SECTION 23 64 00
PACKAGED WATER CHILLERS

SPEC WRITER NOTES:
1 Delete between //---- // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. Provide the year of latest edition to each publication given in paragraph APPLICABLE PUBLICATIONS.

PART 1 - GENERAL

1.1 DESCRIPTION

A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. This section covers //Centrifugal// //Rotary-Screw// //Centrifugal or Rotary-Screw// //Scroll// //Absorption// water-cooled chillers, complete with accessories.

C. //Rotary-Screw// //Scroll// //Rotary-Screw or Scroll// air-cooled chillers complete with accessories.

1.2 DEFINITIONS

A. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.

B. BACNET: Building Automation Control Network Protocol, ASHRAE 135.

C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.

D. FTT-10: Echelon Transmitter-Free Topology Transceiver.

1.3 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

D. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//

E. Section 03 30 00, CAST-IN-PLACE CONCRETE.

F. Section 11 41 21, WALK-IN COOLERS and FREEZERS.

G. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

J. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

K. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

L. Section 23 21 13, HYDRONIC PIPING.

M. Section 23 21 23, HYDRONIC PUMPS.

N. Section 23 23 00, REFRIGERANT PIPING.

O. Section 23 31 00, HVAC DUCTS and CASINGS

P. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

Q. Section 26 29 11, MOTOR CONTROLLERS.

1.4 APPLICABLE PUBLICATIONS

SPEC WRITER NOTES:
1. Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project unless the reference applies to all HVAC systems. Publications that apply to all HVAC systems may not be specifically referenced in the body of the specification but shall form a part of this specification.
2. Insert the year of approved latest edition of the publications between the brackets // // and delete the brackets if applicable to this project.

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. Air Conditioning, Heating, and Refrigeration Institute (AHRI):

495-//2005(R2009)//.....Performance Rating of Refrigerant Liquid Receivers

550/590-//2020//.....Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle

560-//2000//.....Absorption Water Chilling and Water Heating Packages

575-//2017//.....Method of Measuring Machinery Sound Within an Equipment Space

C. American Bearing Manufacturers Association (ABMA):
9-//2015(R2020)//.....Load Ratings and Fatigue Life for Ball Bearings
11-//2014(R2020)//.....Load Ratings and Fatigue Life for Roller Bearings

D. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
15&34-//2019//.....Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants
135-//2020//.....BACnet - A Data Communication Protocol for Building Automation and Control Networks

E. American Society of Mechanical Engineers (ASME):
ASME Boiler and Pressure Vessel Code -
BPVC Section VIII-//2021// Rules for Construction of Pressure Vessels, Division 1

F. American Society of Testing Materials (ASTM):
B117-//2019//.....Standard Practice for Operating Salt Spray (Fog) Apparatus
C534/C534M-//2020a//....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C612-//2014(R2019)//....Standard Specification for Mineral Fiber Block and Board Thermal Insulation
D4587-//2011(R2019)e1//.Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings

G. Occupational Safety and Health Administration (OSHA):
29 CFR 1910.95.....Occupational Noise Exposure

H. Department of Veterans Affairs (VA):
H-18-8-//2019(R2020)//..Seismic Design Requirements
PG-18-10-//2017(R2021)// HVAC Design Manual

1.5 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 XX XX, SECTION TITLE", with applicable paragraph identification.

SPEC WRITER NOTE: There could be more than one type of chillers required for the project. Edit following paragraph and associated subparagraphs to suit project requirements in the chiller selection.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
   1. //Centrifugal// //Rotary-screw// //Scroll// //Absorption// water chillers, including motor starters, control panels, and vibration isolators, and remote condenser data shall include the following:
      a. Rated capacity.
      b. Pressure drop.
      c. Efficiency at full load and part load WITHOUT applying any tolerance indicated in the AHRI 550/590.
      d. Refrigerant
      e. Fan performance (Air-Cooled Chillers only.)
      f. Accessories.
      g. Installation instructions.
      h. Startup procedures.
      i. Wiring diagrams, including factory-installed and field-installed wiring.
      j. Sound/Noise data report. Manufacturer shall provide sound ratings. Noise warning labels shall be posted on equipment.
      k. Refrigerant vapor detectors and monitors.
D. Run test report for all chillers.
E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with AHRI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.

SPEC WRITER NOTE: Show seismic restraints for refrigeration equipment in accordance with the VA H-18-8 Seismic Design Requirements. Delete the following paragraph if the chiller(s) is located outside the seismic zone.

F. //Provide seismic restraints for refrigeration equipment to withstand seismic forces.//

SPEC WRITER NOTE: Coordinate O&M Manual and commissioning requirements with

Section 01 00 00, GENERAL REQUIREMENTS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS. O&M Manuals shall be submitted for content review as part of closeout documents.

G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
   1. Include complete list indicating all components of the systems.
   2. Include complete diagrams of the internal wiring for each item of equipment.
   3. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.

H. //Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

I. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

1.6 QUALITY ASSURANCE

A. Comply with AHRI requirements for testing and certification of the chillers.

SPEC WRITER NOTE: Verify the compressor/motor warranty with the manufacturers of the equipment being specified and edit the following accordingly.

B. Refer to paragraph, WARRANTY, Section 01 00 00, GENERAL REQUIREMENTS, except as noted below:
   1. Provide a 5-year motor//, transmission,// and compressor warranty to include materials, parts and labor.

C. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard.

D. Refer to ASHRAE 15 for refrigerant vapor detectors and monitor.

E. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more

information regarding the product categories covered by the Bio-Preferred Program, visit http://www.biopreferred.gov.

F. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

1.7 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

SPEC WRITER NOTE: Chillers shall be selected on a project specific basis. In general, chillers should be selected within the following ranges:
- Centrifugal(water-cooled): 200-1,250 tons
- Rotary-Screw(water-cooled): 130-400 tons
- Scroll(water-cooled): 30-200 tons
- Rotary-Screw(air-cooled): 70-200 tons
- Scroll(air-cooled): 20-200 tons

Note: Chiller capacities shall be 200 tons maximum for air-cooled chillers; 1,250 tons maximum for water-cooled chillers.

2.1 //CENTRIFUGAL// //ROTARY-SCREW// //SCROLL// WATER-COOLED WATER CHILLERS

SPEC WRITER NOTES:
1. If chillers are required to operate at less than 25 percent of full unit rated capacity, specify provision for hot gas by-pass, to operate the unit stable at any stage of capacity reduction. Check with manufacturers for availability of this feature for the equipment being specified.
2. Provide marine water box for each evaporator and condenser. Make provision for space and design piping layout.
3. Automatic tube cleaning system is not required.

A. General: Chiller shall be factory assembled and factory tested, complete with evaporator, condenser, marine water boxes for condenser and evaporator, compressor, motor, starter, oil heater and cooler, economizer or intercooler, purge system (if required), refrigerant piping, instrumentation and control piping, operating and safety controls mounted on the chiller, and other auxiliaries necessary for safe and proper operation of the unit. Chiller operation shall be fully

automatic. Make provision for space and design piping layout to suit the marine water boxes.

B. Performance: Provide the capacity as shown on the contract drawings. Part load and full load efficiency ratings of the chiller shall not exceed those shown on the contract drawings. //If chillers are required to operate at less than 25 percent of full unit rated capacity, specify provision for hot gas by-pass, to operate the unit stable at any stage of capacity reduction.//

C. Capacity of a single water-cooled chiller shall not exceed 1,250 Tons (standard AHRI conditions).

D. Applicable Standard: Chillers shall be rated and certified in accordance with AHRI 550/590. Chillers shall be AHRI stamped. Chiller efficiency shall comply with FEMP (Federal Energy Management Progress) requirements.

SPEC WRITER NOTE: Specify sound pressure levels at each octave band as well as the overall A-weighted sound pressure dB(A) level based on the project specific acoustic analysis and local ordinance.

E. Acoustics: Sound pressure levels shall not exceed the following specified levels. The manufacturer shall provide sound treatment if required to comply with the specified maximum levels. Testing shall be in accordance with AHRI 575.

OCTAVE BAND								Overall
63	125	250	500	1000	2000	4000	8000	dB(A)

F. Hermetic or Open: Chillers shall be open or hermetically sealed, using one of the following refrigerants: HCFC-123, HFC-134a or HCFC-410A.

SPEC WRITER NOTE: Verify with the manufacturers for the life of bearings for the equipment being specified.

G. Compressor (Centrifugal Type): Single or multistage, having statically and dynamically balanced impeller, either direct or gear driven. Impeller shaft shall be heat-treated carbon steel of sufficient rigidity to prevent whip or vibration at operating speed. Shaft main bearings shall be of journal type with bronze or babbitt line steel cartridge, aluminum alloy one-piece insert type, or rolling element type// with an ABMA L10 life of a minimum of 200,000 hours. Rolling element bearings shall be rated in accordance with ABMA 9 or ABMA 11 as applicable//. Casing shall be cast-iron or steel plate with split

sections gasketed and bolted together. Lubrication System shall be forced-feed type and shall provide oil at proper temperature to all parts requiring lubrication. Make provisions to ensure lubrication of bearings prior to starting and of shaft seal both on stopping and starting, or bearings and shaft seal shall be submerged in oil. On units providing for forced-feed lubrication prior to starting, a differential oil pressure cutout interlocked with compressor starting equipment shall allow compressor to operate only when required oil pressure is provided to bearings. Capacity control shall be by means of variable inlet guide vanes in the compressor suction to modulate the chiller capacity from 100 to 10 percent of full unit rated capacity without unstable compressor operation. The inlet guide vanes shall be electrically operated upon the actuation of temperature or pressure sensor.

H. Compressor (Rotary-Screw Type): Positive displacement oil injected type, direct drive, constructed of precision-machined cast-iron housing. Shaft main bearing shall be of sleeve design, conservatively loaded, with heavy-duty steel-backed babbitt bushings, or rolling element type, both rated with an L10 life of a minimum of 200,000 hours. Rolling element bearings shall be rated in accordance with ABMA 9 or ABMA 11. Casing shall be cast-iron, precision machined for minimum clearance about periphery of rotors. Lubrication system shall provide oil at proper temperature to all moving parts. Capacity control shall be by means of single slide valve to modulate the capacity from 100 to 10 percent of full unit rated capacity without unstable compressor operation. The single slide valve shall be hydraulically operated upon the actuation of temperature or pressure sensor.

I. Compressor (Scroll Type): Three dimensional, positive-displacement, hermetically sealed design, with suction and discharge valves, crankcase oil heater and suction strainer. Compressor shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Lubrication system shall consist of reversible, positive displacement pump, strainer, oil level sight glass, and oil charging valve. Capacity control shall be by on-off compressor cycling of single and multiple compressors// and hot gas bypass//.

SPEC WRITERS NOTE: ASME construction for heat exchangers may not be required for chillers using low-pressure refrigerant,

such as HCFC-123. Edit the following 2 paragraphs accordingly.

J. Evaporator: Shell-and-tube type, constructed and tested and stamped in accordance with ASME BPVC Section VIII where applicable for working pressure produced by refrigerant used and water system installed, but not less than 1034 kPa (150 psig) waterside working pressure. Shell shall be fabricated of carbon steel and shall have carbon steel tube sheets; drilled and reamed to accommodate the tubes. Tubes shall be externally and internally enhanced individually replaceable and shall be expanded full diameter into tube sheets, providing a leak proof seal. Intermediate tube supports sheets shall be provided as recommended by the manufacturer to minimize tube vibration, stress, and wear. Performance shall be based on a water velocity not less than 1 m/s (3 fps) nor greater than 4 m/s (12 fps), and fouling factor of 0.0000176 m2 degrees C (0.0001 hr. sq. ft. degrees F/Btu). Removable marine water box shall be constructed of steel. Design working pressure shall be //1034 kPa (150 psig)// //2070 kPa (300 psig)//; pressure tested at 130 percent of working pressure. Water nozzle connections shall be flanged.

