UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 69 00.00 20

REFRIGERATION EQUIPMENT FOR COLD STORAGE

07/06, CHG 2: 08/18

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USACE / NAVFAC / AFCEC / NASA	**UFGS-23 69 00.00 20 (July 2006)** **Change 2 - 08/18**
Preparing Activity: NAVFAC	**Superseding** **UFGS-23 69 00.00 20 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 23 69 00.00 20

REFRIGERATION EQUIPMENT FOR COLD STORAGE
07/06, CHG 2: 08/18

****
NOTE: This guide specification covers the requirements for requirements for refrigeration equipment for cold storage facilities.

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

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

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

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

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

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 420	(2008) Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration
AHRI 450	(2007) Water-Cooled Refrigerant Condensers, Remote Type
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

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

ANSI/ASHRAE 15 & 34	(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 23.1	(2010) Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the

Refrigerant

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

COOLING TECHNOLOGY INSTITUTE (CTI)

CTI ATC-105	(2000) Acceptance Test Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal

	Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59223	(Basic; Notice 1) Cooling Towers, Liquid

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 207	(2009; Reprint Jan 2020) Refrigerant-Containing Components and Accessories, Nonelectrical

1.2 SUBMITTALS

****

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

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

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

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

SD-02 Shop Drawings

Refrigeration Equipment; G[, [_____]]

Atmospheric Cooling Equipment, including supporting members; G[, [_____]]

SD-03 Product Data

Unit Coolers; G[, [_____]]

Energy Star Label for Unit Cooler Product; S

[Compressor] [Condensing] Units; G[, [_____]]

Condensers; G[, [_____]]

Energy Star Label for Air-Cooled Condenser Product; S

Energy Star Label for Water-Cooled Condenser Product; S

Atmospheric Cooling Equipment; G[, [_____]]

Water Treatment System; G[, [_____]]

Automatic Controls; G[, [_____]]

Heat Recovery Devices; G[, [_____]]

Motors; G[, [_____]]

SD-06 Test Reports

Pressure Vessels; G[, [_____]]

Aquatic Toxicity

SD-07 Certificates

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Refrigeration Equipment; G[, [_____]]

Water Treatment System; G[, [_____]]

Include instruction for evacuation and charging procedures and equipment start-up and initial operation.

SD-10 Operation and Maintenance Data

Refrigeration Equipment, Data Package 3; G[, [_____]]

Automatic Controls, Data Package 3; G[, [_____]]

Motors, Data Package 3; G[, [_____]]

Motor Starters, Data Package 3; G[, [_____]]

Water Treatment System, Data Package 3; G[, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 QUALITY ASSURANCE

1.3.1 Modifications of References

Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.

1.3.2 Safety

Design, manufacture, and installation of refrigeration equipment shall conform to ANSI/ASHRAE 15 & 34, UL 207, and NFPA 70. Provide personnel protection from moving parts including fans, pulleys chains gears and couplings. Guard or cover with insulation high temperature machinery and piping.

1.3.3 Pressure Vessels

The design, fabrication, inspection, and testing of pressure vessels including the waterside and refrigerant side of condensers and evaporators shall be in accordance with ASME BPVC SEC VIII D1, and ANSI/ASHRAE 15 & 34. The presence of the ASME official Code U-Symbol or Code UM-Symbol stamped or marked on the vessels, and the submitting of the applicable ASME required manufacturer's data report will be accepted as evidence that the pressure vessels comply to the ASME rules for construction. 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. [Where service temperatures below minus 7 degrees C 20 degrees F are encountered, materials of construction shall be low temperature alloy carbon steel.] Nozzle length shall be approximately 1/3 greater than insulation thickness. Insulated vessels shall be fitted with rings and other insulation supports as required for installation of insulation. Exterior surfaces of vessels which are insulated and vapor barrier sealed shall be abrasive blasted and primed with 0.076 mm 3 mil dry film thickness of inorganic zinc rich coating.

1.3.4 Refrigeration Equipment

Include layout drawings and control diagrams of the refrigeration equipment.

1.3.5 Ozone Depleting Substances Technician Certification

****
NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.
****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 REFRIGERATION PIPING AND ACCESSORIES

****
NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.
****

Provide as specified under [_____].

1.5 ENVIRONMENTAL REQUIREMENTS

Assess potential effects of all lubricants on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity shall exceed 1,000 ppm at LL50 and biodegradation shall exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

PART 2 PRODUCTS

2.1 UNIT COOLERS

[Forced circulation] [Free delivery] type, factory fabricated, assembled and tested, and packaged in accordance with AHRI 420.

2.1.1 Construction

Construct casings of Type 300 Series stainless steel, aluminum, mill galvanized or hot-dip galvanized steel after fabrication. Provide zinc coated carbon steel with protective coating. Direct or V-belt drive fans of the propeller or centrifugal type. Statically and dynamically balance the fan wheels. Coils service shall have copper tubes and aluminum fins. Provide water-tight, corrosion resistant drain pans. Drain pans and drainage piping for units in spaces maintained at less than 2 degrees C 35 degrees F shall be insulated and fitted with means for defrosting and condensate removal.

2.1.2 Energy Performance

Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize. Equipment efficiency shall meet the requirements of Energy Star. Provide proof of Energy Star label for unit cooler product.

2.1.3 Defrosting

Defrost units mounted in spaces maintained at 2 degrees C 35 degrees F or higher with ambient space air. Provide units mounted in spaces maintained at less than 2 degrees C 35 degrees F with [hot gas] [electric heat] defrosting system. Control room air defrosting by a timer defrost controller adjustable for up to 6 defrost cycles per 24 hours, each of 5 to 120 minutes duration. Defrost systems shall be controlled by [timer] [demand] defrost controller.

2.1.3.1 Timer Defrost Controller

Controller shall include an adjustable timer to control frequency of cycles; [defrost initiating thermostat;] adjustable program timer to control sequence of defrost cycle; [defrost terminating thermostat;] manual override switch; selector switch; and status pilot light.

2.1.3.2 Demand Defrost Controller

Controller shall include an automatic, solid-state circuitry to initiate defrost cycle based on sensing adjustable temperature difference of air moving across coil in direct proportion to frost build-up; thermostat to terminate defrost; adjustable lockout to prevent initiation of defrost during pull-down after defrost cycle; manual override switch; and status pilot light.

