

Part 1 - General

1.1. Description

- A. Air-Cooled Water Chillers.
- B. This standard is intended to provide useful information to the Contractor to establish a basis of requirements. The responsibility of the Contractor is to apply the principles of this section such that the VA Hospital Palo Alto Division may achieve a level of quality and consistency in the generation and construction of their facilities. Deviations from these guidelines must be justified through a RFI and submitted to the COR for approval.
- C. Flow Characteristics: Variable primary flow should be strongly considered for this chiller system. Variable primary flow reduces pump energy consumption, reduces first cost, eliminates low Delta T staging issues, and increases mechanical room space with the deletion of the primary only pumps. When choosing a variable flow system the Contractor must ensure the chiller will allow for at the least 40% reduction in flow and 60% or greater is preferred. Flow switches must be specified with the chiller. The system must be equipped with programmable slow acting isolation valves, a high quality flow meter, and a wide ranging linear flow globe type bypass valves.
- D. Contractor shall ensure chiller specifications meet all of the scheduled manufacturers recommended clearances.

1.2. Related Work

- A. Section 01 00 00, GENERAL REQUIREMENTS
- B. Section 01 32 16.17, PROJECT SCHEDULES
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- D. Section 01 35 26, SAFETY REQUIREMENTS
- E. Section 01 42 19, REFERENCE STANDARDS
- F. Section 01 57 19, ENVIRONMENTAL CONTROLS
- G. Section 02 41 00, DEMOLITIONS
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- I. Section 23 05 11, COMMON WORK RESULTS for HVAC
- J. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- K. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- L. Section 23 07 11, HVAC, and BOILER PLANT INSULATION
- M. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS
- N. Section 23 64 00, PACKAGED WATER CHILLERS

1.3. 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: The Building Automation and Control Network (ANSI/ASHRAE Standard 135-2004) protocol is a standard that allows building automation systems or components from different manufactures to share information and control functions.
- C. Modbus: Modicon Communication Bus is an application layer messaging protocol that provides client/server communication between devices over a variety of networks. The protocol determines how each controller will know its device address, recognize a message addressed to its device, determine what action to take and extract any data or other information contained in the message.
- D. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- E. FTT-10: Echelon Transmitter-Free Topology Transceiver.
- F. Delta T: Variable-flow chilled water plants are designed to maintain a relatively constant delta-T, the difference between return and supply chilled water temperature. If the delta T falls short, the result is flow and load do not track, requiring additional chillers be brought on line to maintain flow requirements even though none of the chillers is fully loaded.
- G. Across the line starters: Are motor starters that connect directly to line voltage. When the contacts are on an across-the-line starter, the current drawn by a typical motor goes from zero to 600 percent of run load amps (RLA) almost instantaneously, while torque goes from zero to 140 percent of rated torque almost instantaneously. This translates to "impact," which can cause premature wear and breakage to the compressor. When a large motor is started across-the-line, it puts a tremendous strain on the gears, couplings and shaft seals.

1.4. Quality Assurance

Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, and comply with the following:

- A. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.
- B. Refer to paragraph, WARRANTY, Section 00 72 00, GENERAL CONDITIONS, except as noted below:
 - 1. Provide a 5-year warranty from date of commission to include materials, parts, labor and refrigerant for the entire period of the warranty.
- C. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard.

- D. Products shall be Tested, Rated and Certified in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:
1. AHRI 550/590 Water Chilling Packages Using the Vapor Compression Cycle
 2. AHRI 370 Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
 3. ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration
 4. ANSI/ASHRAE 34 Number Designation and Safety Classification of Refrigerants
 5. ASHRAE 90.1 Energy Standard for Buildings except Low-Rise Residential Buildings
 6. ANSI/NFPA 70 National Electrical Code (N.E.C.)
 7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
- E. Manufactured in a facility registered to ISO 9001
- F. Refer to ASHRAE Standard 15, Safety Standard for Refrigeration System, for refrigerant vapor detectors and monitor.
- 1.5. Applicable Publications
- 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.
- A. Air Conditioning, Heating and Refrigeration Institute (AHRI):
- 370-01 Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
 - 495-1999 (R2002) Refrigerant Liquid Receivers
 - 550/590-03 Standard for Water Chilling Packages Using the Vapor Compression Cycle
 - 560-00 Absorption Water Chilling and Water Heating Packages
 - 575-94 Methods for Measuring Machinery Sound within Equipment Space
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
- ANSI/ASHRAE-15-2007 Safety Standard for Mechanical Refrigeration Systems
 - GDL 3-1996 Guidelines for Reducing Emission of Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems
- C. American Society of Mechanical Engineers (ASME):
- 2007 ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels - Division 1"
- D. American Society of Testing Materials (ASTM):
- C 534/ C 534M-2008 Preformed, Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - C 612-04 Mineral-fiber Block and Board Thermal Insulation
- E. National Electrical Manufacturing Association (NEMA):
- 250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum)
- F. National Fire Protection Association (NFPA):
- 70-2008 National Electrical Code
- G. Underwriters Laboratories, Inc. (UL):
- 1995-2005 Heating and Cooling Equipment
- 1.6. Submittals
- A. Submit in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data
1. Air-cooled 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 Standard.
 - d. Refrigerant.
 - e. Fan performance.
 - 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.
- C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- 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.

