (three-phase units of less than 240,000 BTU/h) at: https://www.energystar.gov/products/light_comm_heating_cooling/partners.

2.2 MATERIALS

Provide Manufacturer's standard catalog data, at least [5 weeks] [_____] prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.2.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to [bid opening] [request for proposal]. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.2.2 Product Sustainability Criteria

2.2.2.1 Energy Efficient Equipment

****

NOTE: Design federal buildings to conform to the requirements defined in Executive Order 13423 and Public Law (PL) 109-58 - "Energy Policy Act of 2005 (EPAct05)." In accordance with these policies design buildings to achieve energy consumption levels that are at least 30 percent below the levels established in the 2004 publication of ASHRAE 90.1. In addition, all new energy consuming equipment must be either an "energy Star Qualified Product" or a "FEMP Designated Product" unless no such products exist. Where Energy Star Qualified Products or FEMP Designated Products are not applicable, products must meet or exceed the requirements of ASHRAE 90.1.

Present applicable efficiencies either in this paragraph or on the design drawings. Delete this paragraph if equipment efficiencies are shown on the drawings.

The following is a list of terms which are commonly used in regard to efficiency ratings.

COP - Coefficient of Performance (dimensionless)
EER - Energy Efficiency Ratio (Btuh/Watt)
HSPF - Heating System Performance Factor (Btuh/Watt)
SEER - Seasonal Energy Efficiency Ratio (Btuh/Watt)
SCOP - Seasonal Coefficient of Performance (dimensionless)
IPLV - Integrated Part Load Value (dimensionless)

COP and HSPF values are typically used in regard to heating efficiencies. COP values should also be used to define cooling efficiencies when a job is being specified in SI units (EER = 3.415 x COP). COP and EER values are established based strictly upon a unit's full load capacity and not part load capacities.

Equipment selected will have as a minimum the efficiency rating determined in ASHRAE 90.1 - SI ASHRAE 90.1 - IP or CID A-A-50502 may be specified if the designer determines the equipment to be more life-cycle cost effective.

****

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

2.2.2.2 Electrical Equipment / Motors

****

NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.

****

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated, all motors of 746 W 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 00001. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 00001 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with

a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.2.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing. Provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph OZONE DEPLETING SUBSTANCES.

2.2.2.4 Local/Regional Materials

****
NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor.
****

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] kilometer [500][_____] mileradius from the project site, if available from a minimum of three sources.

2.2.2.5 Environmental Data

****
NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.
****

Submit Table 1 of ASTM E2129 for the following products: [_____].

2.2.3 Nameplates

****
NOTE: In a salt water environment substitute acceptable non-corroding metal, such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.
****

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate

secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Fix plates in prominent locations with nonferrous screws or bolts.

2.2.4 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

2.3 EQUIPMENT

****
NOTE: Equipment having a higher efficiency than required by ASHRAE 90.1 or CID A-A-50502 must be specified if shown to be life-cycle cost effective. Minimum efficiencies must be according to Energy Star (https://www.energystar.gov/products) and FEMP https://www.energy.gov/femp/search-energy-efficient-products recommendations.
****

2.3.1 Packaged Terminal [Air Conditioners] [Heat Pumps]

****
NOTE: Refer to ASHRAE 90.1 Table 6.8.1D for the minimum efficiency requirements of electrically operated packaged terminal air conditioners and heat pumps. Air conditioners with a SEER of 14.0 are readily available.
****

2.3.1.1 Packaged Terminal Unit

Provide a [vertical] [through-the-wall], [grade/floor mounted][wall mounted],[wall hung] heavy-duty commercial grade, factory assembled and precharged [air conditioner] [heat pump] unit in accordance with [AHRI 390] [ANSI/AHRI/CSA 310/380] and UL 1995. Provide units listed in AHRI DCAACP.[Provide Units removable from inside the building for servicing without removing the outside cabinet.] Provide unit with a noise rating in accordance with AHRI 350 that does not exceed [85][_____] dB while the entire unit is operating at any fan or compressor speed.[Heat pump units must contain a reversing valve to change unit to heating cycle.] Provide an outdoor coil temperature sensor to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil. Provide [Air Conditioners][Heat pumps] with [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].] [Provide units suitable for use with minimal ductwork having a total external static resistance up to 25 Pa 0.1 inch of water.]

2.3.1.2 Compressor

Provide a hermetically sealed [reciprocating] [rotary] [variable speed]

[digital scroll] [scroll] type Compressor. Provide compressor with permanent split capacitor motor, overload protection, and vibration isolators. Protect compressor against high discharge pressure, loss of charge, low voltage, and short cycling.

2.3.1.3 Air to Refrigerant Coils

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

Provide evaporator and condenser coils with [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 COIL CORROSION PROTECTION.] Provide casing of galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure they are suitable 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][holding charge].[Unit shipped with a holding charge must be field charged with refrigerant and oil.] Provide a condensate removal system.

2.3.1.4 Fans

Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.1.5 Air Filters

Provide standard filter on all packaged terminal units;[25 mm 1 inch] [50 mm 2 inch] [_____] mm inch MERV [7] [8] [13] [_____], throwaway filter capable of filtering the entire air supply.

2.3.1.6 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.1.6.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized

steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.

][2.3.1.6.2 Gas-Fired Heating Section

****
NOTE: Gas-fired heating sections are not available for air conditioning units for electronic data processing (EDP) spaces.
****

[Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.]