2.2 [COMPRESSOR] [CONDENSING] UNITS

****

NOTE: HFC-134a refrigerant is non-ozone depleting, but contributes to global warming. HCFC-123 refrigerant is ozone-depleting (but much less so than R-11), and contributes minimally to global warming. EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at

http://www.epa.gov/ozone/snap/refrigerants/lists/index.html
or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment contributes to achieving sustainability requirements.
****

Factory fabricated, assembled and tested, packaged, ready for full capacity operation after terminal point connection and field charging with operating fluids. Units shall conform to ANSI/AHRI 520, ASHRAE 23.1, and ANSI/ASHRAE 15 & 34. Provide two charges of lubricating oil for each compressor. The first charge shall be used during the operating test period, and at the end of this period shall be withdrawn and replaced with the second charge. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. CFC-based refrigerants are prohibited. [HCFCs][and Halons]shall not be permitted.[Use HFC-134a refrigerant.][Use HCFC-123 refrigerant.]

2.2.1 Capacity Criteria

****
NOTE: Show the capacity and saturated suction temperature, saturated condensing temperature, superheat, and subcooling on the drawings.
****

Application capacity rating shown shall include suction superheat and liquid subcooling. Compressor design saturated condensing temperature and saturated suction temperature limits shall not be exceeded.

2.2.2 Reciprocating Compressors

[Hermetic] [Open], [direct] [V-belt] drive reciprocating piston type, designed and constructed for indicated compression ratio service. [Design welded hermetic compressors for high compression ratio heat pump and low temperature refrigeration service.] Machine cylinder blocks and heads from aged, fine-grained, cast iron. [Provide ammonia service compressor cylinder blocks and heads with self-draining water- or refrigerant-cooled jackets where recommended by the manufacturer.] [Freeze-protect water jackets.] Forge crankshafts of steel or cast nodular iron. Dynamically balance rotating parts, including crankshaft and power transmission components. Design compressors to operate at partial loads without vibration greater than full load vibration and be capable of continuous operation at lowest partial load. Piston speed shall not exceed manufacturer's recommendation or 4 1/2 m/s 875 fpm, whichever is lesser. Provide main journals and ferrous and bronze connecting rods with replaceable sleeve insert type, steel-backed, antifriction metal wear surface bearings, or antifriction bearings or a combination thereof. Aluminum connecting rod bearings shall be integral or replaceable sleeve insert type. Provide bulls-eye type oil sight glass at crankcase operating level. Compressors with a rated input of 2 1/4 kW 3 horsepower and over shall have forced-feed lubrication with reversible, self-priming, suction strainer fitted, direct crankshaft drive, positive-displacement pump. [Open compressor shaft seals shall be oil lubricated and cooled rotary mechanical type with externally, individually, replaceable wearing components.] External drive motor enclosures shall be [open drip-proof.] [totally enclosed.]

2.2.3 Helical Rotary Compressors

Provide positive displacement, oil-injected type, driven by an electric motor. Solid steel rotors, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Provide housings and covers of high-grade cast-iron pressure castings. Lubrication systems shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when the oil management system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electric power supply.

2.2.4 Accessories

Unit accessories with 1 1/8 kW 1 1/2 horsepower and larger compressor shall include suction, discharge and liquid gage ported shutoff valves, suction and discharge service valves, suction strainers, mufflers, crankcase heaters, and pressure relief. Provide double seated service valves with gage ports. Provide lube oil pressure gages and failure switches for forced-feed lubricated open and accessible hermetic compressors. Unless continuous heating is recommended by compressor manufacturer, crankcase heaters shall function only when compressor is stopped.[Provide condensers with purge valves.][Where low ambient control incorporates condenser flooding, receiver shall be sized as required.]

2.2.5 Capacity Controls

Compressors shall start from rest unloaded.[Provide with start-stop control.] [Provide with capacity modulation.][Provide not less than [_____] capacity control steps.]

2.2.6 Condenser, Integral

Provide with [air-cooled] [water-cooled] condenser.[Open compressor unit rated through 2 1/4 kW 3 horsepower may utilize integrally cast blades of compressor flywheel or sheave as the air moving device supplemented by a propeller fan mounted on extended compressor drive motor shaft.][Provide condensers and compressors with manufacturer's standard direct-drive propeller fans which are elastomer mounted in combined, enclosing, guard or support.] Construct coils with separate subcooling circuit [and circuiting as indicated,] of copper tubing with aluminum fins. Test coils in accordance with ANSI/ASHRAE 15 & 34. Provide coils with sheet steel frame and venturi fan shroud.

2.2.7 Condenser, Water-Cooled, Integral

Provide cleanable tube-in-tube condenser with [copper] [70/30 copper-nickel] coolant wetted surfaces and coolant regulating valve. Base condenser rating on coolant fouling factor of [0.0005] [0.001].

2.2.8 Condenser-Receiver, Water-Cooled, Integral

****

NOTE: Normally 70/30 copper nickel performance is superior to 90/10 copper nickel in brackish and salt

water. Where conditions are not detrimental to 90/10 copper nickel, incorporate same as an alternative acceptable material. Use the higher fouling factor for open systems.
****

Provide cleanable shell and tube condenser-receiver with [copper] [70/30 copper-nickel] tubes and coolant regulating valve. Base condenser rating on coolant fouling factor of [0.0005.] [0.001.]

2.2.9 Control Panels

****
NOTE: Verify that reverse-phase, and phase imbalance protection provisions are available in sizes under 70 kW 20 tons. Check with manufacturers before specifying other than across-the-line starting.
****

Control panels and electrical components shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4 and NEMA ICS 6, and mounted in a NEMA ICS 6, Type 1 enclosure. Electrical controls shall include [[fused] [unfused] disconnect;] control transformers with 50 percent excess capacity; main and branch circuit overload protective devices compensated for ambient temperatures as recommended by the manufacturer; reverse phase protection where necessary to preclude damage; single-phase and phase-imbalance protection; low voltage protection; manual reset on power interruption or safety shutdown; [power factor correction capacitors;] [status pilot lights;] compressor safety, operating and capacity controls; [defrost controls;] [local and remote audible and visual alarms with provisions to silence;] short cycling control with lock-out timer; time delay for sequenced compressor starts; remote component interface; and intercomponent wiring to terminal blocks with 10 spares. Provide stranded copper wire of required ampacity and insulation at encountered temperatures. Identify wires at terminal points.

