



- 3.2 MANUFACTURER'S FIELD SERVICE
- 3.3 DEMONSTRATION

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

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 550/590 (1998) Water-Chilling Packages Using the Vapor Compression Cycle

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

ASHRAE-05 (1999) Handbook, HVAC Applications (SI Edition)

ASHRAE-06 (1997) Handbook, HVAC Systems and Equipment (IP Edition)

ASHRAE-Hdbk SE-SI (2000) Handbook, HVAC Systems and Equipment (SI Edition)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1 (2003) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2003) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code 2005 Edition

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CE-6 (2000) How to Buy an Energy-Efficient Air-Cooled Electric Chiller

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the

submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

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

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Connection diagrams shall be submitted indicating the relations and connections of the following items. The drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Compressor  
Motor  
Control Panel  
Condenser  
Evaporator  
Refrigerant Circuit  
Alarm Systems  
Vibration Isolators  
Gages

Control Diagrams shall be submitted for water-cooled reciprocating chiller units in accordance with paragraph entitled, "Control," of this section.

#### SD-03 Product Data

Equipment and Performance Data shall be submitted for the following items indicating use life, system functional flows, safety features, and other features such as electrical system protective device ratings.

Chiller Unit  
Compressor  
Condenser

Manufacturer's catalog data shall be submitted for the following items:

Accessories  
Spare Parts  
Vibration Isolators

#### SD-07 Certificates

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

Compressor  
Motor  
Control Panel  
Condenser  
Evaporator  
Refrigerant Circuit  
Alarm Systems  
Vibration Isolators  
Gages

#### SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for water-cooled reciprocating chiller units in accordance with paragraph entitled, "General Requirements," of this section.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Manufacturer's Field Service," of this section.

### 1.3 GENERAL REQUIREMENTS

Manufacturer's Instructions shall be submitted for water-cooled reciprocating chiller units including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

#### 1.3.1 Mechanical

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NOTE: If Section 15003S GENERAL MECHANICAL PROVISIONS is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted. If Section 15072S VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT is not included in the project specification, applicable requirements therefrom should be inserted and the second paragraph deleted.  
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[Section 15003S GENERAL MECHANICAL PROVISIONS applies to work specified in this section.]

[Section 15072S VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT applies to work specified in this section.]

### 1.3.2 Electrical

Motors shall be rated in accordance with Section 16225S MOTORS.

Solid state sensors and protection shall be in accordance with Section 16286S OVERCURRENT PROTECTIVE DEVICES.

## PART 2 PRODUCTS

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NOTE: Compressor and motor balance shall conform to  
ISO Std. 1940/1 - (1986) Balance Quality  
Requirements of Rigid Rotors - Determination of  
Permissible Residual Unbalance unless otherwise  
noted. Motor vibration levels shall conform to NEMA  
Specification MG-1, Motors and Generators, Part 7  
unless otherwise noted.  
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### 2.1 MANUFACTURED CHILLER UNIT

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NOTE: For descriptive specification, edit this  
article to suit project conditions. If performance  
specification is used for the project, delete this  
article.  
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Provide factory assembled water cooled liquid chiller unit, consisting of  
[two] [\_\_\_\_\_] [semi-] hermetic reciprocating, motor-driven compressor[s]  
mounted on [spring] [\_\_\_\_\_] vibration isolators, [hot gas muffler,]  
condenser, insulated evaporator, [independent refrigerant circuits,]  
thermal expansion valves, refrigeration accessories, and control panels.

Except as specified, unit and spare parts shall be the manufacturer's  
standard product, designed for the service indicated, and shall be tested  
and rated in accordance with ARI 550/590.

Unit shall be factory run-tested prior to shipment, with capacity, current  
draw, and control operation monitored, recorded, and submitted. Unit shall  
ship with a full operating charge of [R-22] or other suitable refrigerant  
with ODP=0.0, and oil. Unit shall operate with [230] [208] [480] volt  
3-phase, 60 Hertz power.

"Energy efficiency ratings shall meet or exceed the full-load efficiency  
and the integrated part-load value (IPLV) efficiency ratings as described  
in ARI Standard 550/590-98 and DOE CE-6."