****
NOTE: The following section applies to Rooftop Units with high efficiency condensing, gas-fired heat exchangers. This equipment is cost effective when used in a dedicated outside air unit with a cooling capacity greater than 60,000 Btu/hr and high run time in a climate with a substantial heating season.
****

[Heating section must be [91 percent][_____] efficient condensing type, factory installed, and design certified to ANSI Z83.8/CSA 2.6. The heating section must be suitable for [natural gas] [liquid propane gas] fuel supply. The power vented system must maintain specified efficiency as a minimum throughout a modulation range of [5:1] [10:1] [_____]. The primary and secondary heat exchanger, burner and condensate drip pan will be constructed of Type 409 series stainless steel. Heating section must be completely assembled and integral to the rooftop unit with complete condensate drainage through the base of the unit. The primary heat exchanger must be specifically designed to handle the treatment of 100 percent outside air including capability of 100 degrees temperature rise. The gas control system must provide ignition control, gas modulation and all necessary safeties. The heating section must be factory wired and include the minimum components as follows: main and pilot manual shutoff valves, main and pilot regulators, main and pilot automatic shut-off valve and adequate union and test ports for unconstrained service. A condensate neutralizer must be provided with the rooftop unit. The condensate neutralizer will contain enough neutralizing agent for the volume of condensate generated annually by the heating section. The condensate neutralizer must allow for ease of replacement of neutralizing media or agent. Condensate drain piping system must be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE, Table 1. Condensate drain must be conveyed from the drain pan outlet to an approved place of disposal.]

][2.3.1.6.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.1.6.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.1.7 Cabinet Construction

Provide cabinet free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal must be a minimum of 1.2 mm 18 gauge steel with a protective coating. Provide removable face panels and allow full access to unit appurtenances. Access to controls must be without removal of the face panel. Discharge conditioned air through adjustable louvers. Thermally and acoustically insulate the cabinet with materials which conform to NFPA 90A. Furnish units with a [field-wired] [prewired] subbase that has leveling screws [with] [without] provisions for remote unit control. Subbase must be of 1.3 mm 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes must comply with the requirements specified in paragraph EQUIPMENT AND COMPONENTS FACTORY COATING.

2.3.1.8 Louver

Provide storm proof type Louver, constructed of [anodized,] [stamped] [or] [extruded] aluminum.

2.3.1.9 Ventilation Damper Assembly

****
NOTE: Delete requirement for ventilation damper when outside air is supplied to the spaced by a central system.
****

Operated by automatic actuator. Dampers must close on unit shutdown or loss of power and open on heating or cooling start-up. Dampers must have a maximum leakage rate of 8 (L/Min)/m2 at 249 Pa 3 CFM/ft2 at 1 inch w.g. static pressure.

2.3.1.10 Wall Sleeve

Provide water and airtight [completely insulated] [non-insulated] assembly, with weather-resistant protective coating.

2.3.1.11 Duct Package

Duct extension must consist of 1.3 mm 18 gauge minimum galvanized steel plenum extender with all necessary internal dampers and baffles to divert [25] [_____] percent of the supply air as indicated. Duct extension must be painted with a protective coating that matches room cabinet.

2.3.1.12 Unit Controls

Controls must include an on-off switch, high and low selector switch for [the cooling mode] [both the heating and cooling mode], multiple speed fan [cooling] [cooling and heating] mode, room air fan switch, outside air damper control, and an adjustable cooling [only] [and heating] thermostat. Function and temperature controls must be [integral to unit] [remotely mounted as indicated or as accepted by the Contracting Officer].

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.

2.3.2 Room [Air Conditioner] [Heat Pump]

****

NOTE: Indicate unit capacity, voltage, phase, installation requirements, etc. on the drawings. At a minimum, the unit will be required to have an Energy Star Label and efficiency for the unit will be in accordance with the International Code Council (ICC) International Green Construction Code (IGCC).

****

Provide a [window] [through-the-wall] mounted, appliance grade, factory assembled [air conditioner] [heat pump] unit in accordance with AHAM RAC-1 and UL 484. Units must include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Provide units removable from inside the building for servicing without removing the outside cabinet. Mount compressors on vibration isolators. Minimum cooling capacity must be not less than that indicated. Provide units listed in the AHAM RAC-1.[Provide light tight units serving dark rooms.] Cooling section must be equipped with a filter-drier on the suction line. Fan and condenser motors must have [open] [drip proof] [totally enclosed] [explosion proof] enclosures.[Room Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]] [Room Heat Pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]

2.3.2.1 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.2.1.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.

][2.3.2.1.2 Gas-Fired Heating Section

****
NOTE: Gas-fired heatng sections are not available for air conditioning units for electronic data processing (EDP) spaces.
****

Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.

][2.3.2.1.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.2.1.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.2.2 Filters

[Provide replaceable media filters of the [dry-media] [washable] type, of the size required to suit the application. Average efficiency must be not

less than [25][_____] percent when tested in accordance with ASHRAE 52.2.] [Provide air filters of the [throw-away] [or] [permanent washable] type removable without the use of tools and arranged to filter both room and ventilating air. Filters must have a minimum efficiency reporting value (MERV) of [6][8][_____] when tested in accordance with ASHRAE 52.2.]

2.3.2.3 Fans

Provide direct driven, statically and dynamically, [centrifugal][or][propeller] type fans. Design outdoor fan so that condensate evaporates without drip, splash, or spray on building exterior. Remove condensate by means of a drain or by evaporation and diffusion.

2.3.2.4 Casing

Provide exterior casings for the specified room HVAC Units constructed of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Incorporate provisions to permit replacement of major unit components. Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.

Construct outside cabinets, including metal grilles to protect condenser coils, of zinc-coated steel or aluminum. Steel and zinc-coated surfaces must receive at least one coat of primer and manufacturer's standard factory-applied finish Insulate cabinets to prevent condensation and run off of moisture. Provide mounting hardware made of corrosion-resistant material or protected by a corrosion-resistant finish. Provide with metal or plastic mounting flanges on each side, top, and bottom of unit. For through-the-wall installations provide aluminum or shop painted zinc-coated steel flanged telescopic wall sleeves. Design wall sleeves to restrict driving rain. For window mounted units provide shop-painted metal mounting brackets, braces, and sill plates.