2.2.10 Base Mounting

****
NOTE: Where condensing units or compressors are located on top of walk-in boxes, mount on spring vibration isolators. Weight of inertia block shall be an engineered solution accommodating site conditions.
****

Mount compressors and components on a rigid, fabricated steel [base,] [rack,]. [Mount compressor assembly to the base on spring type vibration isolation mountings. Mount the base on the floor on elastomer pads.] [Mount assembly supporting base on [cantilevered, height reducing,] spring type vibration isolation mountings, selected to limit transmissibility of imbalanced forces at lowest equipment revolutions per minute to 5 percent.] [Mount assembly on concrete inertia block, fitted with cantilevered, height reducing, spring type vibration isolation mountings. Weight of concrete inertia block shall be [2.0] [_____] times weight of supported assembly. Select spring mountings to limit transmissibility of imbalanced forces at lowest equipment revolutions per minute to 3 percent.] [Integral-to-unit pipe or tubing, and conduit connection to

[control panel] [and] [building services] shall be through service rated flexible connectors.]

2.3 CONDENSERS, AIR-COOLED

****
NOTE: Currently, lowest SRN ratings, in the order of 16 or 17, occur in units rated under 19,045 kW 65 MBH. Largest "quiet" equipment ratings are in 19-20 range.
****

Factory fabricated and tested, packaged, self-contained and ready for full capacity operation after terminal point connections. Unit [shall be manufacturer matched part of split system, and] shall conform to ANSI/AHRI 460, ANSI/AHRI 210/240, and ANSI/AHRI 270. Unit shall produce a Sound Rating Number (SRN) not greater than [16] [21] [_____].

2.3.1 Capacity Rating

Size the condenser for the capacity and conditions indicated. Do not oversize.

2.3.2 Energy Performance

Equipment efficiency shall meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for air-cooled condenser product.

2.3.3 Unit Casing

Construct casing of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Provide with lifting provisions, access panels, removable legs, [discharge hood,] and fan and heat rejection coil guards and screens.

2.3.4 Finishes

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 and subject to a salt atmosphere shall have weather resistant finishes that will withstand 240 hours exposure to the salt spray test conducted in accordance with ASTM B117, using a 20 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3.18 mm 1/8 inch on either side of the scratch mark.

2.3.5 Fans

2.3.5.1 Propeller Fans

Propeller type fans shall be [direct] [V-belt] drive type with dynamically balanced, adjustable or fixed pitch, aluminum or corrosion protected steel blades. [V-belt drive wheels shall be mounted on corrosion protected drive shaft supported by grease lubricated antifriction bearings with cast ferrous pillow block or extended housing.] Each wheel drive shall be independent of any other wheel. Extended lubricant lines shall be provided for maintenance access. Drive bearings shall be protected with

water slingers or shields.

2.3.5.2 Centrifugal Fans

[Forward curve] [Backward inclined] centrifugal scroll type fans shall be provided with streamlined orifice inlet and V-belt drive, limited to three wheels mounted on a corrosion protected drive shaft. Wheels and housing shall be fabricated from aluminum or galvanized steel. Wheels shall be dynamically balanced. Fan shaft first critical speed shall be not less than 25 percent greater than operating speed. Fan shaft shall be mounted in grease lubricated antifriction bearings with cast ferrous pillow block housing. Extended lubricant lines shall be provided for maintenance access.

2.3.5.3 Fan Drives

V-belt drives shall be fitted with guards, [fixed pitch] [or] [adjustable pitch] sheaves.

2.3.6 Fan Motors

Motors less than 3/4 kW 1 hp shall meet NEMA High Efficiency requirements in accordance with NEMA MG 1. Motors 3/4 kW 1 hp and larger shall meet NEMA Premium Efficiency requirements in accordance with NEMA MG 1. Motors shall be variable speed. Motor enclosures shall be [open drip-proof] [totally enclosed] type. Motors and bearings shall be protected by location or with water slingers or shields.

2.3.7 Refrigerant Circuit

Refrigerant containing components shall comply with ANSI/ASHRAE 15 & 34, shall be factory tested, cleaned, dehydrated, charged, and sealed. Each condenser coil connection shall be fitted with a manual isolation valve of the ball type and an access valve on the coil side. Receiver shall conform to ANSI/AHRI 495. [Receiver shall be insulated with not less than 25 mm 1 inch thick, 100 percent adhesive bonded, vaportight, flexible, closed-cell elastomer and finished with two coats of solvent base PVC protective coating or 0.41 mm 0.016 inch thick aluminum jacket.]

2.3.8 Coils

Coils shall be constructed of copper or aluminum tubing with permanently attached fins for thermally efficient contact. Indoor and outdoor coils shall be matched and from same manufacturer. Use a low sensible heat ratio for more moisture removal. Casing shall be galvanized steel or aluminum. [Coils for service in corrosive or salt laden atmosphere shall be constructed of aluminum or with copper tubes and fins and galvanized end sheets.] [In addition, coils shall be protected with baked-on, minimum 0.076 mm 3 mil thick, phenolic coating.] [Separate condenser circuit shall be provided for each compressor complete with separate controls for each related fan.] [Unit shall provide not less than [_____] degrees C degrees F subcooling.] Subcooling circuit shall be liquid sealed. Condenser may be used for refrigerant storage in lieu of separate receiver, provided that storage capacity is 20 percent in excess of fully charged system. Where liquid flooding low ambient control is furnished, a separate receiver shall be provided.

2.3.9 Low Ambient Condenser Controls

Unit shall be capable of operating in ambient temperature of [_____] degrees C degrees F. Controls shall permit proper operation of system with proper differential pressure across thermostatic expansion valve. Control system shall be based on sensing of actual condensing pressure in conjunction with manufacturer's method of fan or damper control or by flooding the condenser. [Multifan units with power operated fan discharge dampers, shall include gravity dampers.] [Electric damper operator torque shall be at least 2.0 times required torque.] [Air volume control is not acceptable for ambient conditions below 2 degrees C 35 degrees F.] Controls shall be set to produce a minimum 21 degrees C 70 degrees F saturated refrigerant condensing temperature.

2.3.10 Control Panels

Unit mounted control panels shall be housed in NEMA ICS 6, Type 1 or 3A enclosures. Controls shall include [control transformer,] [fan motor [contactor] [starters],] [solid-state speed control,] overload protective devices, interface with local and remote components, miscellaneous electric devices, and intercomponent wiring to terminal block points.

2.4 CONDENSERS, WATER-COOLED

Condenser shall be [remote mounted] [and] [integral to water-cooled condensing unit] and shall conform to AHRI 450.