K. Condenser: Shell-and-tube type, constructed, tested, and stamped in accordance with applicable portions of ASME BPVC Section VIII, where applicable for working pressure produced by the refrigerant used and water system installed, but not less than 1034 kPa (150 psig). Shell shall be fabricated of carbon steel and shall have carbon steel tube sheets; drilled and reamed to accommodate the tubes. Tubes shall be nonferrous metal, externally enhanced, and internally enhanced, individually replaceable, and shall be expanded full diameter into tube sheets, providing a leak proof seal. Intermediate tube support sheets shall be provided as recommended by the manufacturer to minimize tube vibration, stress and wear. Tubes shall fit tightly in the supports to prevent chafing due to vibration or pulsation. Performance of condenser shall be based on a water velocity not less than 1 m/s (3 fps) nor greater than 4 m/s (12 fps), and a fouling factor of 0.000044 m2 degrees C (0.00025 hr. sq. ft.) degrees F/Btu. Removable marine water box shall be constructed of steel. Design working pressure shall be //1034 kPa (150 psig)// //2070 kPa (300 psig)//; pressure tested at 130 percent of working pressure. Water nozzle connections shall be flanged.

L. Insulation: Evaporator, suction piping, compressor, and all other parts subject to condensation shall be insulated with 38 mm (1.5 inch) minimum thickness of flexible-elastomeric thermal insulation, complying with ASTM C534/C534M.

M. Economizer: Provide if required by manufacturer. Flash gas shall be piped from economizer to inlet of intermediate stage impeller wheel. In case of rotary compressor flash gas shall be piped from economizer to the intermediate compressor point. Provide a refrigerant flow control system (float valve or variable/multiple orifice system) to automatically regulate flow of liquid refrigerant through economizer. If external-type economizer is used, such economizer shall be constructed and tested in accordance with ASME BPVC Section VIII for working pressures produced by refrigerant used.

N. Motor Load Limiter: Provide a sensing and control system, which will limit maximum load current of compressor motor to a manually selectable percentage of 40 percent to 100 percent of full load current. System shall sense compressor motor current and limit it by modulating inlet guide vanes at the compressor, overriding other controls in their ability to increase loading, but not overriding their ability to reduce loading.

O. Purge System: Chillers utilizing HCFC-123 and chillers using refrigerants with vapor pressure less than 100 kPa (14.5 psig) shall be supplied with Purge System. Purge unit shall be factory mounted, complete with necessary, piping, operating and safety controls and refrigerant service valves to isolate the unit from the chilling unit. Purge unit shall be air, water, or refrigerant cooled. When in operation, purge system shall function automatically to remove, water vapor, and condensable gases from refrigeration system and to condense, separate, and return to system any refrigerant present therein. Purge system shall be manually or automatically started and stopped, and shall be assembled as a compact unit. As an option, a fully automatic purge system that operates continuously while main unit is operating may be furnished. Such purge system shall provide a means to signal operator of occurrence of excessive purging indicating abnormal air leakage into unit. The purge system shall be of high efficiency in recapturing the refrigerant at all load and head conditions and with capability to operate when the chiller is off. The purge unit shall be UL listed.

P. //Isolation Pads: Manufacturer's standard.//

Q. //Spring Isolators: Per Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.//

R. Refrigerant and Oil:

1. Provide sufficient volume of dehydrated refrigerant and lubricating oil to permit maximum unit capacity operation before and during tests. Refrigerant charge lost during the warranty period due to equipment failure shall be replaced without cost to the Government.
2. The manufacturer shall certify that chiller components, such as seals, O-ring, motor windings, etc, are fully compatible with the specified refrigerants.

S. Chillers utilizing HCFC-123 shall be supplied with a vacuum prevention system to maintain the chiller at positive pressure during non-operational cycles.

T. //Chillers utilizing HCFC-123 shall be supplied with //frangible carbon rupture disc// all metal, non-fragmented with reverse buckling design rupture disc and a safety relief valve downstream of the rupture disc//.

U. //Chillers using refrigerants HFC-134a shall be supplied with single or multiple reseating type, spring-loaded relief valve//.

V. Service valves shall be provided to facilitate refrigerant reclaim/removal required during maintenance.

SPEC WRITERS NOTE: Use NEMA 1 enclosure in normal chiller room indoor environment and NEMA 12 in environments subject to excessive airborne dirt, dust, lint, etc.

W. Controls: Chiller shall be furnished with unit mounted, stand-alone, microprocessor-based controls in //NEMA 1// //NEMA 12// enclosure, hinged and lockable, factory wired with a single point power connection and separate control circuit. The control panel provide chiller operation, including monitoring of sensors and actuators, and shall be furnished with light emitting diodes or liquid-crystal display keypad.

SPEC WRITER NOTE: Some display functions are chiller specific. Verify with manufacturers all of the control functions as well as edit the following lists accordingly.

1. The following functions shall display as a minimum:
   a. Date and Time.
   b. Outdoor air temperature.

c. Operating set point temperature and pressure.
d. Operating hours.
e. Operating or alarm status.
f. Chilled water temperature-entering and leaving.
g. Condenser water temperature-entering and leaving.
h. Refrigerant pressure-condenser and evaporator.
i. Low oil pump pressure.
j. High oil supply pressure.
k. Chiller diagnostic codes.
l. Current limit set point.
m. Number of compressor starts.
n. Purge suction temperature, if refrigerant HCFC-123 is used.
o. Purge elapsed time, if refrigerant HCFC-123 is used.

2. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
   b. Control set points for entering and leaving chilled temperatures.
   c. Condenser water temperature.
   d. Current/demand limit.
   e. Motor load limit.
3. Safety Controls: Following conditions shall shut down the chiller and require manual reset to start:
   a. High condenser pressure.
   b. High oil temperature.
   c. High or low oil pressure.
   d. Loss of flow-condenser or chilled water.
   e. Low chilled water temperature.
   f. Low evaporator refrigerant temperature.
   g. Sensor malfunctions.
   h. Power fault.
   i. Extended compressor surge.
   j. Communication loss between the chiller and its control panel. A signal shall be transmitted to Energy Control Center, if provided, for this communication loss and for any abnormal.
4. The chiller control panel shall provide a relay output to initiate system changeover to free cooling. This relay shall be energized upon initiation of free cooling at the chiller control panel.
5. Leaving chilled water temperature reset, where specified in the control sequence, shall be based on //return water temperature//

//outdoor temperature// 4-20 MA or 0-10 VDC signal from a building automation system.

6. Chillers shall be pre-wired to terminal strips for interlocked to other equipment.
7. //Provide contacts for remote start/stop, alarm for abnormal operation or shut down, and for Engineering Control Center (ECC) interface.//
8. //Chiller control panel shall reside on the "BACnet network", provide data using open protocol network variable types and configuration properties, and BACnet interworking using ARCNET or MS/TP physical data link layer protocol for communication with building automation control system.//
9. Auxiliary hydronic system and the chiller(s) shall be electronically interlocked to provide time delay and starting sequence as indicated on control drawings.
10. The chiller control panel shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows.
    a. High pressure switch that is set to 20 psig (adjustable setting) lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
    b. Motor surge pressure that is set at 95 percent of compressor RLA that will automatically unload the compressor to prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
    c. Low pressure switch that is set at 5 psig above the factory low pressure switch that will automatically unload the compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.
    d. In all the above cases, the chiller will continue to run, in an unloaded state and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will

return to normal operation and can then produce full load cooling.

11. With variation of +/-10 percent of design flow per minute, chiller shall be able to maintain +/-0.5 degrees F leaving water temperature control. The chiller shall be able to withstand a +/- 30 percent change in flow rate per minute without unit trip. Variations in the primary flow allow for optimal system efficiency, but the chiller shall be able to maintain temperature control to help ensure occupant comfort.
12. The chiller control panel shall provide +/-0.5 degrees F leaving water temperature control during normal operation. The chiller shall provide multiple steps leaving chilled water temperature controller to minimize part load energy use and optimize leaving chilled water temperature control. If manufacturer is unable to provide at least several steps of unloading, hot gas bypass shall be required to minimize loss of leaving water temperature control.
13. The chiller control panel shall provide a 2-minute stop-to-start and 5 minute start-to-start solid state timer. If the anti-recycle timers are longer than 5 minutes, then hot-gas bypass shall be provided to limit loss of leaving chilled water temperature control in low-load conditions.

X. Motor: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Compressor motor furnished with the chiller shall be in accordance with the chiller manufacturer and Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. Starting torque of the motor shall be suitable for the driven chiller machine.

SPEC WRITER NOTES:
1. For low voltage applications, specify wye-delta closed transition type starter, solid state (reduced voltage) type starter, or variable frequency drive. For medium voltage applications, specify solid-state reduced voltage type starter, across the-line type starter, autotransformer type starter or primary reactor type starter.
2. Optional variable frequency drives shall be used only if it is demonstrated to be cost effective by the life cycle cost analysis.
3. Coordinate with electrical requirements. Both low and medium

voltage starters are specified in Section 26 29 11, MOTOR CONTROLLERS.

Y. Motor Starter: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide a starter for each centrifugal or rotary-screw chiller in NEMA 1 enclosure, designed for floor or unit mounting. For floor mounted starter provide wiring from starter to chiller. Starter shall be a //wye-delta closed transition type// //solid state (reduced voltage) type// //variable frequency drive type// //across the-line type// //autotransformer type// primary reactor type//. Provide starter with the following features in addition to the ones specified in Section 26 29 11, MOTOR CONTROLLERS.

1. Starter shall include incoming line provision for the number and size cables shown on the contract drawings. Incoming line lugs shall be copper mechanical type.
2. Terminals connection pads shall be provided to which customers supply lugs can be attached.
3. Starters shall be coordinated with chiller packages(s) making certain all terminals are properly marked according to the chiller manufacturer’s wiring diagram.
4. Contactors shall be sized per NEMA requirements to the chillers for full load currents.
5. Ammeter(s) shall be provided, capable of displaying current to all three phases. Ammeter shall be calibrated so that inrush current can be indicated.
6. Chiller starter shall include an advanced motor protection system incorporating electronic three phase overloads and current transformers. This electronic motor protection system shall monitor and protect against the following conditions:
   a. Three phase loss with under and over voltage protection.
   b. Phase imbalance.
   c. Phase reversal.
   d. Motor overload.
   e. Motor overload protection incorrectly set.
   f. Momentary power loss protection with auto restart consisting of three phase current sensing device that monitor the status of the current.
   g. Starter contactor fault protection.
   h. Starter transition failure.

i. Distribution fault protection.

