

HVAC – Sample Chiller Pre-Purchase Guide Specifications

236414-3

CHILLER PRE-PURCHASE
GENERIC STATE FACILITY
FRANKFORT, KY
FILE NO. 785-C102-FM01-00

SECTION 236414-3 - PRE-PURCHASED WATER CHILLERS

PART 1 - GENERAL

DESCRIPTION OF WORK

Extent of water chiller work is indicated by requirements of this section.

Types of water chiller specified in this section include the following:

- Centrifugal magnetic-bearing compressor machine -- open or closed motor.

Ingress: The vendor will verify the actual dimensions and routing to ensure that the chiller can pass through the required spaces. If required for installation, disassembly and re-assembly of the chiller (including additional rigging, shall be the responsibility of the vendor.

Electrical: Furnish electrical field-wiring diagrams to installing contractor power wiring and starters for water chiller, and control wiring for field-mounted controls. Wiring will be the responsibility of the installing contractor.

WORK BY OTHERS

Under separate contract, the Installing Contractor will be responsible for receiving, unloading, temporary on-site storage (if needed) and installing the equipment and material at the delivery point as described in the Special Conditions. The chiller vendor shall be responsible for coordination of the delivery and required work (as specified herein) with the installing contractor.

QUALITY ASSURANCE

Regulatory Requirements:

Kentucky Building Code: Chiller shall comply with all relative sections of the latest edition.

ARI Compliance: Provide certified capacity ratings for water chiller in accordance with Air-Conditioning and Refrigeration Institute (ARI) Standard 550/590, current version as of this bid date (hereinafter referred to as "ARI Standard(s)"). NOTE: these specifications take certain exceptions to ARI Standards in selection and testing requirements.

ASHRAE Compliance: Construct refrigerating system of water chiller in accordance with American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

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1 Standard ANSI/ASHRAE 15 "Safety Code for Mechanical Refrigeration". Include all
2 proposed safety features and/or devices required by ASHRAE for refrigerants declared
3 to be toxic.

4
5 Chiller shall meet ASHRAE 90.1 2004 efficiency requirements at standard ARI 550-590
6 conditions. Chiller manufacturer shall provide ARI certified performance data showing
7 compliance. **Compliance with this requirement is necessary as a part of the LEED**
8 **certification for this project.**

9
10 ASME Compliance: When required by code, construct and test water chiller in
11 accordance with American Society of Mechanical Engineers (ASME) Boiler and
12 Pressure Vessel Code, Section VIII.

13
14 National Testing Approval: Chillers and accessories (where applicable) shall be
15 approved by Underwriter's Laboratories, Inc. or other nationally recognized testing
16 agency.

17
18 **SUBMITTALS:**

19
20 LEED Compliance Data: Performance ratings, noting chiller compliance with the United
21 States Green Building Council's LEED Enhanced Refrigerant Management Credit
22 (Eac4).

23
24 Product Data: Submit manufacturer's technical product data, including rated capacities
25 of selected model clearly indicated, weights (shipping, installed, and operating),
26 furnished specialties and accessories; and installation and start-up instructions.

27
28 Submittal Drawings: Submit manufacturer's drawings indicating dimensions, weight
29 loadings, required clearances, and methods of assembly of components.

30
31 Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring
32 required for final installation of water chiller and controls. Clearly differentiate between
33 portions of wiring that are factory-installed and portions to be field-installed.

34
35 Maintenance Data: Manufacturer shall submit maintenance/operational manuals, and
36 parts list for each water chiller, control, and accessory; including "trouble-shooting"
37 maintenance guide. Include current service/repair/overhaul manuals. Furnish to owner
38 any updated or newly released related materials when available during the first five
39 years of service.

40
41 **CHILLER OPERATION AND MAINTENANCE MANUALS**

42
43 **Provide five (5) bound final installation, training, operation, maintenance and repair**
44 **manuals to be turned over to the Owner's Representative and approved for content by**
45 **the Engineer prior to acceptance of substantial completion.**

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1 Manuals provided must be of sufficient detail to enable customer to install, calibrate,
2 train, operate, maintain, service and repair every system, subsystem, and/or piece of
3 equipment installed on or as part of this contract. Manual must contain:
4

5 Project Title, Project number, Location, dates of submittals, names of Engineer,
6 Engineer, Contractor, and Contractor's Sub-contractors. Provide phone numbers and
7 addresses for Contractor and Sub-contractors.
8

