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USACE / NAVFAC / AFCESA / NASA **UFGS-23 82 02.00 10 (April 2008)**

Preparing Activity: USACE **Superseding UFGS-23 82 02.00 10 (January 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2012
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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 82 02.00 10

UNITARY HEATING AND COOLING EQUIPMENT

04/08

-- End of Section Table of Contents --

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SECTION 23 82 02.00 10

UNITARY HEATING AND COOLING EQUIPMENT
04/08

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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).
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PART 1 GENERAL

1.1 REFERENCES

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

Use the Reference Wizard's Check Reference feature when you add a 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.

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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-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 320	(1998) Water-Source Heat Pumps
AHRI 325	(1998) Ground Water-Source Heat Pumps
AHRI 350	(2008) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
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	(2004) Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units
AHRI 700	(2011) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008) 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) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
ANSI/AHRI 370	(2011) 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/CSA 310/380	(2004) Standard for Packaged Terminal

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

ANSI/ASHRAE 15 & 34	(2010; Addenda a, b, c, d, e, f, g, h, I, j, k, l, n and o; Errata 2011) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 127	(2007) Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners
ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata 2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 64	(2011) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2005) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

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

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM B117	(2011) Standard Practice for Operating

	Salt Spray (Fog) Apparatus
ASTM C1071	(2005e1) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2012) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2011) Enclosures
NEMA MG 1	(2011) Motors and Generators
NEMA MG 2	(2001; Rev 1 2007) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2012) National Fuel Gas Code
NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2011) Heating and Cooling Equipment
UL 207	(2009) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 484	(2007; Reprint Nov 2009) Standard for Room Air Conditioners
UL 586	(2009) Standard for High-Efficiency Particulate, Air Filter Units
UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units

1.2 SYSTEM DESCRIPTION

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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 shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall 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, shall be the premium efficiency type in accordance with NEMA MG 1. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 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 shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall 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 shall 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, shall be provided.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed

item for Army projects.
****

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

SD-02 Shop Drawings

Drawings

SD-03 Product Data

Materials and Equipment
Spare Parts
Posted Instructions
Verification of Dimensions
Coil Corrosion Protection
System Performance Tests
Demonstrations[; G][; G, [_____]]

SD-06 Test Reports

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

SD-07 Certificates

Materials and Equipment
Service Organization

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Submit drawings provided in adequate detail to demonstrate compliance with contract requirements. 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.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [_____] 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.

PART 2 PRODUCTS

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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 ANSI/ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ANSI/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 ANSI/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 ANSI/ASHRAE 15 & 34.

Step 4. Estimate the quantity of refrigerant (grams or 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 or 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 ANSI/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.

ANSI/ASHRAE 15 & 34 refers to a mechanical room as a machinery room, however the terms are synonymous. On mechanical room design, ANSI/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, ANSI/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.)

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2.1 MATERIALS AND EQUIPMENT

2.1.1 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. Submit 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.

a. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

b. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall 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.

c. Where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted.

d. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above shall be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

e. Products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall 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. System components shall be environmentally suitable for the indicated locations.

2.1.2 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 shall 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 shall be durable and legible throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.1.3 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 shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

2.2 UNITARY EQUIPMENT, ROOM UNIT

2.2.1 Window or Through-the-Wall Mounted Unit

****
NOTE: Indicate unit capacity, voltage, phase, installation requirements, etc. on the drawings. At a minimum, efficiencies for these units will be in accordance with paragraph "Equipment Efficiency".
****

Unit shall be a [window] [through-the-wall] mounted, appliance grade, factory assembled air-conditioner unit. Unit shall be in accordance with AHAM RAC-1 and UL 484. Units shall include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Cooling section shall be equipped with a filter-drier on the suction line. Fan and condenser motors shall have [open] [dripproof] [totally enclosed] [explosion proof] enclosures.

2.2.2 Packaged Terminal Unit

Unit shall be a through-the-wall mounted, heavy-duty commercial grade, factory assembled and precharged [air-conditioner] [heat pump] unit. Unit shall be in accordance with ANSI/AHRI/CSA 310/380 and UL 1995. Units shall be removable from inside the building for servicing without removing the outside cabinet. Unit shall have a noise rating in accordance with AHRI 350 and not exceed [_____] bels while the entire unit is operating at any fan or compressor speed. Heat pump units shall contain a reversing valve to change unit to heating cycle. An outdoor coil temperature sensor shall be provided to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil.