2.4.1 Capacity Criteria

Ratings shall be in Btuh heat rejection for AHRI 450 Group [1] [3] conditions, and for application at indicated design conditions. Ratings shall be based on [0.0005] [0.001] cooling water side fouling factor at design velocity. Coolant side pressure drop at design condition flow and fouling factor shall not exceed that indicated and shall be based on tube-side velocities of not less than 1.07 nor greater than 2.44 m/s 3.5 nor greater than 8 fps. When condenser is used for refrigerant storage during pumpdown, system charge shall be held within 80 percent of unit volume and storage capacity shall be stated. [Condensers shall be designed for coolant side working pressure of not less than [690] [1034] kPa (gage) [100] [150] psig, refrigerant side working pressure of not less than 2068 kPa (gage) 300 psig.] A portion of entering coolant shall be in heat transfer contact with liquid refrigerant to provide [_____] degrees C degrees F subcooling. Do not oversize equipment.

2.4.2 Energy Performance

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NOTE: UFC 1-200-02 requires new buildings to use 30 percent less energy than the ASHRAE 90.1 - SI ASHRAE 90.1 - IP baseline level.
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Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for water-cooled condenser product.

2.4.3 Shell and Tube Type

Condensers shall be of the shell and tube type with the coolant in the

tubes. The design pressure drop shall govern the number of passes. Condenser heads shall have pipe connections which permit access to or removal of the tubes. Materials of construction shall be suitable for the service in which used. Condensers shall conform to AHRI 450, with safety provisions conforming to ANSI/ASHRAE 15 & 34. Where coolant may be subject to freezing, condensers shall be gravity drainable and shall be fitted with automatic drain and vent valves.

2.4.4 Coolant Control

Control valves shall be [automatic, self-contained, controlled by condensing pressure, and shall close bubble-tight when compressor is not operating.] [modulating three-way mixing type, controlled by pressure controller.] [Atmospheric cooling equipment shall be deenergized at indicated set point.] Control shall be set for a saturated refrigerant condensing temperature of 21 degrees C 70 degrees F.

2.5 ATMOSPHERIC COOLING EQUIPMENT

[Cooling tower] [Evaporative water cooler] [Evaporative condenser] shall be [induced] [or] [forced] mechanical draft, [vertical] [horizontal] discharge [parallel-flow] [counter-flow] [or] [cross-flow] type of fire-resistant construction. Cooling equipment shall be factory fabricated, assembled and tested. [Cooling tower shall conform to requirements of CID A-A-59223, except as modified hereinafter.]

2.5.1 Design and Performance Requirements

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NOTE: When 53 m/s 10,500 fpm velocity is exceeded, noise may become a significant factor. Low tip speeds may or may not increase size of cooling tower. Consider probability of chemically-treated high-dissolved-solids drift loss causing damage to adjacent structures and environment (trees, shrubs, etc.).

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The requirements of CTI ATC-105 shall be the basis of establishing unit capacity and performance. Unit capacity shall include a site recirculation factor. Performance wind velocity shall be 8 km 5 miles per hour. Drift loss shall not exceed 0.1 percent of unit circulation rate. Minimum unit design wind load shall be [146 kg per square meter] [30 pounds per square foot] [_____]. [Minimum design fan deck live load shall be [195 kg per square meter] [40 pounds per square foot] [_____].] Fan tip speed shall not exceed [53 mps] [10,500 feet per minute][_____]. Design and construction of steel members shall conform to AISC 360 and AISI SG03-3.

2.5.2 Materials of Construction

Metallic materials of construction shall be mill galvanized or hot-dip galvanized after fabrication. Plastics shall have an ASTM E84 flame spread rating of 25 or less, except as otherwise specified.

2.5.3 Framework and Casing

Structure shall withstand maximum stresses imposed. Panel joints shall drain to interior. Seals, fasteners, and flashing shall be provided to

preclude external to unit water leakage. [Discharge cylinder height shall be not less than [_____] mm inches above fan deck.]

2.5.4 Inlets and Louvers

Louver material shall be of thickness, configuration and support span to prevent flutter or sagging under loads imposed during operation. Inlet shall be fitted with square mesh galvanized hardware cloth with minimum 80 percent open area.

2.5.5 Distribution System

Hot-water distribution system shall be [open basin] [or] [pressurized spray nozzle] type. [Open basin shall be designed to permit surge water flow 40 percent greater than specified flow without overflow of basin. Basin shall be fitted with removable cover.] System shall be self-draining and nonclogging. [Means to isolate and balance flow to each section of unit shall be provided.]

2.5.5.1 Pumps

Pump casing shall be designed to withstand discharge head indicated, plus static head on system, plus 50 percent of the total, but not less than 862 kPa (gage) 125 psig. Motor shall not be overloaded with pump operating at any point on its characteristic curve, and shall have [open drip-proof] [totally enclosed] enclosure. Pump speed shall not exceed [1800] [3600] revolutions per minute. Pumps shall be [horizontal split-case] [end-suction vertical split-case] [close-coupled in-line] centrifugal type. Casing and bearing housings shall be cast ferrous metal. Casing shall be fitted with manual air vents and drain plugs. [Suction and discharge shall be provided with pressure gage taps.] Shaft seal shall be mechanical type. Impeller and trim shall be bronze. Shaft shall be stainless steel or carbon steel sleeved with stainless steel. Bearings shall be sealed, grease lubricated, antifriction type. Pump shall be accessible for servicing without disturbing piping connections. [Pump and motor shall be mounted on a common cast iron or fabricated structural steel base having lipped edges and tapped drainage openings.] [Pump shall be provided with elastomer-in-shear type shaft coupling with guard.] [Close-coupled pumps shall be provided with drip pockets and tapped openings.] Pump rotating assembly shall be dynamically balanced.

2.5.6 Heat Exchangers

[Evaporative condenser coil shall comply with ANSI/ASHRAE 15 & 34]. Coils shall be completely drainable [serpentine] [or] [straight length, individually cleanable] type. Coil tubes and headers shall be [seamless deoxidized copper] [or] [electric resistance welded, hot rolled, mill scale free, carbon steel tube and header, externally hot-dip galvanized after fabrication to provide not less than 0.70 kg of zinc per square meter 2.3 ounces of zinc per square foot of single side surfaces]. [Coil tubes shall be Schedule 40 carbon steel, internally cleaned to remove mill scale and particulate and externally hot-dip galvanized after fabrication to provide not less than 0.70 kg of zinc per square meter 2.3 ounces of zinc per square foot of single side surfaces.] [[Split-] [Multi] [circuit]] [desuperheater] [subcooling] [refrigerant and jacket cooling water] coils shall be provided as indicated. [Refrigerant subcooling circuit shall produce [_____] degrees C degrees F of subcooling.] Refrigerant receiver shall conform to requirements of ANSI/AHRI 495. [Receiver insulation shall be not less than 25 mm 1 inch thick, 100 percent adhesive bonded,

flexible, closed-cell elastomer, and finished with two coats of solvent base PVC protective coating.] [Copper coils shall) be dielectrically isolated.] Header connections shall be fitted with [thermometer wells,] [pressure gage taps,] and [manual] [automatic] vent connections. Heat exchanger shall be pressure and temperature rated and tested to the same fluid service standards and codes as connecting external piping.

