

# **ATTACHMENT A – CHILLER REPLACEMENT SPECIFICATIONS**

## **ROTARY-SCREW WATER CHILLERS (AIR-COOLED)**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Chiller package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Starters.
- F. Electrical power connections.

#### **1.02 RELATED SECTIONS**

- A. Section 15535 - Refrigeration Piping and Specialties.
- B. Section 15952 - Controls and Instrumentation.
- C. Section 16180 - Equipment Wiring Systems.

#### **1.03 REFERENCES**

- A. ANSI/ARI 550/590-2003 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. ANSI/ASHRAE 90.1 - Energy Efficient Design of New Buildings.
- D. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/UL 1995 - Central Cooling Air Conditioners.
- G. ANSI/UL 984 - Safety Standard for Hermetic Motor Compressors.
- H. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings. Bearings must have life of not less than L10 200,000 hours.

- I. California Administrative Code - Title 24
- J. ASTM B117 - Standard Method of Salt Spray (Fog) Testing
- K. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- L. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
- M. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments
- N. California Zone 4; where applicable

#### 1.04 SUBMITTALS

- A. Submit drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate accessories where required for complete system.
- B. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C. Submit manufacturer's installation instructions.

#### 1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation data.
- B. Include start-up instructions, maintenance data, controls, and accessories.
- C. Submit maintenance data.

#### 1.06 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ARI 550/590-2003 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.
- B. Conform to ANSI/UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at his expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
- C. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.
- D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.

## 1.07 VERIFICATION OF CAPACITY AND EFFICIENCY

A. Each chiller shall be factory performance tested under full load conditions in an ambient controlled test facility per ARI 550/590-2003. The manufacturer shall supply a certified test report to confirm performance as specified. Proper ARI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with ARI Standard 550/590-2003 procedures and tolerances. The test conditions are for the ARI rating point of 44F leaving the evaporator, 54F entering the evaporator, and 95F ambient only.

1. The performance test shall be run with clean tubes in accordance with ARI 550/590-2003 to include the following:
  - a. A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
  - b. An adjustment of the ambient temperature to adjust from design elevation to test facility elevation. This adjustment is to maintain the same saturated condensing temperature at design conditions to those at test conditions.
2. The factory test instrumentation shall be per ARI 550/590-2003, and the calibration of all instrumentation shall be traceable to the National Institute of Technology.
3. The owner or his representative shall be notified 14 days in advance to witness the factory performance test. If the owner or his representative desires to witness the performance test, all travel expenses will be the owner's responsibility.
4. A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

## 1.08 STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.
- C. Unit controls shall be capable of withstanding 203 Deg F (95 Deg C) storage temperatures in the control compartment for an indefinite period of time.

## 1.09 MAINTENANCE SERVICE

- A. Furnish complete service and maintenance of complete assembly for one year from Date of Substantial Completion.

## 1.10 WARRANTY

- A. A 5-year Parts, Refrigerant, and Labor Warranty shall be provided.

## PART 2 PRODUCTS

### 2.01 SUMMARY

The contractor shall furnish and install the air-cooled rotary liquid chiller of size and capacity indicated. Unit shall be installed in strict accordance with this specification. All units shall be furnished complete with twin helical rotary compressors, shell and tube evaporator, air-cooled condenser, expansion valves and microprocessor control panel. Total unit shall be UL certified and include the UL label. The unit shall be designed for outdoor application and painted. The unit shall be rated in accordance with ARI Standard 550/590-2003. The unit shall be factory performance tested under full load conditions at a controlled at 95F ambient in an ambient controlled test facility per ARI 550/590-2003.

### 2.02 COMPRESSORS

- A. Construct chiller using semi-hermetic helical rotary screw compressors with independent circuits.
- B. Statically and dynamically balance rotating parts.
- C. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
- D. Provide compressor with automatic capacity reduction equipment consisting of rotary capacity control slide valve. Use lifting mechanism operated by oil pressure. Compressor must start unloaded for soft start on motors.
- E. Provide constant speed 3600 rpm compressor motor at 60 Hz (3000 rpm at 50 Hz), suction gas cooled with robust construction and system design protection, designed for across-the-line or wye-delta starting. Furnish with starter.
- F. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

### 2.03 EVAPORATOR

- A. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned

copper tubes, roller expanded into tube sheets.

- B. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
- C. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2 separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.