2.2.3 Compressor

Compressor shall be hermetically sealed reciprocating, rotary, or scroll type. Compressor shall be fitted with permanent split capacitor motor, overload protection, and vibration isolators. Compressor shall be protected against high discharge pressure, loss of charge, low voltage, and short cycling.

2.2.4 Air-To-Refrigerant Coils

****

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

****

Evaporator and condenser coils shall 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. [Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. A condensate removal system shall be provided.

2.2.5 Fans

Indoor and outdoor fans shall be the centrifugal, direct driven type. Fans shall be statically and dynamically balanced. Outdoor fan shall be designed so that condensate will evaporate without drip, splash, or spray on building exterior. Indoor fan shall be provided with a minimum two-speed motor with built-in overload protection. Fan motors shall be the inherently protected, permanent split-capacitor type.

2.2.6 Air Filters

Filters shall be of the sectional or panel cleanable type and be capable of filtering the entire air supply.

2.2.7 Primary/Supplemental Heat

[Primary] [Supplemental] heat shall be provided as specified in paragraph "Unitary Equipment Components".

2.2.8 Cabinet Construction

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NOTE: The cabinet subbase is optional and should be deleted if not necessary.

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Cabinet shall be free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal shall be a minimum of 1.2 mm 18 gauge steel with a protective coating. Face panels shall be removable and shall provide full access to unit appurtenances. Access to controls shall be without removal of the face panel. Conditioned air shall discharge through adjustable louvers. Cabinet shall be thermally and acoustically insulated with materials which conform to NFPA 90A. Units shall be furnished with a [field-wired] [prewired] subbase. Subbase shall have leveling screws [with] [without] provisions for remote unit control. Subbase shall be of 1.3 mm 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.2.9 Wall Sleeve

Louver shall be stormproof type, constructed of anodized, stamped or

extruded aluminum. Sleeve shall be a water and airtight [completely insulated] [noninsulated] assembly, with weather-resistant protective coating.

2.2.10 Duct Package

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

2.2.11 Unit Controls

Controls shall 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 shall be [integral to unit] [remotely mounted as indicated or as accepted by the Contracting Officer].

2.3 UNITARY EQUIPMENT, PACKAGE SYSTEM

****

NOTE: 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 ANSI/AHRI 340/360.

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

Water-cooled heat pumps used in closed water loop systems (water-source systems) will be rated in accordance with AHRI 320.

Water-cooled heat pumps used in open ground water loop systems (groundwater-source systems) will be rated in accordance with AHRI 325. Delete the last 2 sentences if an open-loop type unit is not specified.

Specify a sound rating of 8.4 bels for outdoor units with capacities below 11.1 kW (38,000 Btuh). Specify a sound rating of 8.6 bels for outdoor units with capacities between 11.1 kW (38,000 Btuh) and 19 kW (65,000 Btuh). Specify a sound rating of 8.8 bels for outdoor units with capacities greater than 19 kW (65,000 Btuh). Specify ANSI/AHRI 270 for sound ratings for outdoor units with capacities less than 39.5 kW (135,000 Btuh), otherwise specify ANSI/AHRI 370.

Include the last sentence only if a water-cooled

unit is specified and the supply water temperature is capable of falling below 18 degrees C (65 degrees F) in any mode of heat pump operation.

At a minimum, efficiencies for packaged systems will be in accordance with paragraph "Equipment Efficiency". Coordinate the efficiency specified with manufacturers.

****

Unit shall be an [air-cooled][water-cooled][evaporatively-cooled] factory assembled, [weatherproof][indoor] packaged unit as indicated. Unit shall be the [air-conditioning] [heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360][AHRI 320][AHRI 325]. Unit shall be provided with equipment as specified in paragraph "Unitary Equipment Components". Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures. Condenser fans shall be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged with refrigerant and oil in accordance with manufacturer's recommendations. Outdoor unit shall produce a maximum AHRI sound rating of [8.4][8.6][8.8][_____] bels in accordance with [ANSI/AHRI 270][ANSI/AHRI 370].[Interior water source piping shall be insulated as a "cold pipe" described in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.][Water-cooled unit shall be fitted with a strainer protected solenoid shut-off valve. The valve shall be a fully automatic, self-contained temperature regulating valve with integral thermometer.]

2.3.1 Air-to-Refrigerant Coils

****

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

****

Air-to-refrigerant coils shall 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.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.3.2 Water-to-Refrigerant Coils

****

NOTE: In areas where poor water conditions exist or where water conditions are unknown, the 0.001 factor will be specified. In areas where water is known to

be noncorrosive the 0.0005 fouling factor will be specified. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system.