2.5.7 Fill

Fill for cooling tower shall be minimum [0.38 mm 15 mil thick corrugated or molded PVC plastic] [0.48 mm 19 mil thick chloroprene bound asbestos sheet], in honeycomb or wave form, impregnated with melamine or chlorinated rubber, having an ASTM E84 flame spread rating of 5 or less. Fill shall be supported to prevent sagging or misalignment.

2.5.8 Eliminators

Metal eliminators shall be not less than 24 gage steel. Nonmetallic eliminators shall conform to requirements specified for fill.

2.5.9 Cold Water Basin and Accessories

Basin shall be constructed of steel [, and shall be sized for dry-basin operation] [, and shall be sized to have sufficient water capacity and free-board to prevent [pump cavitation,] air-entrainment and to accommodate run-back without overflow]. Basin assembly shall be water-tight. [Multiple basins shall operate as one basin with common water level and shall be complete with interconnecting piping.] Basin outlet screen shall be constructed of galvanized, 13 mm 1/2 inch square mesh hardware cloth, reinforcement, and framing. Basin shall be fitted with overflow and valved drain. [Manufacturer's standard modulating float-controlled makeup valve shall be provided.] [A nonmodulating, pilot actuated, float-controlled, diaphragm type makeup valve shall be provided where a water meter is indicated or specified in the makeup supply line.] Makeup shall discharge 50 mm 2 inches or two pipe diameters, whichever is greater, above maximum attainable basin water level during overflow condition, or as required to preclude backflow. A drainable 20 mm 3/4 inch hose bib connection shall be provided with a vandalproof vacuum breaker for makeup line mounting. [Basin shall be fitted with indicated heaters.]

2.5.10 Access and Safety Provisions

Unit shall be fitted with access provisions as indicated to facilitate inspection, maintenance and replacement of components. Guard screens shall be provided at unducted fan inlets and far discharge. Guards shall be provided for moving power transmission components.

2.5.11 Fans and Drives

[Induced draft counter-flow and cross-flow cooling tower fans shall be propeller type and drive shall be [gear type with motor out of wet airstream] [or] [belt type with motor [in] [out of] wet airstream].] [Induced draft evaporative [water cooler] [condenser] fans shall be propeller type and drive shall be [gear] [belt] type with motor out of wet airstream.] [Forced draft fans shall be propeller or centrifugal type, with multiple V-belt drive and motor out of wet airstream.]

2.5.11.1 Propeller Fans

Shall be airfoil section type with fixed or adjustable pitch blades fabricated from solid aluminum alloy, except fans sized 1220 mm 48 inches and under may be manufacturer's standard. Fixed pitch fans combined with gear drives are not acceptable. Adjustable pitch fans, with pitch set at or near maximum pitch, combined with gear drives, are not acceptable. Fans shall be statically or dynamically balanced to limit imbalance forces on drive shaft.

2.5.11.2 Centrifugal Fans

Shall be forward curve, double-inlet, drainable scroll type with streamlined inlets, constructed of galvanized or stainless sheet steel or aluminum. Fan shaft shall be corrosion protected. Bearings shall be double-shielded, grease lubricated, self-aligning, ball or roller, cast iron (split-bolted), pillow block housed, antifriction type. Sleeve bearings may be used in conjunction with one or more antifriction bearings at locations other than drive-end. Sleeve bearings shall be oil-lubricated, grooved, cast iron housed, antifriction metal liner type, with an effective length at least two times shaft diameter. Fan wheel assembly shall be dynamically balanced. Lubrication of bearings shall be safely accomplished while unit is operating. Oil lubricated sleeve bearings shall be fitted with reservoir.

2.5.11.3 Gear Drive Speed Reducer

Shall have a service factor of not less than 1.5 and shall be reversible. Oil level, vent and drain lines shall be nonferrous metal, vibration isolated, and extended to maintenance access points. Nonlubricated, dynamically balanced, floating shaft and couplings shall be provided. Construction shall be stainless steel or corrosion protected metals.

2.5.11.4 Fan Shafts

Wet service belt drive fan shaft shall be supported by drip and splash protected, grease lubricated, split-bolted, pillow block antifriction bearings. Lubrication provisions shall include automatic grease relief to visible point and grease supply fittings extended to permit lubrication under operating conditions. Belt drive shall be [reversible,] one-piece, integral-back, multiple-groove type, constructed of synthetic fabric or fiber reinforced neoprene.

2.5.11.5 Motors

Motors less than 3/4 kW 1 hp shall meet NEMA High Efficiency requirements in accordance with NEMA MG 1. Motors 3/4 kW 1 hp and larger shall meet NEMA Premium Efficiency requirements in accordance with NEMA MG 1. Motors shall be variable speed. Enclosure shall be totally enclosed, [single] [two] speed, [nonreversing] [reversing] type, fitted with 120 volt a.c. resistance heaters. [Reversing starters shall be fitted with adjustable time delay deceleration relays.] Manufacturer's standard, adjustable set point, manual reset type vibration cut-out switch shall provide to deenergize fans upon excessive vibration.

2.5.12 Vibration Isolation

Unit shall be vibration isolated from supporting structure by mountings which limit imbalanced force transmissibility to [5] [_____] percent at

lowest equipment revolutions per minute.

2.5.13 Corrosion Protection

Galvanize cast and wrought ferrous metal in accordance with [ASTM A123/A123M] [ASTM A653/A653M]. Sheared edges shall receive additional corrosion protection of a zinc rich coating. Other steel items specified to be galvanized shall be coated in accordance with ASTM A153/A153M.

2.5.14 Capacity Control

Unit shall be fitted with [modulating manual] [vortex] [inlet] [internal bypass] [and discharge] damper controls [in addition to [on-off] [fan] [and] [pump] [cycling] [and] [fan motor speed control]]. Dampers shall be constructed of aluminum or galvanized, steel and fitted in such a manner as to preclude freeze-up, mechanical binding or corrosion. Dampers shall be fitted with a non-lubricated damper shaft bearings; corrosion resistant damper shaft journals and pivots; pre-lubricated, antifriction, ball type adjustable linkage; [NEMA Type 4 limit switches;] [waterproof electric operator torque shall be not less than 2.0 times required torque;] and temperature sensing control system with output controlling damper position.