2.3.2.5 Energy Efficiency

****

NOTE: FEMP requires Energy Star-qualified room air conditioners. "Energy Star Program Requirements Product Specification for Room Air Conditioners. Eligibility Criteria Version 3.1" requires the following minimum EER values:

For room air conditioners with louvered sides and a capacity smaller than 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 11.2, for capacities between 2.34 kW and 4.10 kW 8,000 and 13,999 Btuh Energy Star requires a minimum EER of 11.3, for

capacities between 4.10 kW and 5.86 kW 14,000 Btuh and 19,999 Btuh Energy Star requires a minimum EER of 11.2, for capacities greater than or equal to 5.86 kW 20,000 Btuh Energy Star requires a minimum EER of 9.8.

For room air conditioners without louvered sides and a capacity smaller than 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 10.4, and for capacities graeter than or equal to 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 9.8.

****

Minimum energy efficiency ratio (EER) must be in accordance with the paragraph EQUIPMENT EFFICIENCY. [Room air conditioners must include the Energy Star label affixed to the equipment.]

2.3.2.6 Units for Operation on 115 Volts

Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15- or 20-amp, 3-pole, 125-volt ground type plug to match receptacle.

2.3.2.7 Units for Operation on 208 or 230 Volts

Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15-, 20-, or 30-amp, 3-pole, 250-volt ground type plug to match receptacle.

2.3.2.8 Controls

****

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

****

Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995. [Unit must be provided with microprocessor controls to provide all 24V control functions.]
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.

Mount controls in cabinet. Manual controls must permit operation of either the fan or the fan and refrigerating equipment. Fan control must provide two fan speed settings. Automatic controls must include a thermostat for controlling air temperature. Thermostat must have an adjustable range, including 22 to 27 degrees C 72 to 80 degrees F and must automatically turn the refrigeration system on or off to maintain the preselected temperature within plus or minus 20 degrees C 4 degrees F.

2.3.3 Self-Contained Air Conditioners [Heat Pumps]

2.3.3.1 Small-Capacity Self-Contained air conditioners [Heat Pumps] (Not exceeding 19 kW 65,000 Btu/h)

2.3.3.1.1 General

Unit must be an air-cooled, factory assembled, weatherproof packaged unit as indicated. Unit must be the [air conditioning][heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Unit must be provided with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit must be provided with a full factory operating charge of refrigerant. Unit must have an Energy Star label.[Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Unit must be provided with hot gas reheat.]

2.3.3.1.2 Air-to-Refrigerant Coils

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

Air-to-refrigerant coils must have [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]. Contact of dissimilar metals must be avoided. Coils must be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil must be factory pressure and leak tested. Separate expansion devices must be provided for each compressor circuit.

[Condenser] [Evaporator] [Condenser and Evaporator] coil must be coated 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. Coating must be applied 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][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.3.1.3 Fan Section

Fan must be the [centrifugal] [propeller] type in accordance with paragraph FANS. Do not locate fan and fan motor in the discharge airstream of the unit. Motors must have [open] [splash proof] [totally enclosed] enclosure and be suitable for the indicated service. The unit design must prevent water from entering into the fan section.

2.3.3.1.4 Compressor

Provide direct drive, [hermetic reciprocating,] [variable speed] [digital scroll] [scroll] type Compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections.

2.3.3.1.5 Refrigeration Circuit

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

2.3.3.1.6 Unit Controls

****

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. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

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

****

Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995.

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

b. 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.

c. 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.

d. 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.

2.3.3.1.7 Roof Curb

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.]

2.3.3.1.8 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.3.1.8.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.

****
NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.
****

][2.3.3.1.8.2 Gas-Fired Heating Section

Provide factory assembled heating section as an integral part of the packaged unit. Design must be UL certified for outdoor application. Unit must have threaded gas connection. Provide heating section with [an intermittent pilot][an electronic] ignition system to light burner each time thermostat calls for heat. A flame sensor must prove flame and keep main burner on. The main valve must close should a loss of flame occur. When the thermostat is satisfied, extinguish the main burner. Provide a forced combustion blower to supply combustion air to the heating section. Construct the heat exchanger and burners of [aluminized steel][stainless steel].

][2.3.3.1.8.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.3.1.8.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.3.1.9 Single Source Power Entry

Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]

****
NOTE: For Army, Air Force, and Navy projects, ensure compliance with UFC 3-410-01 paragraph ECONOMIZER.
****

[2.3.3.1.10 Fully Modulating Economizer

Provide a fully modulating economizer with 0-100 percent fresh air damper, damper drive motor, and fixed dry bulb enthalpy control [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle.

]2.3.3.1.11 Manual Outside Air Damper

Provide manual outside air damper with rain hood and screen suitable for up to [25][____] percent outside air. Dampers must have a maximum leakage rate of 8 (L/Min)/m2 at 249 Pa 3 CFM/ft2 at 1 inch w.g. static pressure

2.3.3.1.12 Low Ambient Control

Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [minus 18][_____] degrees C [0][_____] degrees F.

2.3.3.1.13 Filters

****
NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with the manufacturer.
****

Provide a [25][50][_____] mm [1][2][_____] inch MERV [7][8][13][_____], throwaway filter.

2.3.3.2 Large-Capacity Self-Contained air conditioners [Heat Pumps] (Greater than 19 kW 65,000 Btu/h)

2.3.3.2.1 General

Provide an air-cooled, factory assembled, weatherproof packaged unit for [dedicated downflow][or][horizontal] airflow. Exterior panels must be zinc coated galvanized steel phosphatized and painted.[All access doors and panels must be hinged with neoprene gaskets.] Unit must be listed, labeled, and classified in accordance with UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Provide unit with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type. UProvide unit with a full factory operating charge of refrigerant. Unit must be 100 percent run tested at the factory. No penetrations are allowed within the perimeter of the curb in the down flow unit's base pan other than the raised 29 mm 1-1/8 inch high supply/return openings to provide added water integrity precaution from condensate drain back up.