****

Coils shall be of the tube-in-tube, shell-and-coil, shell-and-tube, or concentric tube type and be provided as an integral part of the packaged unit. Water-wetted metals shall be [copper][or][90/10][or][70/30] [copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Coils shall be rated for not less than 2758 kPa 400 psi refrigerant side and 862 kPa 125 psi water side pressure service at operating temperatures. Coils shall be supplied with water as indicated. Water supply, return and control system wetted parts shall be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit shall be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement shall include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Performance shall be based on an allowable water velocity not less than 0.9 m/s 3 fps nor more than 3 m/s 10 fps with a fouling factor of [0.001][0.0005].

2.3.3 Evaporatively-Cooled Section

The evaporative section shall be a packaged component of the unitary equipment. Unit shall be the counter-flow blow-through design, with single-side air entry. Unit shall have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section, the cabinet, etc. shall be not lighter than 16-gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A153/A153M and ASTM A123/A123M, as applicable and a minimum coating thickness of 0.76 kg/square meter 2.5 ounces/square foot of surface. Cut edges shall be given a protective coating of zinc-rich compound. After assembly, the manufacturer's standard zinc chromatized aluminum or epoxy paint finish shall be applied to the exterior of the unit.

2.3.3.1 Pan Section

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.3.3.2 Fan Section

Fan shall be the [centrifugal][propeller] type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have [open][splashproof][totally enclosed] enclosure and be suitable for the indicated service. The unit design shall prevent water from entering into the fan section.

2.3.3.3 Condensing Coil

****

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

****

Coils shall have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system.

2.3.3.4 Water Distribution System

Water shall be distributed uniformly over the condensing coil to ensure complete wetting of the coil at all times. Spray nozzles shall be brass, stainless steel, or high-impact plastic. Nozzles shall be the cleanable, nonclogging, removable type. Nozzles shall be designed to permit easy disassembly and be arranged for easy access.

2.3.3.5 Water Pump

The water pump shall be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the unit or remotely on a separate mounting pad. Pumps shall have cast-iron casings. Impellers shall be bronze, and shafts shall be stainless steel with bronze casing wearing rings. Shaft seals shall be the mechanical type. Pump casing shall be factory coated with epoxy paint. Pump motors shall have [open][dripproof] [totally enclosed][explosion proof] enclosures. A bleed line with a flow valve or fixed orifice shall be provided in the pump discharge line and shall be extended to the nearest drain for continuous discharge. Pump suction shall be fully submerged and provided with a galvanized steel or monel screened inlet.

2.3.3.6 Drift Eliminator

Eliminators shall be provided to limit drift loss to not over 0.005 percent of the specified water flow. Eliminators shall be constructed of zinc-coated steel or polyvinyl chloride (PVC). Eliminators shall prevent carry over into the unit's fan section.

2.3.3.7 Evaporator Controls

Unit shall be provided with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers shall modulate to reduce the airflow across the condensing coil. Controls shall include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycling of a fan motor on and off shall be in accordance with the manufacturer.

2.3.4 Compressor

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 35 kW 10 tons and larger shall be provided 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 shall operate in sequence, and each compressor shall have an independent refrigeration

circuit through the condenser and evaporator. Compressors shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,] [high][high and low] pressure safety cutoffs and protection against short cycling.

2.3.5 Refrigeration Circuit

****
NOTE: Filter-driers are optional and may be deleted on most precharged systems.
****

Refrigerant containing components shall comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall 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.

2.3.6 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. Enthalpy controls will not be used.
****

Unit shall be internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall 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 shall sustain unit operation with ambient temperature of [_____]. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

2.4 UNITARY EQUIPMENT, SPLIT SYSTEM

****
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 ANSI/AHRI 340/360.

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

Water-cooled heat pumps used in closed water loop systems (water-source systems) will be rated in accordance with AHRI 320.

Water-cooled heat pumps used in open ground water loop systems (groundwater-source systems) will be rated in accordance with AHRI 325.

At a minimum, efficiencies for split-systems will be in accordance with paragraph "Equipment Efficiency". Coordinate the efficiency specified with manufacturers.

****

Unit shall be an [air-cooled][water-cooled][evaporatively-cooled], split system which employs a remote [condenser][condensing unit], a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the [air-conditioning][heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360][AHRI 320][AHRI 325]. Unit shall be provided with necessary fans, air filters, [coil frost protection,][liquid receiver,] internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT. Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.4.1 Air-to-Refrigerant Coil

****

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

****

Coils shall 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.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.4.2 Compressor

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

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 35 kW 10 tons and larger shall be provided 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 will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,] [high][high and low] pressure safety cutoffs and protection against short cycling.