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

Part 2 – Products

2.1. Air-Cooled Water Chiller

- A. Manufacturer: The make and model for the Air-Cooled Water Chiller submitted for this project must meet the requirements listed in the Presidential Executive Order (EO) 13693, FAR 52.223-15 and ASHRAE 90.1-2013. The COR/Engineering Staff have found that the following makes and models meet the minimum requirements of EO 13693, FAR 52.223-15, and ASHRAE 90.1-2013; however, the following models listed are examples ONLY:
 1. York YVAA, YCIV or YCAV
 2. Trane RTAC High Efficiency models
 3. Carrier Aquaforce
 4. McQuay AWS with VFD

2.2. General

- A. Description: Furnish, Install, and Commission factory assembled charged, and operational run tested air-cooled screw compressor chiller as specified herein. Chiller shall include, but is not limited to: a complete system with multiple independent refrigerant circuits, semi hermetic twin screw compressors, shell and tube hybrid falling film type evaporator, air-cooled condenser, R134a refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.
- B. Operating Characteristics:
 1. Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 0° F to 125° F (-18° C to 52° C) ambient temperature.
 2. Provide capacity control system capable of reducing unit capacity to 10% of full load for 2 compressor units. Compressor shall start in unloaded condition.
- C. Shipping: Unit shall ship in one piece and shall require installer to provide only a single evaporator inlet and outlet pipe connection. If providing chiller model that ships in multiple pieces, bid shall include all the material and field labor costs for factory authorized personnel to install a trim kit to connect the pieces as well as all interconnecting piping and wiring.

2.3. Compressors

- A. Compressors: Shall be semi hermetic, rotary twin-screw type, including: muffler, temperature actuated 'off-cycle' heater, rain-tight terminal box, discharge shut-off service valve, suction shut-off service valve for each compressor, and precision machined cast iron housing. Working pressure of entire compressor, suction to discharge, shall be 350 psig (24 barg) or higher. Compressor shall be U.L. Recognized.
- B. Compressor Motors: Refrigerant suction-gas cooled accessible hermetic compressor motor, full suction gas flow through 0.006" (0.1524 mm) maximum mesh screen, with inherent internal thermal overload protection and external current overload on all three phases.
- C. Balancing Requirements: All rotating parts shall be statically and dynamically balanced.
- D. Lubrication System: External oil separators with no moving parts, 450 psig (31 barg) working pressure, and ETL listing shall be provided on the chiller. Refrigerant system differential pressure shall provide oil flow through service replaceable, 0.5 micron, full flow, cartridge type oil filter.
- E. Capacity Control: Compressors shall start at minimum load. Provide microprocessor control to command compressor capacity to balance compressor capacity with cooling load.

2.4. Refrigerant Circuit Components

- A. Refrigerant: R-134a - Classified as Safety Group A1 according to ASHRAE 34.
- B. Equipment supplied shall comply with LEED Energy & Atmosphere Credit 4, Enhanced Refrigerant Management.
- C. Each independent refrigerant circuit shall incorporate all components necessary for the designed operation including: liquid line shut-off valve with charging port, low side pressure relief device, removable core filter-drier and sight glass with moisture indicator.
- D. Chiller manufacturer shall provide an independent circuit for each compressor to provide maximum redundancy during chiller operation. If equipment does not have independent circuits per compressor, manufacturer shall provide owner one spare compressor of each unique size.
- E. Discharge lines shall be provided with manual compressor shut-off service valves.