Provide a belt driven, forward curved centrifugal indoor fan with adjustable motor sheaves. Thermally protect all motors. Provide unit with a removable, reversible, double-sloped condensate drain pan.[Air conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.3.2.2 Casing

Construct exterior casings for the specified unitary equipment of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. All access doors and panels must have neoprene gaskets.[Casing must have double-wall, hinged access doors for filters, heating, return/exhaust air, and supply fan section.] Incorporate provisions to permit replacement of major unit components.

Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.

2.3.3.2.3 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.

2.3.3.2.4 Compressor

Provide direct drive, [hermetic reciprocating,] [or] [scroll] type compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, high pressure cutout, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections. Compressors must have crankcase heaters. Motor must be suction gas-cooled. Cooling partial load capacity must be provided by [a dual stage compressor] [two or more compressors controlled to stage up and down based on load] [a variable speed compressor].

2.3.3.2.5 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.

2.3.3.2.6 Unit Controls

****

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. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

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

****

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. 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.

c. 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.

d. 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.

2.3.3.2.7 Supply Air Fan

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NOTE: Delete the following paragraph when air ventilation rates or air exchange rates require constant volume.
****

Units having AHRI cooling capacity equal or greater than 32 kW 110,000 Btu/h must have supply fans controlled by [two-speed motors] [variable speed motors].

[Provide direct drive, forward curved, centrifugal scroll type supply air fan.][Provide supply air plenum fan with backward-curved fan wheel.]

2.3.3.2.8 Roof Curb

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.]

2.3.3.2.9 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.3.2.9.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.

][2.3.3.2.9.2 Gas-Fired Heating Section

****
NOTE: Gas-fired heating sections are not available for air conditioning units for EDP spaces.
****

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NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

Construct gas-fired heat exchanger and burner of aluminized steel [stainless steel] suitable for [natural gas] [liquid propane gas] fuel supply. Provide burner with [direct spark] [intermittentpilot] 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.

][2.3.3.2.9.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.3.2.9.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.3.2.10 Single Source Power Entry

Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]

[2.3.3.2.11 Fully Modulating Economizer

Provide fully modulating economizer to include 0-100 percent fresh air damper, damper drive motor, and [fixed dry bulb enthalpy control] [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle. [Economizer dampers must be ultra low-leak type with leakage rate of one percent based on testing data completed in accordance with AMCA 500-D.]

]2.3.3.2.12 Manual Outside Air Damper

Provide manual outside air damper with rain hood and screen suitable for up to [25][_____] percent outside air. [Test Louvers in accordance with AMCA 500-L.]

2.3.3.2.13 Low Ambient Control

Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [minus 18][_____] degrees C [0][_____] degrees F.

2.3.3.2.14 Filters

****

NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with the manufacturer.

****

Provide 50 mm 2 inch thick high efficiency throwaway type filters that are MERV [8][13]. Filters must have an average dust spot efficiency of [25-35][_____] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Filters must be UL Class 1.

2.3.4 Computer Room Air Conditioner

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NOTE: Please refer to the new spec, UFGS 23 81 23 COMPUTER ROOM AIR CONDITIONING UNITS, for computer room air conditioning applications.

****

2.3.5 [Mini-]Split-System Air Conditioners [Heat Pumps]

2.3.5.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding 19 kW 65,000 Btu/hr)

****

NOTE: A remote condensing unit includes both the condensing coil and the compressor. A remote condenser includes only the condensing coil.

Air-cooled, water-cooled, and evaporatively-cooled air conditioning units with capacities less than 19 kW 65,000 Btuh will be rated in accordance with ANSI/AHRI 210/240.

Air-cooled, water-cooled, and evaporatively-cooled air conditioning and heat pump units with capacities greater than or equal to 19 kW 65,000 Btuh will be rated in accordance with AHRI 340/360 I-P.

Air-cooled heat pump units with capacities less than 19 kW 65,000 Btuh will be rated in accordance with ANSI/AHRI 210/240.

At a minimum, efficiencies for split-systems will be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP

****

Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted][wall mounted][ceiling mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning][heat pump] type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type. Fan and condenser motors must have [open][drip proof][totally enclosed][explosion proof] enclosures. Design unit to operate at outdoor ambient temperatures up to [46][_____] degrees C [115] [_____] degrees F.

2.3.5.1.1 Energy Efficiency

Provide unit with an Energy Star label. [Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.5.1.2 Air-to-Refrigerant Coil

****

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

****

Provide condensing coils with [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. Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

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 and be capable of withstanding a minimum [500][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.5.1.3 Compressor

****

NOTE: Delete this paragraph if a remote condensing unit is specified.

****

Provide direct drive [hermetic reciprocating] [variable speed] [digital scroll] [scroll] type compressor.Provide compressor with internal over temperature and pressure protector; sump heater; oil pump; high pressure and low pressure controls; and liquid line dryer.

2.3.5.1.4 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. 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 refrigerant charging valves. Provide filter-drier in liquid line.to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.5.1.5 Unit Controls

****

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. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated. Enthalpy controls will not be used.

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

****

Provide unit internally prewired with a [24][120][_____] volt 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. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. [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.]

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the 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, as well as any network between physically separate units, must meet the 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, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

****

NOTE: The following bracketed requirement is only used when no protocol tailoring option is selected. Since a protocol tailoring option has been selected, remove the bracketed text.

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[

Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.

]2.3.5.1.6 Condensing Coil

****

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

****

Provide coils with [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 CORROSION PROTECTION.] 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 separate expansion devices for each compressor circuit.

2.3.5.1.7 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted 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 104 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 as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have [open][drip proof][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.]