2.4.3 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 shall comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall 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. A refrigerant suction line [thermostatic][thermostatic and water flow switch] control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

2.4.4 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.

****

Unit shall be internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall 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 shall sustain unit operation with ambient temperature of [_____] degrees C degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

2.5 REMOTE CONDENSER OR CONDENSING UNIT

****

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

****

Units with capacities less than 39.5 kW 135,000 Btuh shall produce a maximum AHRI sound rating of [_____] bels when rated in accordance with ANSI/AHRI 270. Units with capacities 39.5 kW 135,000 Btuh or greater shall produce a maximum AHRI sound rating of [_____] bels when rated in accordance with ANSI/AHRI 370. Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 49 degrees C 120 degrees F at 40 degrees C 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of [_____] degrees C degrees F. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.5.1 Air-Cooled Condenser

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

2.5.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between [condenser][condensing unit] and evaporator units shall

be provided.

2.5.1.2 Head Pressure Control and Liquid Subcooling

Low ambient control for multi-circuited units serving more than one evaporator coil shall provide independent condenser pressure controls for each refrigerant circuit. Controls shall be set to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Unit shall be provided with a liquid subcooling circuit which shall ensure proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit shall be provide with [manufacturer's standard] [not less than [4][_____] degrees C [8][_____] degrees F] liquid subcooling. Subcooling circuit shall be liquid sealed.

2.5.1.3 Condensing Coil

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

Coils shall 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.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.5.1.4 Unit Controls

The control system shall be complete 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. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include [control transformer,] [fan motor [starters,]] [solid-state speed control,] [electric heat tracing controls,] [time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.5.2 Evaporative Condenser

Each unit shall be the counter-flow blow-through design, with single-side air entry. The unit shall have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section, the cabinet, etc. shall be not lighter than 1.6 mm 16-gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to 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. Cut edges shall be given a protective coating of zinc-rich compound. After assembly, the manufacturer's standard zinc chromatized aluminum or epoxy paint finish shall be applied to the

exterior of the unit. Unit shall be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

2.5.2.1 Pan Section

The pan shall be watertight and be provided with drain, overflow, and make-up water connections. Standard pan accessories shall include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.5.2.2 Fan Section

Fan shall be the [centrifugal][propeller] type in accordance with paragraph "Fans". Fan and fan motor shall not be located in the discharge airstream of the unit. Motors shall have [open][splashproof][totally enclosed] enclosure and be suitable for the indicated service. The condensing unit design shall prevent water from entering into the fan section.

2.5.2.3 Condensing Coil

****

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

****

Coils shall have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged.

2.5.2.4 Water Distribution System

Water shall be distributed uniformly over the condensing coil to ensure complete wetting of the coil at all times. Spray nozzles shall be brass, stainless steel, or high-impact plastic. Nozzles shall be the cleanable, nonclogging, removable type. Nozzles shall be designed to permit easy disassembly and be arranged for easy access.

2.5.2.5 Water Pump

The water pump shall be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps shall have cast-iron casings. Impellers shall be bronze, and shafts shall be stainless steel with bronze casing wearing rings. Shaft seals shall be the mechanical type. Pump casing shall be factory coated with epoxy paint. Pump motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures. A bleed line with a flow valve or fixed orifice shall be provided in the pump discharge line and shall be extended to the nearest drain for continuous discharge. Pump suction shall be fully submerged and provided with a galvanized steel or monel screened inlet.

2.5.2.6 Drift Eliminator

Eliminators shall be provided to limit drift loss to not over 0.005 percent of the specified water flow. Eliminators shall be constructed of zinc-coated steel or polyvinyl chloride (PVC). Eliminators shall prevent carry over into the unit's fan section.

2.5.2.7 Unit Controls

The evaporative condenser unit shall be provided with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers shall modulate to reduce the airflow through the evaporative condenser. Controls shall include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycling of a fan motor on and off shall be in accordance with the manufacturer.

2.5.3 Compressor

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

Unit shall be rated in accordance with AHRI 540. Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Units 35 kW 120,000 Btuh and larger shall be provided 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 will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater,[lubrication pump,] thermal overloads, and [high][high and low] pressure safety cutoffs and protection against short cycling.

2.6 AIR-CONDITIONERS FOR ELECTRONIC DATA PROCESSING (EDP) SPACES

****
NOTE: Indoor units are inherently noisy. In noise sensitive areas, steps should be taken to attenuate sound.

Air-cooled and water-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 units with capacities greater than or equal to 19 kW (65,000 Btuh) will be rated in accordance with ANSI/AHRI 340/360.