### 2.2 LIQUID CHILLER

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NOTE: Performance specification for one, or  
identical units. Use schedule to specify units of  
different sizes.  
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Reciprocating water chiller unit shall have 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, the fouling factor for evaporator and condenser shall be no less than 0.0005. Water head loss shall not exceed [\_\_\_\_\_] millimeter [\_\_\_\_\_] feet through condenser, or [\_\_\_\_\_] millimeter [\_\_\_\_\_] feet through evaporator.

## 2.3 COMPONENTS

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**NOTE: The following article may be deleted, or  
edited as necessary to suit project conditions and  
to further describe the Manufactured Chiller Unit.**  
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### 2.3.1 Compressor

Compressor(s) shall be 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. Housing, cylinder heads, liners, and handhole covers shall be close grain cast iron. Suction and discharge valves shall be high strength, non-flexing, ring type. Valve plates shall be of cast iron, with ground and lapped seats. Rotating parts shall be statically and dynamically balanced to ISO 1940-1-1986, [G16] [G6.3] [\_\_\_\_\_] . Mount compressors on [spring] [\_\_\_\_\_] vibration isolators. Provide isolation service valves on inlet and outlet lines of each compressor.

#### 2.3.1.1 Lubricating System

Provide lubricating system with 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, and to ensure adequate lubrication during starting, stopping, and normal operation.

#### 2.3.1.2 Capacity-Reduction

Provide automatic capacity-reduction equipment consisting of suction valve unloaders. Lifting mechanism shall be operated by [oil pressure] [gas discharge pressure] [solenoid valve]. Provide for unloaded compressor start.

#### 2.3.1.3 Motor

Compressor shall conform to NEMA MG 1, be direct-driven by [1800] [3600] rpm, [230] [\_\_\_\_\_] volt, 3-phase, 60 Hertz, constant speed motor, UL listed, and designed for [across-the-line] [part-winding] [\_\_\_\_\_] starting. Motor shall have copper windings and be suction gas cooled. Solid state sensor and electronic winding overheating protection shall be provided.

#### 2.3.1.4 Crankcase Heater

Crankcase heater shall be immersible type. Energize heater [continuously] [\_\_\_\_\_] . [Mount a "DANGER - EXTERNAL POWER SUPPLY" sign having 10 millimeter 3/8-inch white letters with red background on the junction box



for the crankcase heater.]

### 2.3.2 Condenser

Condenser shall be shell-and-tube type, of [seamless] [welded] steel construction, with removable [cast iron] [fabricated steel] heads [and independent, dual refrigerant circuits].

Tubes shall be cleanable [and] [replaceable] [seamless copper] [\_\_\_\_], with integral fins, [expanded] [\_\_\_\_] into tube sheets.

Design, test, and stamp refrigerant side for [2050] kilopascal [300] psig [\_\_\_\_] working pressure in accordance with ASHRAE-05 and ASHRAE-Hdbk SE-SI ASHRAE-06, Chapter 13.

Provide [2050] kilopascal [300] psig [\_\_\_\_] safety relief valve on condenser shell.

Design, test, and stamp water side for [1030] kilopascal [150] psig [\_\_\_\_] working pressure in accordance with ASHRAE-05 and ASHRAE-Hdbk SE-SI ASHRAE-06, Chapter 13. Provide drain connection.

### 2.3.3 Evaporator

Evaporator shall be shell-and-tube type, of [seamless] [welded] steel construction, with removable [cast iron] [fabricated steel] heads [and independent, dual refrigerant circuits].

Tubes shall be cleanable [and] [replaceable] [seamless copper] [\_\_\_\_], with integral fins, [expanded] [\_\_\_\_] into tube sheets.

Design, test, and stamp refrigerant side for [1550] kilopascal [225] psig [\_\_\_\_] working pressure, and water side for [1030] kilopascal [150] psig [\_\_\_\_] working pressure, in accordance with ASHRAE-05 and ASHRAE-Hdbk SE-SI ASHRAE-06, Chapter 13. Provide water drain connection.

Insulate with [\_\_\_\_] [25] millimeter [\_\_\_\_] [100] inch thick flexible [expanded polyvinyl chloride] [polyurethane foam] insulation with maximum K value of [0.037] watt per meter per degree Kelvin [0.26] Btu per hour per foot square per degree F [\_\_\_\_].