7. When a motor driven oil pump is furnished, provide a 120-volt control circuit, mounted within starter enclosure. When an oil pump starter is provided at the refrigeration machine, provide fused disconnect in star delta starter for oil pump.
8. The starter shall be equipped with pilot relays to initiate the start sequence of compressor. These relays shall be a self-monitoring safety circuit, which shall indicate improper operation (slow operation, welding of contacts, etc) and shall cause the chiller unit to be shut down and a fault trip indicator be displayed. The "starter circuit fault" indicator shall be located in the door of the enclosure and shall require manual reset.
9. A lockout transition safety circuit shall be provided to prevent damage from prolonged energization due to malfunction of the transistor contactor. Malfunction shall cause the chiller unit to shut down and the "starter circuit fault" indicator be displayed.
10. A permanent nameplate shall be provided and mounted on the starter panel. It shall identify the manufacturer, serial or model number identifying the date of manufacturing and component replacement parts, and all current and voltage rating, and as built wiring schematic showing all items provided.
11. Provide non-fused main power disconnect switch.

2.2 ABSORPTION WATER CHILLERS

A. General: Factory assembled and factory tested //indirect-fired// //direct-fired// //low pressure steam// //high pressure steam// //high temperature hot water// //single-stage// //double-stage// water chiller including absorber, evaporator, generator, condenser, purge system, heat exchanger assembly, solution and evaporator pumps, automatic decrystallization, operating and safety controls, control panels, including gauges and lights, all interconnecting piping, base or supports, and motor starters.

SPEC WRITER NOTE: Specify sound pressure levels at each octave band as well as the overall A-weighted sound pressure dB(A) level based on the project specific acoustic analysis and local ordinance.

B. Acoustics: Sound pressure levels shall not exceed the following specified levels. The manufacturer shall provide sound treatment if

required to comply with the specified maximum levels. Testing shall be in accordance with AHRI 575.

OCTAVE BAND								Overall
63	125	250	500	1000	2000	4000	8000	dB(A)

C. Chiller shall conform to AHRI 560 and applicable portions of ASME BPVC Section VIII for construction and testing of absorption chillers.

D. Chiller shall use water as refrigerant and lithium bromide solution as absorbing agent. Unit shall be capable of operating continuously at any normal conditions between 20 to 100 percent full load.

E. Shell shall be fabricated of carbon steel plate, and of minimum working pressure of 103 kPa (15 psig). Absorber, condenser, and evaporator tubes shall be seamless copper or copper-nickel alloy.

F. //Indirect-Fired: Tubes material for //single-stage generator shall be copper-nickel alloy, 103 to 345 kPa (15 to 50 psig) working pressure// //double-stage generator shall be copper-nickel alloy for first stage generator and copper or copper-nickel for second stage steam generator, 1034 kPa (150 psig) working pressure for indirect-fired units.//

G. //Direct-Fired: Tube material for first stage generator shall be carbon steel, 90 to 103 kPa (13 to 15 psig); UL and FM approved forced-draft type burner suitable for //natural gas// //oil no. 2// with minimum turn-down ratio //3:1// //8:1//; tube material for second stage generator shall be copper or copper-nickel alloy, 90 to 103 kPa (13 to 15 psig) for direct-fired units.//

H. Tube sheets shall be carbon steel plates, drilled and reamed for tubes, individually replaceable and expanded into tube sheets.

I. Provide tube bundles with sufficient clearance between tubes and an adequate number of supports sheets, with tubes tightly fitted in tube sheets, to prevent chafing of tubes or crevice corrosion due to uneven tube expansion, vibration, or pulsation. Holes in tube sheets shall not have sharp corners. Water velocities through evaporator, condenser and absorber tubes shall not exceed 3 m/s (12 fps) for straight tubes or 2 m/s (7 fps) for U tubes.

J. Provide removable welded steel or cast-iron heads for external steam and water connections to permit access to tubes for inspection and cleaning. //Standard// //Marine// water box shall be constructed of steel. Design working pressure shall be //1034 kPa (150 psig)// //2070

kPa (300 psig)//; pressure tested at 150 percent of working pressure. Water nozzle shall be flanged.

K. Evaporator and absorber nozzles shall be made of stainless-steel or non-corrosive material.

L. Provide chiller with purge system consisting of a pump and controls to constantly remove noncondensable vapor from the unit.

M. Provide chiller with automatic decrystallization by recirculating the lithium bromide solution through the heat exchanger. Where machine does not provide for decrystallization without supplemental heating elements, provide heating elements for automatic operation. Solution and refrigerant pumps shall be self-lubricating, hermetically sealed, and cooled by fluid being pumped.

N. //Condensate Return System: Furnish steam control valve for returning condensate from full load to part load.//

O. Provide insulation on components and piping subject to condensation and heat transfer. The insulation shall be 25 mm (1 inch) minimum thickness of flexible elastomeric thermal insulation, complying ASTM C534/C534M for cold surfaces and mineral-fiber board thermal insulation, complying with ASTM C612, Type 1B.

P. Controls: Chiller shall be furnished with unit mounted, stand-alone, microprocessor-based controls in // NEMA 1// //NEMA 12// enclosure, hinged and lockable, factory wired with a single point power connection and separate control circuit. The control panel provide chiller operation, including monitoring of sensors and actuators, and shall be furnished with light emitting diodes or liquid-crystal display keypad.

SPEC WRITER NOTE: Some display functions are chiller specific. Verify with manufacturers all of the control functions as well as edit the following lists accordingly.

1. The following shall display as a minimum on the panel:
   a. Date and time.
   b. Outdoor air temperature.
   c. Operating and alarm status.
   d. Entering and leaving water temperature-chilled water and condenser water.
   e. Operating set points-temperature and pressure.
   f. Refrigerant temperature.
   g. Solution concentration and temperature.

h. Indication of refrigerant/solution/purge pump operation.
i. Operating hours.
j. Number of starts.
k. Number of purge cycles.
l. Steam demand limit.
m. Inlet steam pressure and temperature.
n. Steam valve actuator potentiometer position in percent.
o. First-stage generator pressure and temperature.

2. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
   b. Automatic cycle to prevent crystallization during operation of cycle.
   c. Condenser water temperature.
   d. Entering and leaving chilled water temperature and control set points.
3. Safety Functions: The following conditions shall shut down the chiller and require manual reset to start.
   a. Crystallization.
   b. Loss of chilled water flow.
   c. Loss of condenser water flow.
   d. Low chilled water temperature.
   e. High inlet steam pressure and temperature.
   f. First-stage generator low-solution level.
   g. First-stage generator high temperature or pressure.
   h. High solution concentration.
   i. Pump overloads.
   j. Power failure.
   k. Incomplete dilution solution.
4. Warning Conditions: Control panel shall generate a message whenever following condition occurs:
   a. Low refrigerant temperature.
   b. High generator temperature or pressure.
   c. Low chilled water flow.
   d. High or low entering condenser water temperature.
   e. Purge pump overload.
   f. Solution temperature sensor failure.
   g. Incomplete dilution solution.

Q. Leaving chilled water temperature reset shall be based on //return water temperature// //outdoor air temperature// //4-20 MA or 0-10 VDC// signal from a building automation system.

R. Chiller shall be pre-wired to terminal strips for interlocking to other equipment.

S. //Provide contacts for remote start/stop, alarm for abnormal operation or shut down, and for Engineering Control Center (ECC) interface.//

T. //Chiller control panel shall reside on the "BACnet network", and provide data using open protocol network variable types and configuration properties, BACnet interworking using ARCNET or MS/TP physical data link layer protocol for communication with building automation control system.//

U. Auxiliary hydronic system and the chiller(s) shall be interlocked to provide time delay and start sequencing as indicated on control drawings.

V. Periodic tests shall be readily made on the concentration of the inhibitor and lithium solution by a field test kit, furnished by the chiller manufacturer, or by other means as recommended by the chiller manufacturer.

2.3 ROTARY-SCREW AND SCROLL AIR-COOLED WATER CHILLERS

SPEC WRITER NOTE: If chillers are required to operate at less than 25 percent of full unit rated capacity, specify provision for hot gas by-pass, to operate the unit stable at any stage of capacity reduction. Check with manufacturers for availability of this feature for the equipment being specified.

A. General: Factory assembled and factory tested rotary-screw or scroll water chillers, complete with evaporator, compressors, motor, starters, //integral// //or// //remote// condenser, and controls mounted on a welded steel base. The chiller unit shall consist of two compressors minimum, but not more than eight, mounted on a single welded steel base. Where compressors are paralleled, not more than two shall be so connected and not less than two independent refrigerant circuits shall be provided. Chiller shall be capable of operating one of the following refrigerants: HCFC-134a or HCFC-410a.

B. Performance: Provide the capacity as shown on the contract drawings. Part load and full load efficiency ratings of the chiller shall not

exceed those shown on the contract drawings. //If chillers are required to operate at less than 25 percent of full unit rated capacity, specify provision for hot gas by-pass, to operate the unit stable at any stage of capacity reduction.//

C. Capacity of a single air-cooled chiller shall not exceed 250 Tons (Standard AHRI Conditions).

D. Applicable Standard: Chillers shall be rated and certified according to AHRI 550/590, and shall be stamped in compliance with AHRI certification.

SPEC WRITER NOTE: Specify sound pressure levels at each octave band as well as the overall A-weighted sound pressure dB(A) level based on the project specific acoustic analysis and local ordinance.

E. Acoustics: Sound pressure levels shall not exceed the following specified levels. The manufacturer shall provide sound treatment if required to comply with the specified maximum levels. Testing shall be in accordance with AHRI requirements.

OCTAVE BAND								Overall
63	125	250	500	1000	2000	4000	8000	dB(A)

SPEC WRITER NOTE: Verify with the manufacturers minimum range of capacity modulation available for the equipment specified.

F. Compressor (Rotary-Screw Type): Positive-displacement oil injected type, direct drive, cast-iron casing, precision-machined for minimum clearance about periphery of rotors. Lubrication system shall provide oil at proper temperature to all moving parts. Capacity control shall be by means of single slide valve to modulate the capacity from 100 to //20// //25// //30// percent of full unit rated capacity //and hot gas bypass// without unstable compressor operation. The slide valve shall be hydraulically operated upon the actuation of temperature or pressure sensor.

G. Compressor (Scroll Type): Three dimensional, positive-displacement, hermetically sealed design, with suction and discharge valves, crankcase oil heater and suction strainer. Compressor shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Lubrication system shall consist of reversible, positive displacement pump, strainer, oil level sight glass, and oil charging valve. Capacity

control shall be by on-off compressor cycling of single and multiple compressors //and hot gas bypass//.

SPEC WRITER NOTE: Verify with the manufacturers for availability of hot gas muffler for the equipment specified.

H. Refrigerants Circuit: Each circuit shall contain include an expansion valve, refrigerant charging connections, hot-gas muffler, compressor suction and discharge shutoff valves, replaceable-core filter drier, sight glass with moisture indicator, liquid-line solenoid valve and insulated suction line.

I. Refrigerant and Oil: Sufficient volume of dehydrated refrigerant and lubricating oil shall be provided to permit maximum unit capacity operation before and during tests. Replace refrigerant charge lost during the warranty period, due to equipment failure, without cost to the Government.

J. Condenser:

1. Air-cooled //integral// //or// //remote// condenser as shown on the contract drawings and specified hereinafter.
2. Integral Condenser: Condenser coils shall be extended surface fin and tube type, seamless copper tubes with aluminum fins. Refer to paragraph CORROSION PROTECTION. Condenser coils shall be factory air tested at 3102 kPa (450 psig). Condenser fans shall be propeller type, directly connected to motor shaft. Fans shall be statically and dynamically balanced, with wire safety guards. Condenser fan motors with permanently lubricated ball bearings and three phase thermal overload protection. Unit shall start -18 degrees C (0 degrees F) with external damper assemblies. Units shall have grilles factory mounted to prevent damage to coil surfaces.
3. Remote Condenser: Refer to paragraph CONDENSERS.