2.5. Heat Exchangers

- A. Evaporator:
 1. Evaporator shall be shell and tube type with 2 or 3 pass arrangements to optimize efficiency and refrigerant charge. Tubes shall be high-efficiency, internally and externally enhanced type copper tubes with 0.035" (0.89 mm) minimum wall thickness at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Independent refrigerant circuits shall be provided per compressor.

2. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 235 psig (16 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.
 3. Water boxes shall be removable to permit tube cleaning and replacement. Water boxes shall include liquid nozzle connections suitable for ANSI/AWWA C-606 couplings, welding, or flanges.
 4. Provide vent and drain fittings, and thermostatically controlled heaters to protect to -20° F (-28° C) ambient temperature in off-cycle. A separate power connection for evaporator heaters is required and shall be provided by the Contractor. If strainers are required by the manufacturer they must be provided by the manufacturer.
- B. Air-Cooled Condenser:
1. Condenser coils shall be micro-channel type or aluminum fin with black fin coating and copper tube. Condenser coils can be made of a single material to avoid galvanic corrosion due to dissimilar metals. Tube and fin type condenser coils are an acceptable alternate when tubes and fins are fabricated of the same metal material to avoid galvanic corrosion due to dissimilar metals.
 2. Fan Motors: High efficiency, direct drive, 3-phase, insulation class "F", current protected, Totally Enclosed Air-Over (TEAO), with double sealed, permanently-lubricated ball bearings. Open Drip Proof (ODP) fan motors will not be acceptable.
- 2.6. Insulation
- A. Material: Closed-cell, flexible, UV protected, thermal insulation complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.
 - B. Thickness: 3/4" (20mm).
 - C. Thermal conductivity: 0.26 (BTU/HR-Ft²-°F/in) maximum at 75°F mean temperature.
 - D. Factory-applied insulation over cold surfaces of liquid chiller components including evaporator shell, water boxes, and suction line. Liquid nozzles shall be insulated by Contractor after pipe installation.
 - E. Adhesive: As recommended by insulation manufacturer and applied to 100% of insulation contact surface including all seams and joints.
- 2.7. Acoustical Data
- A. Provide acoustical sound power or sound pressure level data in decibels (dB) at the scheduled 8 octave band center frequencies. A-weighted sound data alone is not acceptable.
 - B. Provide all sound power or sound pressure level data at 100%, 75%, 50%, and 25% load.
 - C. Supplied equipment shall not exceed scheduled sound power or sound pressure level data at any load point. The Contractor shall be responsible for any additional costs associated with equipment deviation.
 - D. Acoustical performance ratings shall be in accordance with AHRI Standard 370.
- 2.8. Power and Electrical Requirements
- A. Power and Control Panel:
1. Factory installed and wired NEMA 3R, powder painted steel cabinets with tool lockable, hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor starters and fan motor contactors, current overloads, and factory wiring.
 2. Panel shall include control display access door.
- B. Single Point Power:
1. Provide single point power connection to chiller, shall be 3 phase of scheduled voltage.
 2. Single Point Circuit Breaker or fused disconnect: A circuit breaker/fused disconnect and lockable external handle shall be provided at the point of incoming single point connection for field connection, interconnecting wiring to the compressors, and isolating the unit power voltage for servicing. Separate external fusing must be supplied, by others, in the incoming power wiring which must comply with federal and local codes.
 3. Contractor shall ensure current electrical amperage of the VA facility is suitable for replacement chiller.
 - a. Existing Equipment:
 - 1) York Chiller model number YCAS0150EC
 - i. 460 volts/60 hertz/3 phase
 - ii. 400 amperage
- C. Control Transformer: Power panel shall be supplied with a factory mounted and wired control transformer that will supply all unit control voltage from the main unit power supply. Transformer shall utilize scheduled line voltage on the primary side and provide 115V/10 on secondary.
- D. Short Circuit Withstand Ratings of the chiller electrical enclosure shall be (380, 400, & 460V: 50,000 Amps.). Rating shall be published in accordance with UL508.
- E. Motor Starters: Motor starters shall be Variable Frequency Drive type, NEMA 3R enclosed with zero electrical inrush current.
1. Wye-Delta and Solid State type starters are acceptable.
 2. Across the Line type starters will not be acceptable.
- F. Power Factor:

1. Provide equipment with power factor correction capacitors as required to maintain a displacement power factor of 95% at all load conditions.
 2. The Contractor is responsible for additional cost to furnish and install power factor correction capacitors if they are not factory mounted and wired.
- G. All exposed power wiring shall be routed through liquid-tight, UV-stabilized, non-metallic conduit.
- H. Supplied equipment shall not exceed scheduled MOC. The Contractor shall be responsible for any additional costs associated with equipment deviation.