Delete the last sentence if an integral water-cooled condenser or a packaged air-cooled unit is specified.

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-Conditioner/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.

****

Unit shall be an [air-cooled][water-cooled], self-contained type air-conditioning unit. Unit shall be [a packaged unit with an internal water-cooled condenser][a split-system with a remote [condenser][condensing unit]]. Unit shall be designed and constructed for automatic control of space conditions. Unit shall be in accordance with ASHRAE 127 and UL 1995. Unit shall be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. AHRI certification is not required. The system shall be designed and constructed for maximum reliability and ease of maintenance. Necessary redundancy, access to refrigeration circuits, means of troubleshooting, and malfunction alarms shall be provided. Unit shall be provided with necessary fans, air filters,[coil frost protection,][liquid receiver,] internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "Unitary Equipment Components". Evaporator or supply fans shall be double-width, double inlet, forward curved centrifugal scroll type. Condenser or outdoor fans shall be manufacturer's standard for unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures.[Remote unit shall be as specified in paragraph REMOTE CONDENSER/CONDENSING UNIT.]

2.6.1 Air-to-Refrigerant Coils

****

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

****

[Evaporator][Evaporator and condenser] coils shall 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.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Units shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.6.2 Water-to-Refrigerant Coils

****

NOTE: Delete this paragraph if a remote condenser/condensing unit is specified. Delete the last two sentences if a once-thru water source is not used in conjunction with the self-contained unit.

Delete the inapplicable fouling factor. In areas where poor water conditions exist or where water conditions are unknown, the 0.001 factor will be specified. In areas where water is known to be noncorrosive the 0.0005 fouling factor will be specified. The inapplicable fouling factor will be deleted. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system.

****

Unit shall be of the tube-in-tube, shell-and-coil, shell-and-tube, or concentric tube type and be provided as an integral part of the self-contained unit. Water-wetted metals shall be [copper][or][90/10][or][70/30][copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Unit shall be rated for not less than 2758 kPa 400 psi refrigerant side and 862 kPa 125 psi water side pressure service at operating temperatures. Unit shall be supplied with water as indicated. Water supply, return and control system wetted parts shall be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit shall be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement shall include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Performance shall be based on an allowable water velocity not less than 0.9 m/s 3 fps nor more than 3 m/s 10 fps with a fouling factor of [0.001][0.0005]. A separate condenser shall be provided for each compressor circuit. Control shall be set for refrigerant condensing temperature of [_____] degrees C degrees F. Units which use a once-thru water-source shall be fitted with a strainer protected solenoid shut-off valve. The valve shall be a fully automatic, self-contained temperature regulating valve with integral thermometer. Mercury shall not be used in thermometers.

2.6.3 Compressor

****

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

****

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 26 kW 7.5 tons and larger shall be provided 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 will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, [lubrication pump,] thermal overloads, and [high] [high and low] pressure safety cutoffs and protection against short cycling.

2.6.4 Refrigeration Circuit

****
NOTE: Filter-driers are optional and may be deleted on most precharged systems. Delete the last two sentences except when needed for a self-contained heat pump with an integral water-cooled condenser.
****

Refrigerant-containing components shall comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall 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. A refrigerant suction line [thermostatic][thermostatic and water flow switch] control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

2.6.5 Unit Controls

A unit's basic functions and space ambient conditions shall be controllable at one station. A temperature and humidity strip-chart recorder, integral or external to the unit, readable to specified control accuracy, shall be provided, complete with cartridge ink and chart supply for 1 year of operation.

2.6.5.1 Externally Accessible Controls

The following controls shall be externally accessible:

a. Start and stop total system functions.

b. Audible alarm silence.

c. Main power disconnect.

2.6.5.2 Status Indicators

The following status indicators shall be externally visible:

a. Power On.

b. System On.

c. Malfunction.

d. Provision for remote alarm status indication.

2.6.5.3 Alarmed Conditions

The following system status conditions shall be both audibly and visually alarmed:

a. Loss of air flow.

b. Dirty filters.

c. Compressor overload or lock-out (compressor high head pressure and low suction pressure).

d. [High][High and low] room temperature.

e. High humidity alarm at [_____] percent relative humidity.

2.6.5.4 Space Temperature

Space temperature shall be controlled within plus or minus 1 degree C 1.5 degrees F of the set point over a range of 16 to 32 degrees C 60 to 90 degrees F with a set point of [_____]. Space relative humidity shall be controlled within plus or minus 5 percent of the set point over a range of 20 to 80 percent with a set point of [_____] percent.