#### 2.04 CONDENSER AND FANS

- A. Chiller shall be able to operate in ambient conditions down to 25 degrees F
- B. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 510 psig.
- C. Provide a complete, flexible epoxy dip and bake coating of condenser coils. Coil with coating shall be able to handle 3000-hour salt spray test. All coil surfaces shall be coated with epoxy material giving uniform coverage (minimum of 0.8 mils), without bridging between fins. Any coating showing bridging will degrade performance and be deemed unacceptable. Coatings not covering any part of the fin and/or parts of condenser frame will be unacceptable. Baked phenolic coatings are unacceptable because of their brittle nature. The heat transfer decrease due to the coating shall be less than 1% so that design capacity and efficiency are maintained. Baked phenolic coatings are also unacceptable due to performance losses of up to 5%. If baked phenolic is allowed, unit provided must account for performance degradation. Coating shall be able to withstand corrosive environments in the pH range of 3-12. Coating shall be flexible so that bare surfaces will not form. The coating shall be able to handle temperatures ranging from -50 to 250F without degrading. UV protection shall be applied on surface of coating to prevent degradation from sunlight.
- D. Provide factory mounted, louvered, "architecturally pleasing" guard panels. Panel louvers shall cover condenser, evaporator and compressor sections so all are hidden from sight. Wire screens or wire mesh will not be allowed.
- F. Provide vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be either PVC, chrome, or zinc coated.
- G. Provide Open Drip Proof fan motors with permanently lubricated ball bearings and built-in thermal overload protection.

#### 2.05 ENCLOSURES

- A. House components in a galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters

Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

- B. Unit panels and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.
- C. Mount starters and Terminal Blocks in weatherproof panel provided with full opening access doors. Provide lockable through-the-door circuit breaker switch external to panel and clearly visible from outside of unit indicating if power is on or off. Provide Short Circuit Current Rating of 65,000 Amps.
- D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

## 2.06 REFRIGERANT CIRCUIT

- A. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressors on each circuit. Single refrigerant circuit chillers are not acceptable.
- B. Provide for each refrigerant circuit:
  - 1. Liquid line shutoff valve.
  - 2. Filter (replaceable core type).
  - 3. Liquid line sight glass.
  - 4. Electronic or thermal expansion valve sized for maximum operating pressure.
  - 5. Charging valve.
  - 6. Discharge and oil line check valves.
  - 7. Compressor Discharge service valves.
  - 8. High side pressure relief valve.
  - 9. Full operating charge of HFC-134a and oil.

- C. Capacity Modulation: Provide capacity modulation that includes linear unloading to maintain close leaving water temperature control. Unit shall be capable of operation down to 15%. In the event manufacturer can not provide a unit with modulation down to 15%, Hot Gas Bypass must be provided.

## 2.07 CONTROLS

- A. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
  - 1. Phase reversal/unbalance/single phasing and over/under voltage protection.
  - 2. Low chilled water temperature protection.
  - 3. High and low refrigerant pressure protection.
  - 4. Load limit thermostat to limit compressor loading on high return water temperature.
  - 5. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, and condenser pressure to optimize unit efficiency.
  - 6. Display diagnostics.
  - 7. Oil pressure control.
  - 8. Compressors: Status (on/off), %RLA, solid state anti-short cycle timer, and automatic compressor lead-lag.
- B. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt single phase connection for evaporator freeze protection heaters.
  - 1. The unit controller 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 20 PSIG 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 protector that is set at 95% of compressor RLA that will automatically unload the compressor to help prevent an overcurrent 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.
  - C. In the above case, 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 will be required. Once the "near-trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
  - D. For each compressor provide Across-the-Line starter. Delta-Delta and Solid State Starters shall be unacceptable because they accomplish a smaller reduction in inrush than Y-delta.
  - E. Provide the following safety controls with indicating lights or diagnostic readouts.
    - 1. Low chilled water temperature protection.
    - 2. High refrigerant pressure.
    - 3. Low oil flow protection.
    - 4. Loss of chilled water flow.
    - 5. Contact for remote emergency shut-down.
    - 6. Motor current overload.
    - 7. Phase reversal/unbalance/single phasing.
    - 8. Over/under voltage.
    - 9. Failure of water temperature sensor used by controller.
    - 10. Compressor status (on or off).
  - F. Provide the following operating controls:
    - 1. Leaving chilled water temperature controller which cycles compressors and activates slide valve based on PI algorithms.

2. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
  3. Chilled water pump output relay that closes when the chiller is given a signal to start.
  4. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance tripouts.
  5. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance tripouts on days when outside ambient is above design.
  6. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance tripouts.
  7. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor can not provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
  8. Low ambient lockout control with adjustable setpoint.
  9. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.
- G. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from LCD input
  2. Entering and leaving chilled water temperature output
  3. Percent RLA output for each compressor
  4. Pressure output of condenser for circuits one and two
  5. Pressure output of evaporator for circuits one and two
  6. Ambient temperature output

7. Voltage output
  8. Current limit setpoint adjustment from LCD input.
  9. Remote leaving water temperature setpoint.
  10. Alarm indicating light and relay
- H. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning.

### 3.02 MANUFACTURER'S FIELD SERVICES

- A. Supply service of factory trained representative for a period of one days to supervise testing, start-up, and instruction on operation and maintenance to Owner.
- B. Supply initial charge of refrigerant and oil.