## 2.4 ACCESSORIES

### 2.4.1 Refrigerant Circuit

Each independent refrigerant circuit shall be factory supplied and piped, and complete with 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, [discharge line check valve.]

### 2.4.2 Control

Control Diagrams shall be submitted for water-cooled reciprocating chiller units showing the physical and functional relationship of equipment. Electrical diagrams shall show size, type, and capacity of the systems.

Power and control devices, including but not limited to motor starters, relays, timers, fuses, circuit breakers, shall be in accordance with

## Section 16286S OVERCURRENT PROTECTIVE DEVICES.

Components of the control panel, and external control devices, shall be UL listed. All components shall be designated with a code, and called out by that code on the wiring diagrams and schematics.

Timers shall be electronic, with adjustable settings. Indicating lights shall be push-to-test type and 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.**  
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Provide a [remote mounted] sequence panel, with sequence switch, temperature controller, and low temperature cutout, to permit operation in [series] [parallel] with lead-lag switching.

### 2.4.2.2 Control Panel

Control panel, having separate sections for starter and refrigeration controls, shall be furnished for each compressor and located [on] [near] chiller unit. Starter section shall have internal access door and customer connection junction box with knockouts for remote interlocks.

Control panels shall be factory assembled, and shall be wired in accordance with UL and NFPA 70 requirements, with single point power connection. Each wire shall be identified at every termination with a wire number matching the wiring diagram and control schematic. Wire identification shall utilize preprinted heat-shrink wire sleeves. Hand lettering or marking is not acceptable.

For each control panel, the starter section shall have:

Circuit breaker type combination starter.

Power controls for [across-the-line] [part winding] [\_\_\_\_\_] starting.

Control power [fuse] [circuit breaker].

Control power transformer for [115] [\_\_\_\_\_] -volt control voltage.

Terminal blocks, having terminals for the main power supply and all auxiliary connections clearly identified.

Pumpdown control relay.

Compressor starter relay.

Reset relay.

Non-recycling compressor overload relay.

Anti-recycle timer.

For each control panel, the refrigeration section shall have:

High pressure control.

Low pressure control.

Motor protection.

Oil pressure control.

The following devices shall be mounted on the control panel face:

Compressor run lights.

System start-stop switch.

Hand, Off, Auto switch.

[Suction and Discharge Pressure Gages.]

[Compressor lead-lag switch.]

Demand limit switch.

#### 2.4.2.3 Operating Controls

Provide the following operating controls:

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

Five minute off timer to prevent short cycling.

[Part-winding start timer.]

Periodic pump-out timer, to pump down on chilled water flow and high evaporator refrigerant pressure.

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

Three phase monitor to protect unit by stopping compressor on phase loss, phase reversal, phase unbalance, or under voltage.

Cycle counter and operating hour meter.

Computer switching circuit.

#### 2.4.3 Alarm Package

An alarm package for alarm systems with test button shall be furnished. Lights shall be furnished to indicate when control circuit is energized and compressors are running. An audible alarm and indicating lights shall be provided to indicate compressor malfunction, low chilled water temperature, and evaporator water flow failure.

#### 2.4.4 Hot Gas Bypass

Provide hot gas bypass valve, and associated control panel wiring and piping, to allow operation of unit below the minimum step of unloading.

#### 2.4.5 Gage Board

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

#### 2.4.6 Vibration Isolators

Provide vibration isolators as recommended by the manufacturer to support complete chiller unit. Refer to Section 15072S VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT for vibration isolation considerations.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

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

Provide connections for chilled water piping, condenser water piping, and auxiliary water piping. [Arrange piping for easy dismantling to permit tube cleaning.] Provide piping from safety relief valve to outdoors.

Chilled water inlet piping shall have [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Chilled water outlet piping shall have [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

Condenser inlet piping shall have [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Condenser outlet piping shall have [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

#### 3.2 MANUFACTURER'S FIELD SERVICE

Contractor shall submit [6] [\_\_\_\_\_] copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the water-cooled reciprocating water chiller units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Service of factory trained representative shall be furnished for a period of [\_\_\_\_\_] calendar days, to conduct training and supervise [dehydration and charging,] testing, and start-up.

#### 3.3 DEMONSTRATION

Demonstrate system operations and verify specified performance.

-- End of Section --