SPEC WRITER NOTE: Verify with manufacturers availability of shell and tube design for the evaporator specified. Smaller units typically provided with brazed plate and frame type evaporators.

K. Evaporator:

1. //Shell and tube design with seamless copper tubes roller expanded into tube sheets. Designed, tested, and stamped in accordance with applicable portions of ASME BPVC Section VIII, for working pressure produced by the water system, but not less than 1034 kPa (15 psig).

Refrigerant side working pressure shall comply with ASHRAE 15. Shell shall be constructed of carbon steel. For the waterside of liquid cooler the performance shall be based on a water velocity not less than 1 m/s (3 fps) with a maximum water velocity of 3 m/s (10 fps) and a fouling factor 0.0000176 m2 degrees C (0.0001 hr. sq. ft.) degrees F/Btu.//

2. //Brazed plate and frame type heat exchanger design. Brazed plate evaporator shall be constructed of stainless-steel with copper brazing material. The evaporator shall be designed for a minimum of 1.5 times the working pressure produced by the water system, but not less than 1034 kPa (150 psig). Refrigerant side working pressure shall comply with ASHRAE 15.//

L. Evaporator for packaged air-cooled chiller units designed for outdoor installation shall be protected against freeze-up in ambient temperature down to -30 degrees C (-22 degrees F) by a resistance heater cable under insulation with thermostat set to operate below 3 degrees C (37.4 degrees F) ambient. //If electric resistance heater is required and the chiller is connected to emergency power, provide emergency power to the heater cable.//

M. Insulation: Evaporator, suction piping, compressor, and all other parts subject to condensation shall be insulated with 19 mm (3/4 inch) minimum thickness of flexible-elastomeric thermal insulation, complying with ASTM C534/C534M.

N. Refrigerant Receiver: Provide a liquid receiver for chiller units when system refrigerant charge exceeds 80 percent of condenser refrigerant volume. Liquid receivers shall be horizontal type, designed, fitted, and rated in conformance with AHRI 495. Receiver shall be constructed and tested in conformance with ASME BPVC Section VIII. Each receiver shall have a storage capacity not less than 20 percent in excess of that required for fully charged system. Each receiver shall be equipped with inlet, outlet drop pipes, drain plug, purging valve, and relief devices as required by ASHRAE 15.

SPEC WRITER NOTE: Based on the location of the equipment, verify with the manufacturers for NEMA enclosure for the equipment being specified.

O. Controls: Chiller shall be furnished with unit mounted, stand-alone, microprocessor-based controls in //NEMA 1// //NEMA 12// //NEMA 3R// //NEMA 4// enclosure, hinged and lockable, factory wired with a single

point power connection and separate control circuit. The control panel provide chiller operation, including monitoring of sensors and actuators, and shall be furnished with light emitting diodes or liquid-crystal display keypad.

SPEC WRITER NOTE: Some display functions listed below are chiller specific. Verify with manufacturers all of the control functions as well as edit the following lists accordingly.

1. The following shall display as a minimum on the panel:
   a. Date and time.
   b. Outdoor air temperature.
   c. Operating and alarm status.
   d. Entering and leaving water temperature-chilled water //and condenser water//.
   e. Operating set points-temperature and pressure.
   f. Refrigerant temperature and pressure.
   g. Operating hours.
   h. Number of starts.
   i. Current limit set point.
   j. Maximum motor amperage (percent).
2. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
   b. Condenser water temperature.
   c. Entering and leaving chilled water temperature and control set points.
   d. Automatic lead-lag switch.
3. Safety Functions: The following conditions shall shut down the chiller and require manual reset to start.
   a. Loss of chilled water flow.
   b. Loss of condenser water flow (for water-cooled chillers only).
   c. Low chilled water temperature.
   d. Compressor motor current-overload protection.
   e. Freeze protection (for air-cooled chillers).
   f. Starter fault.
   g. High or low oil pressure.
   h. Recycling pumpdown.

P. The chiller control panel shall provide leaving chilled water temperature reset based on //return water temperature// //outdoor air

temperature// //4-20 ma or 0-10 VDC// signal from Energy Control Center (ECC).

Q. //Provide contacts for remote start/stop, alarm for abnormal operation or shutdown, and for Engineering Control Center (ECC).//

R. //Chiller control panel shall either reside on the "LonTalk FTT-10a network", and provide data using LonMark standard network variable types and configuration properties, or BACnet interworking using ARCNET or MS/TP physical data link layer protocol for communication with building automation control system.//

S. Auxiliary hydronic system and the chiller(s) shall be interlocked to provide time delay and start sequencing as indicated on control drawings.

T. Motor: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Compressor motor furnished with the chiller shall be in accordance with the chiller manufacturer and Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. Starting torque of motors shall be suitable for driven machines.

SPEC WRITER NOTE: Specify across-the-line starter or star-delta (reduced voltage), closed transition starter. Coordinate with electrical requirements.

U. Motor Starter: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide a starter in NEMA 1 enclosure, designed for floor or unit mounted chiller using multiple compressors, with the lead compressor starting at its minimum capacity shall be provided with across-the-line starter. See Section 26 29 11, MOTOR CONTROLLERS for additional requirements.

2.4 CONDENSING UNITS FOR AIR CONDITIONING SERVICE

SPEC WRITER NOTE: Condensing units for walk-in refrigerators and freezers are in Section 11 41 21, WALK-IN COOLERS AND FREEZERS.