2.6 AUTOMATIC CONTROLS

Temperatures in the refrigerated rooms shall be regulated by room thermostats and electric solenoid valves in the refrigerant supply piping to the evaporators. Compressors for each system shall operate on suction pressure switches, functioning in such a manner as to cut in and cut out compressors as the suction pressure rises above or falls below predetermined operating conditions. Provide a multiple step controller for multiple compressor units in a single system.

2.6.1 Temperature Control Cabinets

Provide the necessary controllers, relays, clocks, alarms, and temperature gages in or on the face of control cabinets for each system. Construct cabinets of steel or aluminum with hinged door and lock. Provide temperature gages, pressure switches and pilot lights flush on the cabinet door. Provide controllers and relays in the interior of the cabinet on a steel or aluminum subpanel which shall also act as the back of the cabinet. Electrical controls shall be prewired to numbered screw type terminal strips. Cabinets shall be [floor-mounted free-standing type] [or] [integral with refrigeration compressor unit control panels].

2.6.2 Safety Cutout Switches

Provide automatic high pressure, low oil level, and compressor overload safety cutout switches for each compressor. The switches shall be located in the condensing unit control panel. The cutout switches shall automatically stop the respective compressors and simultaneously ring an alarm bell whenever the pressure within the condenser rises above the predetermined safe point.

2.6.3 Thermostats

Shall be of a lock shield type suitable for operation in connection with its respective solenoid valve. The thermostats shall maintain the temperature of the refrigerated rooms within a maximum range of plus or

minus one degrees C 2 degrees F. The thermostats shall be of the adjustable type, with gas filled tube. The thermostats shall have temperature range of minus 34 degrees C to plus 10 degrees C 30 degrees F to plus 50 degrees F. Thermostats shall be mounted adjacent to interior door, unless otherwise indicated.

2.6.4 Controllers

2.6.4.1 Differential Pressure

Controller shall be provided with high and low pressure sensing ports and shall be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output shall be [low voltage electric] [pneumatic] [4-20 mA dc], proportional to the pressure differential sensed. Local and remote set point adjustments shall be included. Range shall be as required to meet system requirements.

2.6.4.2 Differential Temperature

Controller shall be provided with two filled, remote sensing bulbs connected to the controller by [armored] capillary tubing. Controller shall be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output shall be [low voltage electric] [pneumatic] [4-20 mA dc], proportional to the temperature differential sensed. Provisions for local and remote set point adjustments shall be included. Range shall be as required to meet system requirements. For immersion service, thermal wells shall be provided.

2.6.5 Pilot Lights

Panel mounted pilot lights shall be NEMA Class 12 oil-tight, push-to-test transformer type for 6-8 Vac lamps. Lamps shall be replaceable by removal of color cap. Caps color shall be as indicated.

2.6.6 Programmer, Demand Control/Load

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NOTE: Before application of energy management systems/load shedders to refrigeration systems, and related fans and pumps, the designer shall ascertain that application will not be conducive to equipment damage and counterproductive. Safety trips, compressor slugging, freeze-ups and reloading of circuits may occur.

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Programmer shall be fully automatic, fail safe, field programmable, solid-state, demand control and load programming for [_____] [16] loads. Demand control portion shall monitor power consumption by [watt] [or] [current] transducers. Set point shall be field adjustable with adjustable dead band. Load shedding sequence time and differential time between load shedding shall be adjustable. Contacts shall store alarm condition. Meter readout shall indicate demand deviation from set point. Load profile recorder shall be strip chart type with readily discernable event record. Load programmer shall permit programming of on/off time of each load for any time element within a week and shall equalize power demand over a preset time cycle. System shall include input override and time cycle accelerator for checkout. Alarm condition, status of loads and time period shall be visually indicated and recorded. Each load shall

include a H-O-A toggle switch. Alarm provisions shall include relay contacts for external, remote alarm functions and test provisions. Override [thermostat] [pressure switch] [timer] shall be provided to restore shedded loads indicated. Control panel enclosure shall be NEMA ICS 6, Type 1, surface mounted type with key lock. Load profile recorder shall be [surface] [flush panel] mounted type. Load relays shall be plug-in type with critical load failure in "on" mode and contacts rated for pilot duty at 120 volt a.c. Load shedding position switches shall shed loads on a first shed/last restore basis and remove loads from system logic for shedding cycle. Time clock shall be fitted with spring motor to maintain time in event of power failure.

2.6.7 Switches, Fluid Service

Switches shall be field adjustable SPDT type and shall have NEMA ICS 6, Type 1 enclosure with operating range specified or indicated. Circuits shall be as required for the applicable functions.

a. Provide air flow switches with a service pressure range of 30 to 2940 Pa 0.12 to 10 inches water gage.

b. Provide water flow switches with a body rating suitable for the service, field adjustable activating flow rate, and a pressure drop not in excess of 13.8 kPa 2 pounds per square inch at maximum flow rate.

c. Pressure switches shall be factory set, one or two stage as indicated, with adjustable operating and differential pressure. Bourdon tube inlet shall be fitted with damper screw adjustment.

d. Differential pressure switches shall be factory set, provided with high and low sensing ports, one or two stages and adjustable differential range and pressure.

e. Temperature switches shall be factory set, provided with [armored] capillary tubing and filled sensing system, one or two stages as indicated, and operating adjustable differential range. For immersion service, thermal wells shall be provided.

f. Differential temperature switch shall be factory set, provided with two separate, [armored] capillary systems, one or two stages, and adjustable differential range and temperature. For immersion service, thermal wells shall be provided.

2.6.8 Push-Button Stations

Stations shall be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated. Start-push-buttons shall have a fully guarded or flush black operator button. Stop-push-buttons shall have an unguarded or extended red operator button.

2.6.9 Selector

Switches shall be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated, with standard operator.

2.7 HEAT RECOVERY DEVICES

Water heater shall be double-wall, tube-within-tube heat exchanger type,

complete with thermostatic control. [Heater shall be provided with [refrigerant compressor head pressure control] [and] [interlocked, potable water circulating pump].] [Cabinet shall be fabricated of zinc protected steel and shall be internally insulated in coil space.] 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. [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 [remotely mounted and] rated for [115] [208] [230] volt a.c. power supply. [Heat exchanger shall be sized to extract not more than [_____] [25] percent [of the superheated portion] of the total rated condenser load.]