[2.3.5.1.7.1 Sound Rating

****

NOTE: Delete the sound requirements unless the unit

is located in a sound-sensitive area.
****

Provide units of capacities less than 39.5 kW 135,000 Btu/h with a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 270.

]2.3.5.1.7.2 Air-Cooled Condenser

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

2.3.5.1.8 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.5.1.8.1 Electric Heating

[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

][2.3.5.1.8.2 Gas-Fired Heating Section

****
NOTE: Gas-fired heatng sections are not available for air conditioning units for EDP spaces.
****

****
NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures

drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

[Construct the gas-fired heat exchanger and burner of aluminized steel [stainless steel] suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. 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 allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][

Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas 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 burner to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of [78][85][90][_____] percent AFUE.]

][2.3.5.1.8.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.5.1.8.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.5.1.9 Air Filters

****

NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with the manufacturer.

****

Provide filters of the [sectional][or][panel] [cleanable] type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. [25][50] mm [1][2] inch MERV [7][8][13], provide throwaway filter on all units below 19kW 6 Tons.

Provide filter rack that can be converted to 50 mm 2.0 inch capability. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.

2.3.5.1.10 Fans

Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.5.2 Large-Capacity Split-System Air Conditioners (Greater Than 19 kW 65,000 Btu/h)

Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted][wall mounted][ceiling mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning][heat pump] type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Provide unit with necessary fans, air filters, and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Provide double-width, double inlet, [forward curved] [backward inclined] [airfoil blade] centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type condenser or outdoor fans. Enclose fan condenser motors in [open][drip proof][totally enclosed][explosion proof] enclosures [and permanently lubricate ball bearings]. [Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.5.2.1 Air-To-Refrigerant Coil

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

Provide coils with [nonferrous][copper] [or] [aluminum] tubes tubes of 10 mm 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Provide casing of [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil 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. Provide separate expansion devices for each compressor circuit. [Condenser coil must have an integral sub-cooler.] [Condenser coil must have special coating for corrosion resistance.] [Condenser coil must be copper finned.]

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 and be capable of withstanding a minimum [500][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.5.2.2 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.

2.3.5.2.3 Refrigeration Circuit

****
NOTE: Filter-driers are optional and may be deleted on most precharged systems. Delete the last two sentences if an integral water-cooled condenser is not specified.
****

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit. Provide reversible-flow type filter-drier in each liquid line. Refrigerant flow control devices must be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Provide a refrigerant suction line [thermostatic][thermostatic and water flow switch] control to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.5.2.4 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.5.2.4.1 Electric Heating

[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil

must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

][2.3.5.2.4.2 Gas-Fired Heating Section

****
NOTE: Gas-fired heatng sections are not available for air conditioning units for EDP spaces.
****

****
NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.
****

[Construct the gas-fired heat exchanger and burner of stainless steel suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. 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 allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][

Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas 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 burner to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with

NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of [78][85][90][_____] percent AFUE.]

][2.3.5.2.4.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.5.2.4.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.5.2.5 Unit Controls

****

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. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

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

****

Provide unit internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Unit must have cutoffs for [high][high and low] pressure,[and] low oil pressure for compressors with positive displacement oil pumps, [supply fan failure], [and safety interlocks on all service panels]. Head pressure controls must sustain unit operation with ambient temperature of [-6][13] [_____] degrees C [20][55][_____]degrees F. Adjustable-cycle timers must prevent short-cycling. Stage multiple compressors by means of a time delay. Internally protect unit by [fuses] [or] [a circuit breaker] in accordance with UL 1995. Make low cost cooling possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the 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, as well as any network between physically separate units, must meet the 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, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

****

NOTE: The following bracketed requirement is only used when no protocol tailoring option is selected. Since a protocol tailoring option has been selected, remove the bracketed text.

****

[

Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.

]

2.3.5.2.6 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 UNITARY EQUIPMENT COMPONENTS. 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.]

2.3.5.2.6.1 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 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 COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with 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.

2.3.5.2.6.2 Evaporative Condenser

****
NOTE: Evaporative condensers are only used in dry climates due to problems with condensate scaling and algae 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 CORROSION PROTECTION.] 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.

2.3.5.2.6.3 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.

2.3.5.2.6.4 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 cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [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.

2.3.5.2.7 Filters

****

NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with the manufacturer.

****

Provide filters of the [sectional] [or] [panel] [cleanable] type, capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. Factory supply 50 mm 2.0 inch, MERV [8][13], throwaway filters. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][__] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.

2.3.6 Air-Source Unitary Heat Pumps

Provide air source unitary heat pumps with capacity up to 19 KW 65,000 Btu/hr that comply with ANSI/AHRI 210/2400. Provide air source heat pumps with capacity above 19KW above 65,000 Btu/hr that comply with ANSI/AHRI 340/360.

Provide units with assembled refrigerant circuit or circuits [packaged unit][or][split system having remote outdoor section separate from indoor section]. [Provide unit with hot gas reheat.]

2.3.6.1 Energy Efficiency

Provide unitary heat pumps that bear the Energy Star label. [Heat pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]

2.3.6.2 Casing

Construct the casing of zinc coated, heavy-gage (14-gage minimum) galvanized steel. Clean, phosphatize and finish exterior surfaces with a weather-resistant baked enamel finish. Test unit surfaces [500] [1,000] [_____] hours in a salt spray test in compliance with ASTM B117. Fabricate cabinet panels with lifting handles and water- and air-tight seal. Insulate all exposed vertical, top covers and base pan [13 mm] [25 mm] [50 mm] [1/2-inch] [1-inch] [2-inch], [matt-faced,] [fire-resistant,] [odorless,] [glass fiber material]. Surfaces in contact with the airstream must comply with requirements in ASHRAE 62.1. Provide for forklift and crane lifting the base of the unit.