9 Equipment Index that includes vendor's name, address, and telephone number for all
10 equipment purchased on the project.
11

12 Emergency instructions with phone numbers and names of contact persons on
13 warranty items.
14

15 All manuals in binders shall be original copies provided by the manufacturer. At
16 minimum these binders must include:
17

- 18 • Installation manuals, Calibration manuals
- 19 • Training manuals, Operation manuals
- 20 • Service Manual, Repair manuals
- 21 • Parts list, Wire list
- 22 • Reviewed submittals.
- 23 • Certification that owner is to receive all published service, repair and overhaul
24 manuals by being placed on the current mailing list.
- 25 • Copies of all inspection and guarantee certificates.
- 26 • Copies of all manufacturers' warranties as filed for all equipment provided
27 and/or installed, with the "Commonwealth of Kentucky" listed as the owner
28

29 Manuals: Bound in hard cover three (3) ring (D-type) binder, 1", 1.5" or 2" maximum,
30 white vinyl, presentation type with clear vinyl view cover on front, back and spine and
31 with pockets on front and back. Contents shall be indexed in CSI format, tabbed (4,5,8
32 or 16th cut), with no more than 80% binder fill. Maximum drawing size in binder shall be
33 folded 11"x17" and shall be hole punched and reinforcements added. Do not put
34 drawings in pockets. Top of all drawings shall be at top or spine side of the manual.
35 Complete drawings must be viewed without opening rings. Provide binders as
36 manufactured by Universal Office Products, Des Plaines, IL. 1" (S# B2-20742), 1.5" (B2-
37 20744), or 2" (B2-20746) or equal.
38

39 If the binder includes manuals from any one vendor covering several different model
40 numbers, the model used on the project must be highlighted.
41

42 **REQUIRED SUBMITTALS:**
43

44 The following chart is supplied for the benefit of the Owner, Engineer and Contractor to
45 assure a complete submission of required information. It is a reference listing of
46 documents required by the Specifications under this Section.

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ITEM	SHOP DWG.	M & O MANUAL	PARTS LIST	CERTIFICATION
Chiller*	X	X	X	X

* Provide wiring diagrams.

PART 2 - PRODUCTS

WATER CHILLERS -- GENERAL

Provide electric-driven, hermetic or open, centrifugal chillers as specified hereafter. Chillers shall be provided with all parts as necessary for automatic operation.

CENTRIFUGAL WATER CHILLERS:

General

Chillers shall be manufactured as complete package, factory assembled and wired. If manufacturer does not provide unit as a complete factory package, then furnish the necessary labor and material to complete the assembly and erection and insulation of the machine in the field.

If an open-drive motor/compressor design is used, the chiller size must be increased to handle the added chilled water load.

Dimensional Restrictions (exclusive of service clearances):

[mechanical designer to furnish dimensions to DECA]

Maximum width, including all controls and electrical panels: 9'3"

Maximum length, including all water boxes: 17'9"

Maximum height: 9'0"

Variable-Flow Primary Requirements [if applicable – designer to advise DECA]

The centrifugal chillers on this project will be applied using a variable water-flow primary pumping system. The chilled water evaporators must be selected by the chiller manufacturer to allow trouble-free chiller operation with a reduced chilled water flow rate of 40% (minimum) of the design chilled water flow rate. The manufacturer shall submit certified selections showing this capability.

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1 Acceptable Refrigerants:

2
3 Centrifugal --- R-134a; R-123 (maximum 2.6 lbs/ton)

4 **Compliance with this requirement is necessary as a part of the LEED**
5 **certification for this project.**

6
7 Surging: Chiller shall provide surge-free operation at 100% to 25% capacity at maximum
8 operating conditions specified including, but not limited to, 42 deg.F. leaving chilled
9 water temperature and 85 deg.F. entering condenser water temperature with specified
10 water flows.

11
12 Sound: Each chiller sound pressure level (SPL), in decibels (dB), with a reference
13 pressure of 20 micropascals, shall not exceed the values listed herein. All ratings shall
14 be in accordance with ARI Standard 575-94, "Method of Measuring Machinery Sound
15 Within Equipment Rooms".

16
17 No reduction of entering condenser water or raising of leaving chilled water
18 temperatures will be allowed in the sound levels. Making such a temperature
19 adjustment does not represent the loudest operating condition the chiller will
20 experience while on the job, and could mask sound problems that would
21 otherwise occur. A minimum of 75% of the sound data points along the length of
22 the machine shall be taken, and established as the minimum percentage of total
23 possible points used to determine sound levels.