2.8 MOTORS

Provide continuous duty rated motors conforming to NEMA MG 1. Unless otherwise specified, motor synchronous speed shall be 1800 rpm. Motors less than 3/4 kW 1 hp shall meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger shall meet NEMA Premium Efficiency requirements. Motors shall be variable speed. Refrigeration compressor motors shall comply with compressor manufacturer's recommendations. Rate motors with nameplate power less than 3/8 kW 1/2 hp for 115 volts, single-phase, 60 Hz power supply. Rate motors with nameplate power 3/8 kW 1/2 hp and greater as indicated. Extended voltage motors nameplated 208-230 and rated for 187-253 volts are not acceptable. Provide NEMA Class B insulated polyphase motors, normal torque and starting current, Design B, squirrel-cage induction type, except as otherwise specified. Provide Nema Design Class C when high starting torque is required. [Provide [one] [two] -winding type two-speed polyphase motors.] Nameplate for polyphase motors shall include efficiency index letter. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. 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. Provide [open drip-proof] [totally enclosed] [explosion-proof] motor enclosures. Polyphase motor bearings shall be double-shielded, grease lubricated, antifriction type with provisions for radial and thrust loads as imposed by application duty. Provide bearings with grease supply fitting and grease relief to outside of enclosure. Single phase motor bearings shall be as specified for polyphase motors, except manufacturer's standard prelubricated, sealed cartridge types are acceptable. Provide [across-the-line magnetic] [reduced voltage] type motor starters conforming to NEMA ICS 1 and NEMA ICS 2.

2.9 POWER TRANSMISSION COMPONENTS

Fan and open compressor drives shall be [direct] [and] [V-belt] type as specified or indicated. Provide drives in accordance with the manufacturer's published recommendations, except as otherwise specified. Base horsepower rating of V-belt drives on maximum pitch diameter of sheaves. Provide compressors with fixed sheaves and drives with a minimum service factor of [1.5] [2.0]. Drives with motors rated up to and including 7 1/2 kW 10 horsepower shall be classical belt section, adjustable sheave type, with a service factor of not less than 1.5. Drives with motors rated over 7 1/2 kW 10 horsepower [up to and including 22 3/8 kW 30 horsepower,] shall be classical section, adjustable sheave type with a service factor of not less than 1.5. Where the number of unit starts exceeds 8 per 24 hours, add 0.1 to the required drive service

factor. Provide statically and dynamically balanced sheaves, machined ferrous metal, bushing type, secured by key and keyway. Pitch diameter of fixed pitch sheaves and adjustable sheaves, when adjusted to specific limits, shall be not less than that recommended by NEMA MG 1. Select adjustable sheaves to provide the required operating speed with the sheave set at mid-point of its adjustment range. The adjustment range for various size and type belts shall be 16 percent minimum for classical section belts and 12 percent minimum for narrow section belts. Provide belt drive motors with slide rail or equivalent adjustable motor bases. Provide manufacturer's standard direct drive couplings for motors rated less than 2 1/4 kW 3 horsepower. For 2 1/4 kW 3 horsepower and greater, direct drive couplings shall be elastomer-in-shear type.

2.10 ALARM SYSTEM

Provide both audible alarms and trouble lights to indicate when an abnormal condition exists in each room. Locate pushbuttons inside each room and adjacent to door. Alarm bell shall be located outside of each refrigerated room and adjacent to door. Each refrigerant room having electric defrost shall be provided with a defrost compensator which shall deenergize the abnormal condition alarm system during the defrost cycle; these devices shall be coordinated with defrost time clock on the respective compressors. Systems shall detect a temperature rise above the designated temperature or actuation of entrapment pushbutton and shall energize an alarm lamp and horn at cooler local alarm panel.

2.10.1 Refrigeration Alarm System

Provide an electrically supervised refrigeration alarm system. Operation of any high-temperature alarm devices shall cause an alarm to register as follows:

a. Lamp and horn at local alarm panel

b. Annunciator panel shall light up and identify which cooler is malfunctioning

c. Alarm bell shall ring

2.10.2 Refrigeration Local Alarm Panel

Provide local alarm panel adjacent to refrigerator. Alarm panel shall include alarm lamp, "power on" lamp, alarm test switch, reset switch, an alarm line supervisory meter, alarm silencing switch, high temperature alarm device entrapment manual switch, alarm horn, and required relays. System shall normally work off 120 volts a.c. and transfer automatically to 24 volt d.c. operation in the event of power failure. The d.c. power shall be from rechargeable batteries and operate the system for a minimum of 24 hours in supervisory condition and 15 minutes in alarm condition. The power supply shall be capable of fully recharging the batteries (as well as powering the system) within 36 hours.

2.10.3 Annunciator Panel

Provide an electrically supervised annunciator panel. Provide the panel adjacent to local alarm panel. Cover shall be such as to prevent tampering and yet allow full viewing of annunciator lamps and zone identification lettering. Detector loops shall be electrically supervised by the remote alarm panel. Panels shall be equipped with terminals for

all necessary wiring. Annunciator panel shall be so connected to detection panel so that zone lights shall be battery-powered in case of electrical failure.

2.10.4 High Temperature Alarm Device

Each refrigerated room shall have a high temperature alarm device of the remote bulb type with minimum 1 1/2 meters 5 feet of capillary. Temperature range shall be minus 34 degrees C to plus 10 degrees C 30 degrees F to plus 50 degrees F, with adjustable differential of not less than 2 to 5 degrees C 4 to 10 degrees F.

2.11 COOLING TOWER WATER TREATMENT SYSTEM

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NOTE: If the activity has a cooling water treatment contract in effect, ensure that the system specified is compatible with it.

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Shall automatically feed chemicals, and bleed system water to prevent scale, corrosion, and biological growths. The system shall include chemical feed pump, tank, bleed-off solenoid valve, electric impulse water meter, electric timer, and conductivity controller. Provide a polyethylene tank and injection valve assembly for each feed pump.

2.11.1 Feed Pumps

Shall be positive displacement type with an adjustable capacity and discharge pressure not less than 1.5 times the line pressure at the point of connection. Provide with pressure relief valve, and check valve mounted in the pump discharge.

2.11.2 Tanks

Construct of high density polyethylene, cylindrical in shape, and with a hinged cover. The tank shall have sufficient capacity to require recharging only once per 7 days during normal operation. Provide tank with a valved cold water line and, if necessary, a valved hot water fill line with suitable air gap. Provide tank with device to indicate quantity of solution in the tank. Provide electric mixing device with tank.

2.11.3 Valve Injection Assembly

Provide for each feed pump. Construct of bronze or material suitable for chemicals being used and install in condenser water line common to all pumps. Injection fitting shall have male pipe threads. Each assembly shall include a shut-off valve and a check valve installed close to condenser water line.

2.11.4 Bleed-off Solenoid Valve

Provide in bleed-off line. Valve shall normally be in closed position and be opened by a 120 volt waterproof solenoid coil. Connect bleed-off line to condenser water line and include a gate valve ahead of solenoid valve. Extend a discharge line from solenoid valve to sewer drain.