2.9. Controls

A. General:

1. Provide automatic control of chiller operation including compressor start/stop and load/unload anti-recycle timers, condenser fans, evaporator pump, evaporator heater, unit alarm contacts and run signal contacts.
2. Chiller shall automatically reset to normal chiller operation after power failure.
3. Unit operating software shall be stored in non-volatile memory. Field programmed set points shall be retained in lithium battery backed regulated time clock (RTC) memory for minimum 5 years.
4. Alarm contacts shall be provided to remote alert for any unit or system safety fault.
5. Contractor shall ensure control unit communication with existing equipment.

B. Display and Keypad:

1. Provide minimum 80 character liquid crystal display that is both viewable in direct sunlight and has LED backlighting for nighttime viewing. Provide one keypad and display panel per chiller.
2. Display and keypad shall be accessible through display access door without opening main control/electrical cabinet doors.
3. Display shall provide a minimum of unit set points, status, electrical data, temperature data, pressures, safety lockouts and diagnostics.
4. Descriptions in English and numeric data in English units.
5. Sealed keypad shall include unit On/Off switch.

C. Programmable Set points (within Manufacturer limits): Display language, chilled liquid cooling mode, local/remote control mode, display units mode, system lead/lag control mode, remote temperature reset, remote current limit, low ambient temperature cutout enable/disable, leaving chilled liquid set point and range, maximum remote temperature reset.

D. Display Data: Chilled liquid leaving and entering temperatures; outside ambient air temperature; lead system; evaporator pump status; active remote control; compressor suction, discharge, and; compressor discharge; saturation temperatures per refrigerant circuit; compressor speed; condenser fan status; condenser sub-cooling temperature; compressor capacity in percentage of Full Load Amps; compressor number of starts; run time; operating hours; evaporator heater status; history data for last 10 shutdown faults; history data for last 20 normal (non-fault) shutdowns.

E. Predictive Control Points: Unit controls shall avoid safety shutdown when operating outside design conditions by optimizing the chiller controls and cooling load output to stay online and avoid safety limits being reached. The system shall monitor the following parameters and maintain the maximum cooling output possible without shutdown of the equipment: motor current, suction pressure, discharge pressure.

F. Unit Safeties: Manufacturers standard but to include phase monitor protection.

G. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.10. Accessories

A. Controls:

1. Gateway: Provides communication for Building Automation Systems, including Modbus. (see 2.9.A.5 of 23 64 00.01)

B. General:

1. IFM Efactor IR flow switch. (see definition BACnet; see 2.9.A.5 of 23 64 00.01)

2.11. Corrosion Protection

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 and Variable Frequency Drive: 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 (ASTM B117) AND 500 hours UV resistance (ASTM D4587).

Part 3 – Execution

3.1. Arrangement and Installation of Equipment and Piping

- A. General:
 1. Rig and Install in full accordance with Manufacturer's requirements, and Contract documents. Contractor is ultimately responsible for installation of equipment with all trades. Contractor must review requirements for equipment and ensure all requirements are met.
- B. Location:
 1. Locate chiller as indicated in SOW, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.
 2. Anchor chiller to concrete base as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE for seismic restraint on vibration isolators.
 3. 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. Determine exact locations before proceeding with installation.
 4. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.
- C. Components:
 1. Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.
 2. Contractor shall 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.
 3. Install refrigerant piping as specified in Section 23 23 00, REFRIGERANT PIPING and ASHRAE Standard 15.
 4. Make piping connections to the chiller for chilled water, condenser water and other connections as necessary for proper operation and maintenance of the equipment.
 5. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
- D. Electrical:
 1. Coordinate electrical requirements and connections for all power feeds with the COR.
- E. Controls:
 1. Manufacturer to coordinate all control requirements and connections with Contractor.
 2. Install thermometers and gauges as recommended by the manufacturer.
 3. Install refrigerant monitoring and safety equipment in accordance with ASHRAE Standard 15.

3.2. 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 VA 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 VA.
- D. Finish:
 1. Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.
 2. Contractor shall provide manufacturer's certified factory trained representative to provide training for 6 to 8 personnel for 8 hours for the VA maintenance and operation to adjust, operate and maintain equipment.

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