UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 42 - PROCESS HEATING, COOLING, AND DRYING EQUIPMENT

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08/17

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SECTION 42 22 16.00 40

RECIPROCATING PROCESS CHILLERS AND COOLERS
08/17

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NOTE: This guide specification covers the requirements for water-cooled reciprocating water chillers for refrigerating and air-conditioning applications.

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

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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NOTE: If Section 23 30 00 HVAC AIR DISTRIBUTION is not included in the project specification, insert applicable requirements therefrom and delete the following paragraph. If Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT is not included in the project specification, insert applicable requirements therefrom and delete the second paragraph.
****

[Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

][Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT applies to work specified in this section.

]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 550/590 I-P	(2015; ERTA 2016) Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle

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

ASHRAE EQUIP IP HDBK	(2012) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE EQUIP SI HDBK	(2012) Handbook, HVAC Systems and Equipment (SI Edition)
ASHRAE HVAC APP SI HDBK	(2019) HVAC Applications Handbook, SI Edition

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 21940-11	(2016) Mechanical vibration -- Rotor balancing -- Part 11: Procedures and Tolerances for Rotors with Rigid Behavior

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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

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

Compressor; G[, [____]]

Motor; G[, [____]]

Control Diagrams; G[, [____]]

Control Panel; G[, [____]]

Condenser; G[, [____]]

Evaporator; G[, [____]]

Refrigerant Circuit; G[, [____]]

Alarm System; G[, [____]]

Vibration Isolators; G[, [____]]

Gages; G[, [____]]

SD-03 Product Data

Chiller Unit; G[, [____]]

Compressor; G[, [____]]

Condenser; G[, [____]]

Accessories; G[, [____]]

Spare Parts; G[, [____]]

Vibration Isolators; G[, [____]]

SD-06 Test Reports

Factory-Run Tests; G[, [____]]

SD-07 Certificates

Certificates of Conformance

Energy Efficiency Rating

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

1.3 QUALITY CONTROL

Submit certificates of conformance for following items, showing conformance with the standards cited in this section:

a. Compressor

b. Motor

c. Control panel

d. Condenser

e. Evaporator

f. Refrigerant circuit

g. Alarm system

h. Vibration isolators

i. Gages

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit equipment and performance data for the following items, indicating use life, system functional flows, safety features, and other information such as ratings for electrical system protective devices:

a. Chiller unit

b. Compressor

c. Condenser

d. Accessories

e. Spare parts

f. Vibration isolators

g. Motor

h. Evaporator

i. Refrigerant circuit

j. Control panel

k. Alarm system

l. Gages

2.1.1 Design Requirements

Submit shop drawings that indicate the general physical layout of reciprocating process [chiller][and][cooler] components, controls, and internal tubing and wiring details. Submit shop drawings and connection diagrams that indicate relationships and connections for the following items:

a. Compressor

b. Motor

c. Control diagrams

d. Control panel

e. Condenser

f. Evaporator

g. Refrigerant circuit

h. Alarm system

i. Vibration isolators

j. Gages

2.2 MANUFACTURED UNITS

****
NOTE: For a descriptive specification, edit this article to suit project conditions. If a performance specification is used for the project, delete this article.
****

Provide a factory-assembled water-cooled liquid chiller unit, consisting of [two] [_____] [semi]-hermetic reciprocating, motor-driven compressors mounted on [spring] [_____] vibration isolators, a [hot gas muffler,] condenser, insulated evaporator, [independent refrigerant circuits,] thermal expansion valves, refrigeration accessories, and control panels.

Except as specified, ensure the unit and spare parts are the manufacturer's standard product, designed for the service indicated, and tested and rated in accordance with AHRI 550/590 I-P.

Submit certificates for an energy efficiency rating (EER) that meets or exceeds the full-load efficiency and the integrated part-load value (IPLV) efficiency ratings as described in AHRI 550/590 I-P.

2.2.1 Liquid Chiller

****
NOTE: Describe a performance specification for one unit, or more than one identical units. Use a schedule to specify units of different sizes.
****

Provide a reciprocating water chiller unit with a minimum capacity of [_____] watt tons of refrigeration when delivering [_____] cubic meter per second gpm of chilled water at [_____] degrees C degrees F when supplied with [_____] cubic meter per second gpm of condenser water at [_____] cubic meter per second [_____] degrees F. For determining this capacity, ensure that the fouling factor for the evaporator and condenser is not less than 0.0005, with the water head loss not exceeding [_____] millimeter [_____] feet through the condenser, or [_____] millimeter [_____] feet through the evaporator.

2.3 COMPONENTS

****
NOTE: Specify compressor and motor balance conforming to ISO Std. 1940/1 unless otherwise noted. Specify motor vibration levels conforming to NEMA Specification MG-1, unless otherwise noted.
****

****

NOTE: Edit the following article or delete as necessary to suit project conditions and to further describe the manufactured chiller unit.