2.11.5 Water Meter

Provide with electric contacting register, and remote accumulative counter and installed in make-up water line near cooling tower. Meter shall be standard product used in water treatment.

2.11.6 Timers

Shall be automatic reset, adjustable type, and electrically operated. House in metal NEMA type cabinet with a hinged front. Timer shall be suitable for 120 volt current.

2.11.7 Conductivity Controller

Controller shall measure the total dissolved solids in system water by conductivity. The conductivity sensor shall consist of epoxy insulated carbon electrodes and shall not require platinizing. Controller shall have a meter with a visual readout, set point adjustment with a range between 200 micromhos/cm and 4000 micromhos/cm and a red pilot light indicating water conductivity above set point. Unit shall operate from a 120 volt power source.

2.11.8 Control Panel

Provide a factory-wired, NEMA 12, control panel for each system. Construct of steel with hinged door and lock, and suitable for surface mounting. Pre-wire controls to numbered terminal strips. Provide laminated plastic nameplates identifying the switch function. Include the following with the panel:

a. Main power switch and indicating lamp

b. MAN-OFF-AUTO selector switch

c. Indicating lamp for bleed-off valve

d. 120 Volt, heavy-duty, grounded duplex receptacle

e. Conductivity controller

f. Electric timer

g. Accumulative counter

2.11.9 Sequence of Operation

2.11.9.1 Conductivity Controller

Shall open the bleed-off solenoid valve when the conductivity of the cooling water rises above the set point of the controller. When the conductivity falls below the set-point, the valve shall close.

2.11.9.2 Water Meter

Shall start the timer after a pre-set volume of make water has been measured.

2.11.9.3 Timer

Shall turn the feed pumps on for a pre-set amount of time.

2.11.10 Piping

Provide plastic piping and fittings conforming to ASTM D2996 for water treatment system. Piping for feed pump suction shall contain a foot valve and strainer.

2.11.11 Chemicals

****
NOTE: Select the applicable paragraphs from the following:
****

[Provide sufficient chemicals to initially place system in service and make tests.] [Provide same chemicals used for treatment at station's other towers.]

2.11.11.1 Water Analysis

Description	[_____]
Silica (Si02)	[_____]
Insoluble	[_____]
Iron and Aluminum Oxides	[_____]
Calcium (Ca	[_____]
Magnesium (Mg)	[_____]
Sodium and Potassium (Na and K)	[_____]
Carbonate (C03)	[_____]
Bicarbonate (HC03)	[_____]
Sulfate (S04	[_____]
Chloride (C1)	[_____]
Nitrate (N03)	[_____]
Turbidity	[_____]
pH	[_____]
Residual Chlorine	[_____]

Description	[_____]
Total Alkalinity	[_____]
Noncarbonate Hardness	[_____]
Total Hardness	[_____]
Dissolve Solids	[_____]
Fluorine	[_____]

[Furnish water analysis and provide sufficient chemicals to initially place system in service and make tests prior to start up and acceptance by Government. [Provide same chemicals used for treatment at station's other towers.]]

PART 3 EXECUTION

3.1 INSTALLATION

Installation procedures shall conform to ANSI/ASHRAE 15 & 34 and the manufacturer's instructions. Set floor mounted equipment on 150 mm 6 inches thick concrete housekeeping pads, complete with anchor bolts and grouting. Finish housekeeping pads with two coats of oil-resistant epoxy polyamid coating. No drilling, cutting, burning, or welding of structural parts of building will be permitted. Provide access panels for concealed valves, vent controls, and control devices and items requiring periodic operation, inspection, or maintenance. Access panels shall be of sufficient size and so located that concealed items may be serviced and maintained or removed and replaced. Refrigerant safety relief devices shall have discharge piped to building exterior. Interlock compressor operation with the water pump starters, so that the compressors cannot operate unless the pumps are operating.

3.2 MANUFACTURER'S FIELD SERVICES

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturers representatives shall furnish advice and services on the following matters:

a. Erection, alignment, testing and dehydrating

b. Charging equipment with refrigerant and oil

c. Starting equipment and training Government personnel as to its proper care, operation, and maintenance.

3.3 LOCATIONS AND CLEARANCES

Equipment shall be located so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead

lines.

3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use. Plates and tags shall be brass or nonferrous material. Minimum letter and numeral sizes shall be 3.18 mm 1/8 inch high.

3.5 OPERATION AND MAINTENANCE MANUALS

Submit six copies of operating instructions outlining the step-by-step procedures required for system start-up, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and a brief description of equipment and their basic operating features. Submit 6 copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified wiring diagrams. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets, shall be submitted prior to posting. The framed instructions, including wiring and control diagrams, shall be posted before acceptance testing of the systems.

3.6 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Contractor shall 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 shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.7 TESTS

Perform the tests and provide everything required. Notify the Contracting Officer, in writing, 10 days before performing tests. Tests shall be performed in the presence of a manufacturer's representative.

3.7.1 Initial Start-Up and Operational Test

Provide chemicals and place water treatment systems in operation before initial start-up. Equipment shall be started and operated. Follow the manufacturer's procedures and place the systems under all modes of operation. Initial charges of lubricating oil shall be supplemented to assure maximum operating capacity. Safety and automatic control instruments shall be adjusted. Record manufacturer's recommended readings hourly. Operational tests shall cover a period of not less than [_____] days.

3.7.2 Test Reports

Submit the final test report for each system tested, describing test

apparatus, instrumentation calculations, and equipment data based on industry standard forms or reasonable facsimiles thereof. Data shall include: compressor suction and discharge pressure; refrigerant charge pump, compressor and air moving device ampere readings; power supply characteristics, including phase imbalance, with 1/2 percent accuracy; thermostatic expansion valve superheat-value as determined by field test; subcooling; high and low refrigerant temperature switch set-points; low oil pressure switch set-point; [defrost system timer and thermostat set-points;] moisture content; ambient, condensing and coolant temperatures; capacity control set-points; field data and adjustments which affect unit performance and energy consumption. Where final adjustments and settings cannot be permanently marked or drilled and pinned as an integral part of device, adjustment and setting data shall be included in test report.

3.8 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Thermostat Temp-Range	= minus 30 to 50 degrees F	= minus 34 to 10 degrees C
b. Motors Capacity	= 1/2 hp	= 3/8 kW
	= 10 hp	= 7 1/2 kW
	= 30 hp	= 22 3/8 kW
	= 3 hp	= 2 1/4 kW

-- End of Section --