2.3.6.3 Filters

****
NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with the manufacturer.
****

Provide[25mm 1 inch][50 mm 2 inch], MERV [7][8][13], throwaway filter on all units below 19kW 6 Tons. Filter rack may be converted to 50 mm 2.0 inch capability. Factory supply 50 mm 2.0 inch, MERV [8][13], throwaway filters on all units above 19 kW 6 Tons.

2.3.6.4 Compressors

Provide direct-drive, [variable speed] [digital scroll] [hermetic scroll] type compressors with centrifugal type oil pumps. Motor must be suction gas-cooled. Use internal overloads and crankcase heaters with all compressors.

2.3.6.5 Refrigerant Circuit

A minimum of two circuits are required. Provide each refrigerant circuit with independent fixed orifice or thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area must be provided for replacement suction line driers.

2.3.6.6 Evaporator and Condenser Coils

****
NOTE: For high-humidity locations and coastal environments, provide E-coated aluminum fins and corrosion-resistant cabinets.
****

Provide internally finned, DN 10 (NPS 3/8) copper tubes mechanically bonded to a configured aluminum plate fin. Leak test the evaporator coil and condenser coil at the factory to 1378 kPa 200 psig and pressure test to 2756 kPa 400 psig. All dual compressor units must have intermingled evaporator coils. Provide sloped condensate drain pans.

2.3.6.7 Outdoor Fans

Direct driven, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motors must be permanently lubricated and have built-in thermal overload protection.

2.3.6.8 Indoor Fan

Provide forward-curved, centrifugal, v-belt driven fan with adjustable motor sheaves and adjustable idler-arm assembly for quick-adjustment of fan belts and motor sheaves. Thermally protect motors. Provide oversized motors for high static application.

2.3.6.9 Defrost Controls

Provide a time initiated, temperature terminated defrost system shipped with a setting of 70-minute cycle, and a choice of 50 or 90-minute cycle. Timed override limits defrost cycle to 10 minutes must be available on

units from 35-kW to 70-kW 10 to 20 tons. Provide adaptive demand defrost on units below 35 kW 10 Tons.

2.3.6.10 Unit Electrical

a. Provide single point unit power connection.

b. Locate the Unit control box within the unit that contains controls for compressor, reversing valve and fan motor operation and must have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.

c. Wire high pressure, low temperature, and low pressure safety switches through a latching lockout circuit to hold the conditioner off until it is reset electrically by interrupting the power supply to the conditioner. All safety switches must be normally closed, opening upon fault detection.

2.3.6.11 Operating Controls

****

NOTE: Select UFGS 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 UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

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

****

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

b. Low voltage, adjustable room thermostat to control heating and cooling in sequence with delay between stages, compressor and supply fan to maintain temperature setting. Include system selector switch [(heat-off-cool)][(off-heat-auto-cool)][and] [fan control switch (auto-on)].

2.3.6.11.1 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. The wall mounted space temperature sensor must include occupied and unoccupied set point control, pushbutton unoccupied override, space temperature offset and space temperature indication. Refer to [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] for additional requirements.

2.3.6.11.2 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.

2.3.6.12 Corrosion Protection

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

2.3.6.12.1 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 (Minimum 6,000 Hours)

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)

2.3.6.12.2 Exposed Outdoor Cabinet

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][____] hours (ASTM B117) and [500][1,000][____] hours UV resistance (ASTM D4587).

2.4 COMPONENTS

2.4.1 Refrigerant and Oil

****

NOTE: Equipment must operate on a refrigerant with an ozone depletion potential (ODP) less than or equal to 0.05. R-22, R-123 and R-134a all meet this requirement. R-22 is the most commonly used refrigerant.

****

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

2.4.2 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the LPS cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [open][dripproof][totally enclosed][explosion proof] enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed 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. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [_____] mm inches. Direct-drive fan motors must be of the multiple-speed variety. Belt-driven fans must have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades.

V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

2.4.3 Primary/Supplemental Heating

****
NOTE: Inapplicable types of heating coils will be deleted. In some cases, unitary products are not available with steam or water heating coils.
****

2.4.3.1 Water Coil

****
NOTE: Drainable coils will be specified where coils are subject to freezing during the heating season. If drainable coils are not required, delete the last sentence.
****

Coil must conform to the provisions of AHRI 410. Coil must be fin-and-tube type constructed of seamless copper tubes and [aluminum][or][copper] fins mechanically bonded or soldered to tubes. Headers must be constructed of cast iron, welded steel or copper. Coil must be constructed to float within the casing to allow free expansion and contraction of tubing. Casing and tube support sheets must not be lighter than 1.6 mm 16 gauge galvanized steel formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. Coil must be circuited for suitable water velocity without excessive pressure drop and properly pitched for drainage where required or indicated. Each coil must be tested at the factory under water at not less than 2000 kPa 300 psi air pressure, tested hydrostatically after assembly of the unit and proved tight under a gauge pressure of 1400 kPa 200 psi. Coil must be suitable for use with water up to 120 degrees C 250 degrees F. Coil must allow complete coil drainage with a pitch of not less than 10 mm/meter 1/8 inch/foot slope to drain.

2.4.3.2 Steam Coil

Coil must conform to the provisions of AHRI 410. Coil must be constructed of cast semi-steel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered. Tubes must be rolled and bushed and brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, must be not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. The fin tube and header section must float within the casing to allow free expansion of tubing for coils subject to high pressure-steam service. Coils must be factory pressure tested and capable of withstanding 1700 kPa 250 psi hydrostatic test pressure or 1700 kPa 250 psi air pressure, and be for [700][1400] kPa [100][200] psi steam working pressure. Preheat coils must be steam-distributing tube type. Condensing tubes must be not less than 15 mm 5/8 inch outside diameter. Distribution tubes must be not less than 10 mm 3/8 inch outside diameter, and be

equipped with orifices to discharge steam to condensing tubes. Distribution tubes must be installed concentrically inside of condenser tubes and be held securely in alignment. The maximum length of a single coil must be limited to 120 times the diameter of the outside tube. Other heating coils must be minimum 13 mm 1/2 inch outside diameter single-tube type. Supply headers must distribute steam evenly to all tubes at the indicated steam pressure. Coil must allow complete coil drainage with a pitch of not less than 10 mm/meter 1/8 inch/foot slope to drain.