****

2.3.1 Compressor

Provide a compressor constructed with heat-treated [forged-steel] [ductile iron] crankshafts, aluminum alloy connecting rods, cast aluminum pistons fitted with one compression ring and one oil ring, replaceable cylinder liners, and double-mesh suction inlet screens. Provide a housing, cylinder heads, liners, and handhole covers of close grain cast iron. Ensure the housing has high-strength, nonflexing ring suction and discharge valves. Ensure valve plates are cast iron, with ground and lapped seats, with any rotating parts statically and dynamically balanced to ISO 21940-11, [G16] [G6.3] [_____]. Mount compressors on [spring] [_____] vibration isolators. Provide isolation service valves on the inlet and outlet lines of each compressor.

2.3.1.1 Lubricating System

Provide the lubricating system with a positive displacement oil pump, oil-charging valve, oil-level sight glass, oil filter, and magnetic plug-on strainer, arranged to be self-relieving to the suction side. Ensure that adequate lubrication is provided during starting, stopping, and normal operation.

2.3.1.2 Capacity-Reduction

Provide automatic capacity-reduction equipment consisting of suction valve unloaders. Operate the lifting mechanism by [oil pressure] [gas discharge pressure] [a solenoid valve]. Provide the capability for an unloaded compressor start.

2.3.1.3 Motor

Rate the motors in accordance with Section 26 60 13.00 40 LOW-VOLTAGE MOTORS.

Provide solid state sensors and protection in accordance with Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide a compressor conforming to NEMA MG 1, direct-driven by [1800] [3600] rpm. Operate the unit with a [230] [208] [480] volt 3-phase, 60 Hertz power, constant-speed motor that is UL-listed and designed for [across-the-line] [part-winding] [_____] starting. Provide a motor with copper windings and suction gas cooling. Provide a solid state sensor and electronic protection against overheating of the windings.

2.3.1.4 Crankcase Heater

Provide an immersion crankcase heater. Energize the heater [continuously] [_____]. [Mount a "DANGER - EXTERNAL POWER SUPPLY" sign to the junction box for the crankcase heater. Ensure that the sign has 10 millimeter 3/8-inch white letters on a red background.]

2.3.2 Condenser

Provide a shell-and-tube condenser constructed of [seamless] [welded] steel, with removable [cast-iron] [fabricated-steel] heads [and independent, dual-refrigerant circuits].

Provide with cleanable [and] [replaceable] [seamless copper] [_____] tubes, with integral fins, [expanded] [_____] into tube sheets.

Design, test, and stamp the refrigerant side for [2050] kilopascal [300] psig [_____] working pressure in accordance with ASHRAE HVAC APP SI HDBK and ASHRAE EQUIP SI HDBK ASHRAE EQUIP IP HDBK, Chapter 13.

Provide a [2050] kilopascal [300] psig [_____] safety-relief valve on the condenser shell.

Design, test, and stamp the water side for [1030] kilopascal [150] psig [_____] working pressure in accordance with ASHRAE HVAC APP SI HDBK and ASHRAE EQUIP SI HDBK ASHRAE EQUIP IP HDBK, Chapter 13. Provide drain connection.

2.3.3 Evaporator

Provide a shell-and-tube evaporator constructed of [seamless] [welded] steel, with removable [cast-iron] [fabricated-steel] heads [and independent, dual-refrigerant circuits].

Provide an evaporator with cleanable [and] [replaceable] [seamless copper] [_____] tubes, with integral fins, [expanded] [_____] into the tube sheets.

Design, test, and stamp the refrigerant side for [1550] kilopascal [225] psig [_____] working pressure, and the water side for [1030] kilopascal [150] psig [_____] working pressure, in accordance with ASHRAE HVAC APP SI HDBK and ASHRAE EQUIP SI HDBK ASHRAE EQUIP IP HDBK, Chapter 13. Provide a water drain connection.

Insulate with [_____] [25] millimeter [_____] [1]-inch-thick flexible [expanded polyvinyl chloride] [polyurethane foam] insulation with a maximum K value of [0.037] watt per meter per degree Kelvin [0.26] Btu per hour per square foot per degree F [_____].

2.4 ACCESSORIES

2.4.1 Refrigerant Circuit

Ensure that each independent refrigerant circuit is factory-supplied and factory-piped, complete with a liquid-line solenoid valve, filter dryer, liquid-line sight glass and moisture indicator, thermal expansion valve, [charging valve][8 millimeter 1/4-inch flare charging ports], insulated suction line, compressor discharge service valve, [and discharge line check valve].

2.4.2 Control

Submit control diagrams for water-cooled reciprocating chiller units, showing the physical and functional relationship of equipment. Show the size, type, and capacity of the systems on electrical diagrams.