2.6.5.5 Safety Controls

Safety controls shall include the following:

a. Fused, unfused or line-break circuit breaker disconnects, as indicated or required.

b. Automatic pump-out or pump-down liquid flooding controls.

c. High refrigerant pressure cutout.

d. Low refrigerant pressure cutout where automatic pump-down is not provided.

e. Accessible hermetic and open compressor low oil pressure cutout.

f. Elapsed time meter for each compressor where load equalization is not incorporated.

g. Lead and lag compressor selector switch, when compatible with system.

2.6.6 Cabinet Construction

****
NOTE: Delete the last sentence if inapplicable.
****

Cabinet shall be totally enclosed. Enclosure surfaces shall be pulsation free, with hinged and removable doors and panels for vertical side or front access to unit components. Routine maintenance access to compressor and system control components shall be possible without unit shut-down. Enclosure surfaces shall be thermally and acoustically insulated. Interior baffle and compartment surfaces shall be galvanized steel. Drain pans shall collect all condensate and be steel with external insulation as required. Surface mounting steel pads and vibration isolating pads shall be provided. Enclosure surfaces shall be prepared, primed and finished. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING. Cabinets shall be fitted with integral or separable, adjustable and lockable jacks to support the units from the structural slab at the raised-floor elevation.

2.7 EQUIPMENT EFFICIENCY

****

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 shall 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 shall 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 http://www.hnd.usace.army.mil/criteria/fyo8/epact05/unitary_Eff.xls. Equipment having a higher efficiency may be specified if the designer determines the equipment to be more life-cycle cost effective.

****

Unit shall have an efficiency [of [_____]][as indicated on the drawings].

2.8 UNITARY EQUIPMENT COMPONENTS

****

NOTE: System components which are not referenced from the equipment specified above, excluding refrigerant and oil, will be deleted.

****

2.8.1 Refrigerant and Oil

****

NOTE: Equipment shall 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 shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants shall meet the requirements of AHRI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.8.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a [open][dripproof][totally enclosed][explosion proof] enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall 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 shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Forward curved fan wheels shall be limited to [_____] mm inches. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size shall 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 shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades. V-belt driven fans shall 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 shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

2.8.3 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.

****

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

2.8.3.2 Steam Coil

Coil shall conform to the provisions of AHRI 410. Coil shall 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 shall be rolled and bushed and brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, shall be not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. The fin tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure-steam service. Coils shall 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 shall be steam-distributing tube type. Condensing tubes shall be not less than 15 mm 5/8 inch outside diameter. Distribution tubes shall be not less than 10 mm 3/8 inch outside diameter, and be equipped with orifices to discharge steam to condensing tubes. Distribution tubes shall be installed concentrically inside of condenser tubes and be held securely in alignment. The maximum length of a single coil shall be limited to 120 times the diameter of the outside tube. Other heating coils shall be minimum 13 mm 1/2 inch outside diameter single-tube type. Supply headers shall distribute steam evenly to all tubes at the indicated steam pressure. Coil shall allow complete coil drainage with a pitch of not less than 10 mm/meter 1/8 inch/foot slope to drain.

2.8.3.3 Electric Heating Coil

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

Coil shall be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil shall be duct- or unit-mounted. Coil shall be of the [nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil shall 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 shall be of galvanized steel or aluminum. Coil shall be mounted to eliminate noise from expansion and contraction and be completely accessible for service.

2.8.3.4 Gas-Fired Heating Section

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

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

2.8.4 Air Filters

****
NOTE: References to inapplicable filter types will be deleted.
****

Air filters shall 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 shall be as listed under the label service and shall meet the requirements of UL 586.

2.8.4.1 Extended Surface Pleated Panel Filters

Filters shall be 50 mm 2 inch depth sectional type of the size indicated and shall 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 will not exceed 90 Pa 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.8.4.2 Replaceable Media Filters

Replaceable media filters shall be the [dry-media][viscous adhesive] type, of the size required to suit the application. Filtering media shall be not less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall 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. The air flow capacity of the filter shall be based 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 shall be not less than [_____] percent when tested in accordance with ASHRAE 52.2.

2.8.4.3 Sectional Cleanable Filters

****
NOTE: Delete the last three sentences if a washing and cleaning unit is not necessary.
****

Cleanable filters shall be [25][50] mm [1][2] inches thick. Viscous adhesive shall 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 shall be provided for every 100 filter sections or fraction thereof. Each washing and charging unit shall consist of a tank and [single] [double] drain rack mounted on legs. Drain rack shall be provided with dividers and partitions to properly support the filters in the draining position.