A. Refer to Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

2.5 CONDENSERS

A. Air-Cooled Condensers: Suitable for remote installation in a weather-protected casing. For multiple compressors chiller units, provide a separate air-cooled condenser to match the compressor:

1. Condenser coils shall be extended surface fin and tube type, seamless copper tubes with aluminum fins. Refer to paragraph CORROSION PROTECTION.
2. Fans shall be either housed-centrifugal or plenum or propeller type as best suited for application, directly connected to motor shaft or indirectly connected to motor by means of a V-belt drive. Fans shall be statically and dynamically balanced.
3. Discharge air from each air-cooled condenser in vertical direction either directly from fan casing or by means of supplementary wind deflectors.

SPEC WRITER NOTE: Make sure to provide proper condenser control if the condenser is to operate in ambient temperature of less than 5 degrees C (41 degrees F).

4. Condenser Controls: Provide head pressure controls for operation of the system down to 5 degrees C (41 degrees F) by cycling the fans.

B. Refrigerant Piping: Refrigerant piping shall be as specified in Section 23 23 00, REFRIGERANT PIPING.

2.6 REFRIGERANT MONITORING AND SAFETY EQUIPMENT

SPEC WRITER NOTES:
1. Show the exact number of sensor(s) on mechanical drawings.
2. Coordinate interface between chiller room ventilation and refrigerant leak detection system.

A. General: Provide refrigerant monitoring sensor/alarm system and safety equipment as specified here. Refrigerant sensor and alarm system shall comply with ASHRAE 15. The refrigerant monitoring system will be provided by the chiller manufacturer and shall be interfaced with the DDC control system.

B. Refrigerant monitor shall continuously display the specific gas (refrigerant used) concentration; shall be capable of indicating, alarming and shutting down equipment; and automatically activating ventilation system. On leak detection by refrigerant sensor(s), the following shall occur:
1. Activate machinery (chiller) room ventilation.
2. Activate visual and audio alarm inside and outside of machinery room, with beacon light(s) and horn sounds equipment room and outside equipment room door(s). Shut down combustion process where combustion equipment is employed in the machinery room.

3. Notify Engineering Control Center (ECC) of the alarm condition.

C. Refrigerant monitor shall be capable of detecting concentration of 1 part per million (ppm) for low-level detection and for ensuring the safety of operators. It shall be supplied factory-calibrated for the apparent refrigerant.

D. Monitor design and construction shall be compatible with temperature, humidity, barometric pressure, and voltage fluctuations of the machinery room operating environment.

2.7 CORROSION PROTECTION

SPEC WRITER NOTE: For high-humidity locations provide E-coated aluminum fins and corrosion-resistant cabinets in accordance with the VA H-18-10 HVAC Design Manual.

A. Remote Outdoor Condenser Coils (Epoxy Immersion Coating – Electrically Deposited): The multi-stage corrosion-resistant coating application comprises of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. The coating thickness shall be maintained between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, they are treated to permeate immersion rinse and spray. Where the coils are subject to UV exposure, UV protection spray treatment comprising of UV-resistant urethane mastic topcoat shall be applied. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process shall be such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:

1. Salt Spray Resistance (Minimum 6,000 Hours)
2. Humidity Resistance (Minimum 1,000 Hours)
3. Water Immersion (Minimum 260 Hours)
4. Cross-Hatch Adhesion (Minimum 4B-5B Rating)
5. Impact Resistance (Up to 160 Inch/Pound)

B. Exposed Outdoor Cabinet: Casing Surfaces (Exterior and Interior): All exposed and accessible metal surfaces shall be protected with a water-reducible acrylic with stainless-steel pigment spray-applied over the manufacturer’s standard finish. The spray coating thickness shall be 2-4 mils and provide minimum salt-spray resistance of 1,000 hours in

accordance with ASTM B117 and 500 hours UV resistance in accordance with ASTM D4587.

PART 3 – EXECUTION

3.1 EXAMINATION

A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

B. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might affect chiller performance, maintenance, and operation. Equipment locations shown on the contract drawings are approximate. Determine exact locations before proceeding with installation.

3.2 EQUIPMENT INSTALLATION

A. Install chiller on concrete base with isolation pads or vibration isolators.

1. Concrete base is specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
3. Anchor chiller to concrete base according to manufacturer’s written instructions //and for seismic restraint on vibration isolators//.
4. Charge the chiller with refrigerant, if not factory charged.
5. Install accessories and any other equipment furnished loose by the manufacturer, including remote starter, remote control panel, and remote flow switches, according to the manufacturer written instructions and electrical requirements.
6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.

B. Install refrigerant monitoring and safety equipment in accordance with ASHRAE 15.

C. Install refrigerant piping as specified in Section 23 23 00, REFRIGERANT PIPING and ASHRAE 15.

D. Install thermometers and gauges as recommended by the manufacturer and/or as shown on the contract drawings.

E. Piping Connections:

1. Make piping connections to the chiller for chilled water, condenser water, //and automatic tube brush cleaning system// and other connections as necessary for proper operation and maintenance of the equipment.
2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
3. Extend vent piping from the //relief valve// //rupture disc// and purge system to the outside.

3.3 STARTUP AND TESTING

A. Engage manufacturer's factory-trained representative to perform startup and testing service.

B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.

C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the COR that the equipment operate and perform as intended.

1. Check refrigerant charge is sufficient and chiller has been tested for refrigerant leak.
2. Check bearing lubrication and oil levels.
3. Verify proper motor rotation.
4. Verify pumps associated with chillers are installed and operational.
5. Verify thermometers and gauges are installed.
6. Verify purge system, if installed, is functional and relief piping is routed outdoor.
7. Operate chiller for run-in-period in accordance with the manufacturer’s instruction and observe its performance.
8. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller.
9. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
10. Prepare a written report outlining the results of tests and inspections, and submit it to the COR.

D. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

E. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

F. //The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.

3.4 //COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

B. Components provided under this section of the specification will be tested as part of a larger system.**//**

3.5 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for //4// // // hour//s// to instruct each VA personnel responsible in operation and maintenance of the system. Coordinate this training with that of the cooling tower, if furnished together.

B. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

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