Provide power to control devices, including motor starters, relays,

timers, fuses, and circuit breakers, in accordance with Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide UL-listed components in the control panel and external control devices. Designate all components with a code, and ensure that the components are called out by that code on the wiring diagrams and schematics.

Provide electronic controls with adjustable settings and push-to-test indicating lights that are easily replaceable from the front of the panel.

2.4.2.1 Sequence Panel

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NOTE: Include this paragraph only if multiple units are provided.
****

For operation in [series] [parallel] with lead-lag switching, provide a [remote-mounted] sequence panel, with a sequence switch, temperature controller, and low-temperature cutout.

2.4.2.2 Control Panel

For each compressor, provide a control panel that has separate sections for the starter and the refrigeration controls, that is located [on] [near] the chiller unit. Ensure that the starter has an internal access door and a customer connection junction box with knockouts for remote interlocks.

Ensure that control panels are factory assembled and wired in accordance with UL and NFPA 70 requirements, with a single-point power connection. Identify each wire at every termination with a wire number matching the wiring diagram and control schematic. Ensure that the wire identification uses preprinted heat-shrink wire sleeves. Do not use hand lettering or marking.

For each control panel, provide the starter section with the following:

a. Circuit breaker combination starter

b. Power controls for [across-the-line] [part-winding] [_____] starting

c. Control power [fuse] [circuit breaker]

d. Control power transformer for [115] [_____]-volt control voltage

e. Terminal blocks, that have terminals for the main power supply and that clearly identify all auxiliary connections

f. Pumpdown control relay

g. Compressor starter relay

h. Reset relay

i. Nonrecycling compressor overload relay

j. Antirecycle timer

For each control panel, ensure that the refrigeration section has the following:

a. High-pressure control

b. Low-pressure control

c. Motor protection

d. Oil-pressure control

Mount the following devices on the control panel face:

a. Compressor run lights.

b. System start-stop switch.

c. Hand, Off, Auto switch

[d. Suction and discharge pressure gages

][e. Compressor lead-lag switch

] f. Demand limit switch

2.4.2.3 Operating Controls

Provide the unit with the following operating controls:

a. [Multi] [_____]-step capacity control in response to [leaving] [return] chilled water temperature

b. Five-minute shut-off timer to prevent short cycling

[c. Part-winding start timer

] d. Periodic pump-out timer, to decrease chilled water flow and high evaporator refrigerant pressure

e. Load limit thermostat to limit compressor loading on high return chilled water temperature

f. Three-phase monitor to protect the unit by stopping the compressor when a phase loss, phase reversal, phase unbalance, or under voltage occurs

g. Cycle counter and operating-hour meter

h. Computer switching circuit

2.4.3 Alarm Package

Furnish an alarm package with a test button for the alarm system. Furnish lights to indicate when the control circuit is energized and when compressors are running. Provide an audible alarm and indicating lights to show a compressor malfunction, low-chilled water temperature, and failure of the evaporator water flow.

2.4.4 Hot Gas Bypass

Provide a hot gas bypass valve and associated control panel wiring and piping that will allow the unit to operate below the minimum step set for unloading.

2.4.5 Gage Board

Provide a factory-piped gage board for each compressor, with pressure gages to indicate suction and discharge refrigerant pressures, and oil pressures.

2.4.6 Vibration Isolators

Provide vibration isolators as recommended by the manufacturer to support the complete chiller unit. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation considerations.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit results of factory-run tests performed before shipment. Ensure that results indicate capacity, current draw, and control operation monitoring. Ship units with a full operating charge of [_____] refrigerant with an ozone depletion potential of zero, and oil.

PART 3 EXECUTION

3.1 INSTALLATION

Install the chiller assembly in accordance with the manufacturer's instructions. [Provide a connection for electrical service.]

Provide connections for chilled-water piping, condenser-water piping, and auxiliary-water piping. [Arrange the piping so that the piping can be easily dismantled for tube cleaning.]Provide piping from the safety relief valve to outside the building.

Provide chilled-water inlet piping with a [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Provide chilled-water outlet piping with a [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

Provide condenser inlet piping with a [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Provide condenser outlet piping with a [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

3.2 FIELD QUALITY CONTROL

3.2.1 Manufacturer's Field Service

Submit the manufacturer's instructions for the water-cooled reciprocating chiller unit including the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and information about the fabrication site.

Submit [six] [_____] copies of the operation and maintenance manuals 30 calendar days before testing the units. No later than 30 calendar days prior to contract completion, update and resubmit data for final approval.

Furnish the service of a factory-trained representative for [_____] calendar days to conduct training and to supervise [dehydration and charging,] testing, and start-up.

Demonstrate system operations and verify that the system meets the specified performance requirements.

-- End of Section --