2.8.5 Coil Frost Protection

****
NOTE: If coil frost protection is required, manufacturer's recommended coil frost protection systems shall be evaluated. If the manufacturer's standard coil frost protection is not appropriate, determine if a hot gas bypass system is an economical and practical coil frost protection system and modify the specification as required.
****

Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.8.6 Pressure Vessels

Pressure vessels shall 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, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.8.6.1 Hot Gas Muffler

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

2.8.6.2 Liquid Receiver

A liquid receiver shall 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 shall be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver shall 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 shall be provided with a relief valve of capacity and setting in accordance with ANSI/ASHRAE 15 & 34.

2.8.6.3 Oil Separator

Separator shall 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 shall not exceed [70][_____] kPa [10][_____] psi during the removal of hot gas entrained oil. Connections to compressor shall be as recommended by the compressor manufacturer. Separator shall 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.

2.8.6.4 Oil Reservoir

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

2.8.7 Internal Dampers

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

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

2.8.8 Mixing Boxes

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

2.8.9 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 shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall 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 shall 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 shall be 1.0 mm 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall 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 shall conform to ASTM C1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.8.9.1 Indoor Cabinet

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

2.8.9.2 Outdoor Cabinet

Outdoor cabinets shall 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.

2.9 ACCESSORIES

2.9.1 Dry-Cooler, Glycol Solution

Unit shall be factory fabricated and tested, packaged, self-contained, complete with casing, propeller or centrifugal type fans, heat rejection coils, appurtenances, and intercomponent piping and wiring. Unit shall be certified by the manufacturer or an independent test laboratory that the

unit's ratings meet AHRI 410 the indicated conditions. Unit shall be designed for [outdoor][indoor] installation and comply with the requirements of UL 1995. Unit shall compatible with the solution specified in paragraph "Glycol Solution". Unit shall be fitted with[duplex] recirculating pump, expansion tank, [black steel][Type L copper][schedule 80 PVC] intercomponent piping, system accessories and controls. Factory assembled piping shall be Type L copper. Cabinet construction shall be in accordance with paragraph "Unitary Equipment Components".

2.9.1.1 Coil

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

Coils shall 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.[Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION.] Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall 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 shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.9.1.2 Fan Section

Fan shall be the [centrifugal][propeller] type in accordance with paragraph "Fans". Motors shall have [open][dripproof][totally enclosed][explosion proof] enclosures and be suitable for the indicated service.

2.9.1.3 Pump

Pump and controls shall be mounted within a lockable sheet metal enclosure supported from dry cooler structure. Pump shall be of the end-suction type with an [open][dripproof][totally enclosed][explosion proof] motor. Pump construction shall be as specified in paragraph "Pumps". Seals shall be mechanical type suitable for ethylene glycol solution up to a 60 percent concentration of glycol, and be rated for 82 degrees C 180 degrees F service.

2.9.1.4 Controls

The control system shall be complete with all required accessories for regulating glycol temperature by [fan cycling.][solid-state variable fan speed.][modulating glycol 3-way mixing valve or modulating fan dampers.] Unit-mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include a [control transformer,][fan motor[starters],] [solid-state speed control,][pump motor starters,][electric heat tracing controls,][time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.9.2 Humidifier

2.9.2.1 Steam Spray Type

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

2.9.2.2 Steam-Diffuser Type

Diffuser units shall be of a design that will 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 shall be [noncorrosive materials][Type 300 stainless steel].

2.9.3 Purge System

****

NOTE: Refrigeration systems which operate below atmospheric pressure (i.e., R-123 machines) will require a refrigerant purge piping system. Indicate the routing of purge piping on the drawings. Require the Contractor to delete the piping if a purge system is not required for the type of refrigeration system that is to be provided. Indicate that it will be the Contractor's responsibility to size the piping based upon the recommendations of the refrigeration system's manufacturer. Purge discharge piping may be connected to the pressure-relief piping on the equipment side of the piping's vibration isolators.

****

Refrigeration systems which operate at pressures below atmospheric pressure shall be provided with a purge system. Purge systems shall automatically remove air, water vapor, and non-condensable gases from the system's refrigerant. Purge systems shall condense, separate, and return all refrigerant back to the system. An oil separator shall be provided with the purge system if required by the manufacturer. Purge system shall not discharge to occupied areas, or create a potential hazard to personnel. Purge system shall include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system shall include lights or an alarm which indicate excessive purge or an abnormal air leakage into the system.