2.4.3.3 Electric Heating Coil

****
NOTE: Choose the second set of brackets if an air conditioning unit for EDP is specified.
****

Coil must be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be duct- or unit-mounted. Coil must be of the [nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source.

2.4.3.4 Gas-Fired Heating Section

****
NOTE: Gas-fired heating sections are not available for air conditioning units for EDP spaces.
****

****
NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.
****

Gas-fired heat exchanger must be constructed of aluminized steel[stainless steel] suitable for [natural gas][liquid propane gas] fuel supply. Burner must have direct spark or hot surface ignition. Valve must include a pressure regulator. Combustion air must be supplied with a centrifugal combustion air blower. Safety controls must include a flame sensor and air pressure switch. Heater section must be mounted to eliminate noise from expansion and contraction and must be completely accessible for service. Gas equipment must bear the AGA label for the type of service involved. Burner must be in accordance with NFPA 54.

2.4.4 Air Filters

****
NOTE: Design airflow must be able to be attained with the use of the MERV filter. Coordinate with

the manufacturer.
****

Provide filters to filter outside air and return air and locate [as indicated] [inside air conditioners] [inside filter box] [inside combination air filter mixing box]. Provide [replaceable (throw-away)] [high efficiency] [cleanable (reusable)] type. Filters must conform to UL 900, [Class 1] [or] [Class 2]. Polyurethane filters cannot be used on units with multiframe filters.

Air filters must be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method must be as listed under the label service and must meet the requirements of UL 586.

2.4.4.1 Extended Surface Pleated Panel Filters

Filters must be 50 mm 2 inch depth sectional type of the size indicated and must have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.2. Initial resistance at 2.54 m/s 500 feet/minute must not exceed 90 Pa 0.36 inches water gauge. Filters must be UL Class 2. Media must be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media must be attached to a moisture resistant fiberboard frame. Four edges of the filter media must be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.4.4.2 Replaceable Media Filters

Provide replaceable media filters of the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media must not be less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad must be enclosed in a holding frame of not less than 1.6 mm 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.52] [_____] m/s [300][_____] feet/minute, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Average efficiency must be not less than [_____] percent when tested in accordance with ASHRAE 52.2.

2.4.4.3 Sectional Cleanable Filters

Provide sufficient oil to coat filters six times based on 0.5 L 1 pint of oil per each square meter 10 square feet of filter area. Provide washing and charging tanks for cleaning and coating filters. Filters must have a MERV of [6] [8] [_____] when tested in accordance with ASHRAE 52.2.

Cleanable filters must be [25][50] mm [1][2] inches thick. Viscous adhesive must be provided in 18.9 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than 1 L one quart for each filter section. One washing and charging tank must be provided for every 100 filter sections or fraction thereof. Each washing and charging unit must consist of a tank and [single] [double] drain rack mounted on legs. Drain rack must be provided with dividers and partitions to properly support the filters in the draining position.

2.4.4.4 High Efficiency Filters

Filters must have a MERV of 17 when tested in accordance with ASHRAE 52.2. Filter assembly must include; holding frame and fastener assembly, filter

cartridge, mounting frame, and retainer assembly. Reinforce filter media with glass fiber mat. Pressure drop across clean filter exceeding [_____] Pa inches of water gage is not permitted. Precede high efficiency filters with a UL Class 2 replaceable type filter.

2.4.4.5 Manometers

Provide inclined-type manometers for filter stations of 944 L/s 2,000 cfm capacity or larger including filters furnished as integral parts of air-handling units and filters installed separately. Provide sufficient length to read at least 250 Pa one inch of water column with 10 major graduations, and equipped with spirit level. Equip manometers with overpressure safety traps to prevent loss of fluid, and two three-way vent valves for checking zero setting. [Mercury cannot be used as the operating fluid.]

2.4.5 Coil Frost Protection

Provide each circuit with a manufacturer's standard coil frost protection system. The coil frost protection system must use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Use timers to prevent the compressor from rapid cycling.

2.4.6 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.4.6.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for 100 kW 30 tons capacity and under may be field tunable type.

2.4.6.2 Liquid Receiver

A liquid receiver must be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver must be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver must be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves;[thermal well for thermostat;][float switch column;][external float switches;] and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be provided with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34.

2.4.6.3 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator must not exceed

[70][_____] kPa [10][_____] psi during the removal of hot gas entrained oil. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, [filter for removal of all particulate sized 10 microns and larger,][thermometer and low temperature thermostat fitted to thermal well,] [immersion heater,][external float valve fitted with three-valve bypass,] and strainer.

2.4.6.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 35 kPa 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.4.7 Internal Dampers

****
NOTE: Specify the sequence of operation of all damper operations on the drawings.
****

Dampers must be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions must be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers must [have minimum position stops][be linked together][have [manual][automatic] modulation] and operate as specified.

2.4.8 Mixing Boxes

Mixing boxes must match the base unit in physical size and must include equally-sized[flanged] openings, each capable of full air flow. Arrangement must be as indicated.

2.4.9 Cabinet Construction

****
NOTE: Delete this paragraph if room air conditioner/heat pumps or air conditioners for EDP spaces are specified.
****

Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces must be 1.3 mm 18 gauge galvanized steel or 1.8 mm 0.071 inch thick aluminum on units with a capacity above 70 kW 20 tons and 1.0 mm 20 gauge galvanized steel or 1.6 mm 0.064 inch thick aluminum on units with a capacity less than 70 kW 20 tons. Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be 1.0 mm 20 gauge. Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor,

must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.

2.4.9.1 Indoor Cabinet

Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.

2.4.9.2 Outdoor Cabinet

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.

2.4.10 Condenser Water Piping And Accessories

Provide condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.4.11 Refrigerant Piping

Provide refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.4.12 Cooling Tower

Provide cooling towers in accordance with Section 23 65 00 COOLING TOWERS.

2.4.13 Condensate Drain Piping

provide condensate drain piping in accordance with Section 23 05 15 COMMON PIPING FOR HVAC.

2.4.14 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.15 Temperature Controls

****

NOTE: This paragraph should only be included for packaged and self-contained unitary systems requiring controls (i.e. thermostats, duct modulation, SLDC, etc.) not covered by this specifications. In projects where this section of the specification is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature

control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each cooling tower fan, chilled water pump, condenser water pump, etc. in order to define the overall system operation.

****

Provide temperature controls [in accordance with [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 BUILDNG CONTROL SYSTEMS]][fully coordinated with and integrated into the existing air-conditioning system].

2.5 UNITARY EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.5.1 Air Economizer

Provide [down flow][horizontal flow][field][factory] installed economizer with fully modulating 0-100 percent motor and dampers, barometric relief, minimum position setting and fixed dry bulb. [Field install solid state enthalpy and differential enthalpy control.]

2.5.2 Humidifier

Provide humidifiers that meet the requirements of ANSI/AHRI 640

2.5.2.1 Steam Spray Type Humidifier

Provide steam spray humidifiers that inject steam directly into the [surrounding air][or][air stream]. [Single grid humidifiers must consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Field install automatic steam control valves and condenser traps.][House enclosed grid in a copper enclosure with a built-in condensate drain connection.] [Exposed grid must be wick wrapped.][Equip package type steam spray humidifiers to trap out and to evaporate condensate and to supply dry steam to a single distribution grid. Grid must be steam jacketed and condensate drained. Unit must trap excess condensate to return system. Package type steam spray humidifiers must have modulating electric, electronic, or pneumatic steam control valve.] Steam spray humidifiers must be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

2.5.2.2 Steam-Diffuser Type Humidifier

Provide diffuser units that separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials must be [noncorrosive materials][Type 30X stainless steel].

2.5.2.3 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.

2.5.2.4 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.

2.5.2.5 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.

2.5.2.6 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.

2.5.2.7 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 458 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

As required by ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 & 34 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to

the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.

****

Provide continuously-operating, halogen-specific type refrigerant leak detector. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include [a single sampling point][[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay must be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy or utility management and control system (EMCS/UMCS). The EMCS/UMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.5.2.8 Refrigerant Relief Valve/Rupture Disc Assembly

****

NOTE: ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ASHRAE 15 & 34.

****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.5.2.9 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.5.2.9.1 Installation Identification

Provide each new refrigeration system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.5.2.9.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow[, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device(s).

2.5.2.10 Heat Recovery Devices

2.5.2.10.1 Hot Air Reclaim

Provide a [built in] heat recovery unit, factory-fabricated in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.2.10.2 Hot Water Reclaim

****
NOTE: Indicate the size of the exchanger either as a percent of the total rated condenser load or as a percent of the superheated portion of the total rated condenser load. The refrigerant compressor head pressure control and the circulating pump can be deleted if inapplicable.
****

Unit must be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit must be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15 & 34. Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Cabinet must be fabricated of zinc-protected steel and be internally insulated in coil space. The recovery device must be provided with a refrigerant compressor head pressure control and a interlocked, potable water circulating pump. Pump and motor assembly must be close-coupled, manufacturer's standard type

with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Pump must be mounted [remotely][integral] to the exchanger and be rated for [115][208][230] volt ac power supply.

2.5.2.11 Gaskets

Provide gaskets conforming to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

2.5.2.12 Bolts and Nuts

Bolts and nuts must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.5.2.13 Bird Screen

Screen must be 1.6 mm 0.063 inch diameter aluminum wire or 0.79 mm 0.031 inch diameter stainless steel wire.

2.6 FINISHES

2.6.1 Coil Corrosion Protection

****

NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result.

****

Provide 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. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating

must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.6.2 Equipment and Components Factory Coating

****
NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 125 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.
****

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125][500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.6.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils.

2.6.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 43 to 60 degrees C 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 0.025 mm 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours.

Coating materials must have 300 percent flexibility, operate in temperatures of minus 46 to plus 104 degrees C 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.6.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 0.165 mm 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 0.051 mm 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 0.114 mm 4.5 mils thick

2.6.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system

must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

****

NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined and the blank filled in with the appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages are: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

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Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Isolate compressors from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to [10] [10-20] [20-40] [_____] percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Provide foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2 Mechanical Room Ventilation

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NOTE: For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 & 34 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 & 34 allows the use of either natural or mechanical ventilation systems, however, natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6 m 20 ft from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15 & 34. In order to use these equations, a designer must approximate the mass of refrigerant (kgs or lbs) expected in the largest system located in the mechanical room.

Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 & 34 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 & 34 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements (2.5 1/s/m2 or 0.5 cfm/ft2) and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15 & 34. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also in accordance with ASHRAE 15 & 34, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

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Provide mechanical ventilation systems in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.2.3 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.4 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [8] [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Submit a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

b. Submit the field posted instructions, at least [2] [_____] weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. [Submit [6] [_____] complete copies of an operation manual in bound 216 by 279 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.]

d. Submit [[6] [_____] complete copies of maintenance manual in bound 216 by 279 mm 8-1/2 by 11 inch booklets listing] routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 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. [Submit [6] [_____] 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.

3.5.1 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.

3.5.2 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.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration 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. [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 [6] [_____] 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.

3.7 MAINTENANCE

3.7.1 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

-- End of Section --