2.9.4 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ANSI/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 foot) 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 ANSI/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, ANSI/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.

****

Detector shall be the continuously-operating, halogen-specific type. Detector shall be appropriate for the refrigerant in use. Detector shall be specifically designed for area monitoring and shall include [a single

sampling point][[_____] sampling points] installed where indicated. Detector design and construction shall be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector shall have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector shall be supplied factory-calibrated for the appropriate refrigerant(s). Detector shall 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 shall be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector shall be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector shall be compatible with the facility's energy management and control system (EMCS). The EMCS shall 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.]

2.9.5 Refrigerant Relief Valve/Rupture Disc Assembly

****

NOTE: ANSI/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 ANSI/ASHRAE 15 & 34.

****

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

2.9.6 Refrigerant Signs

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

2.9.6.1 Installation Identification

Each new refrigeration system shall be provided 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.

2.9.6.2 Controls and Piping Identification

Refrigerant systems containing more than 50 kg 110 lb of refrigerant shall be provided 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).

2.9.7 Heat Recovery Devices

2.9.7.1 Hot Air Reclaim

Unit shall be a heat recovery, factory-fabricated, draw-through, central station type air conditioner in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.9.7.2 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 shall be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit shall be constructed and refrigerant pressure/temperature rated in accordance with ANSI/ASHRAE 15 & 34. Heat exchanger coil shall consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Cabinet shall be fabricated of zinc-protected steel and be internally insulated in coil space. The recovery device shall be provided with a refrigerant compressor head pressure control and a interlocked, potable water circulating pump. Pump and motor assembly shall be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Pump shall be mounted [remotely][integral] to the exchanger and be rated for [115][208][230] volt ac power supply.

2.9.8 Gaskets

Gaskets shall conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

2.9.9 Bolts and Nuts

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

2.9.10 Bird Screen

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

2.10 FINISHES

2.10.1 Factory Coating

2.10.1.1 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 shall be applied at either the coil or coating manufacturer's factory. Coating process shall ensure complete coil encapsulation. Coating shall 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.

2.10.1.2 Equipment and Components

****
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, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall 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 shall 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 shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.10.2 Factory Applied Insulation

Refrigeration equipment shall 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 shall 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 shall 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 shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84. Insulation shall 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 shall be tested as a composite material. Jackets, facings, and adhesives shall 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.

2.11 SUPPLEMENTAL COMPONENTS/SERVICES

2.11.1 Condenser Water Piping and Accessories

Condenser water piping and accessories shall be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.11.2 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.11.3 Cooling Tower

Cooling towers shall be provided and installed in accordance with Section 23 65 00 COOLING TOWERS.

2.11.4 Ductwork

Ductwork shall be provided and installed in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.11.5 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.

****

Temperature controls shall be [in accordance with Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS][fully coordinated with and integrated into the existing air-conditioning system].

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. Submit a letter, at least [2] [_____] weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

3.2 INSTALLATION

Work shall be performed 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 shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

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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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Refrigeration equipment and the installation thereof shall conform to ANSI/ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall 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 shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to [_____] percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE. Equipment shall 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 ANSI/ASHRAE 15 & 34 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ANSI/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 6.1 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 ANSI/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, ANSI/ASHRAE 15 & 34 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ANSI/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 ANSI/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 ANSI/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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Mechanical ventilation systems shall be in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.2.3 Field Applied Insulation

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

3.4 DEMONSTRATIONS

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] 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 shall 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 shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions shall 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 shall include the manufacturer's name, model number, and parts list. The manuals shall 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 shall 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 shall be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant

systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems shall 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 shall 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 shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall 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 shall 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 shall more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall 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 shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

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

b. Make corrections and adjustments, as necessary, tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant

lost during the system startup shall be replaced.

c. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted 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. Field tests shall be coordinated 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 shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall 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):

aa. Date and outside weather conditions.

bb. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) Ambient, condensing and coolant temperatures.
(5) Running current, voltage and proper phase sequence for each phase of all motors.

cc. The actual on-site setting of operating and safety controls.

dd. Thermostatic expansion valve superheat - value as determined by field test.

ee. Subcooling.

ff. High and low refrigerant temperature switch set-points

gg. Low oil pressure switch set-point.

hh. Defrost system timer and thermostat set-points.

ii. Moisture content.

jj. Capacity control set-points.

kk. Field data and adjustments which affect unit performance and energy consumption.

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

-- End of Section --