24
25 Water chillers shall be complete with compressor and motor, evaporator, condenser,
26 lubrication system, capacity control and controller, motor starter, instrument and control
27 panel mounted and factory wired on the machine, purge system, mounting isolation and
28 other items as herein specified.

29
30 Centrifugal Compressors:

31
32 Compressors shall be single or multi-stage centrifugal type. Impellers must be
33 high strength aluminum alloy balanced both statically and dynamically. Impellers
34 shall be proof tested at least 15 percent above design operating speed.

35
36 Automatic capacity control shall modulate performance from 15 to 100 percent of
37 rated unit capacity at design conditions. Compressor shall always start unloaded.

38
39 Compressor shall be field serviceable.

40
41 Forced-fed lubrication system with a hermetic motor-driven oil pump shall be furnished
42 as part of the water chiller. System shall be complete with oil pump, oil cooler, pressure
43 regulator, oil filters, thermostatically controller oil heater and necessary motor control. Oil
44 pumps shall be energized prior to chiller motor energization. Oil pump starter shall be
45 factory supplied and mounted on the chiller and factory wired with only field power leads
46 required.

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1 Evaporator and condenser shall be fabricated with high performance integrally finned
2 copper tubing rolled into the tube sheets in both the evaporator and condenser as well
3 as expanded into the tube support sheets in the evaporator. Tubing shall be finned
4 except in the area adjacent to and in contact with the tube and tube support sheets.
5 Tube support sheet shall be spaced at intervals to maintain proper tube spacing and to
6 minimize tube vibration and wear.

7
8 Tubes shall be removable from either end of the heat exchanger.

9
10 Provide stub out water connections having Victaulic grooves.

11
12 Provide vent and drain connections with plugs.

13
14 Minimum tube wall thickness shall be 0.028 inches.

15
16 Construction and materials for the heat exchangers shall conform to
17 ANSI/ASHRAE 15-1994 Safety Code for mechanical refrigeration (which in turn
18 requires conformance to the ASME Code for Unfired Pressure Vessels where
19 applicable).

20
21 Provide true marine water boxes on both ends of condenser (hinged heads;
22 removable without disconnection of piping). Provide factory-mounted pivoting
23 gantries at both ends of condenser to allow removal of marine water box covers
24 without the need for auxiliary hoists. Hinged, davited marine water box covers
25 that will allow the cover to be opened and hinged out of the way without
26 disturbing or removing the piping are an acceptable alternative to the pivoting
27 gantries.

28
29 Unit(s) shall be equipped with a factory-mounted, spring-loaded reseating relief
30 valve designed for exterior venting.

31
32 Provide purge system, factory installed, wired and piped; system shall be self-contained.
33 Provide any necessary devices for separating and returning refrigerant to the system.

34
35 Low-pressure hermetic chillers (HCFC-123) must have a separate high-efficiency
36 purge system that operates independently of the unit. Include a purge pressure
37 gauge, number of starts counter, and an hour meter in the purge system.

38
39 Low-pressure open-drive chillers (HCFC-123) must have a separate high-
40 efficiency purge system. Include a purge pressure gauge, number of starts
41 counter, and an hour meter in the purge system. If purge system does not
42 operate when chiller is off, include a refrigerant warming system to maintain
43 refrigerant at sufficient temperature to prevent negative pressure within the
44 chiller.

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1 Units operating with refrigerants having positive pressure (R-134a) at 75 Deg. F.
2 shall have isolation valves so that chiller has the capability of storing the
3 refrigerant charge in the condenser. Provide the isolating valves at the chiller
4 compressor discharge and the refrigerant liquid line, so that the refrigerant
5 charge can be isolated in the condenser. If the condenser does not have the
6 capacity to store a minimum of 80% of the total refrigerant charge, provide a
7 separate storage receiver.
8

9 Demand limiter -- Demand limiter device shall be provided within the standard control
10 panel so that maximum current may be manually set to any fraction between 30% and
11 100% of full load amperes.
12

13 Unit Controller:
14

15 The unit shall be equipped with a complete microprocessor control system. This system
16 shall consist of control transformer, temperature and pressure (thermistor and
17 transducer) sensors, Input/Output (I/O) board, power supply board, main processor
18 board and interface board with display and keypad. All devices and sensors shall be
19 factory mounted and wired. These devices shall be capable of self-diagnostics. All
20 sensors shall be hard-wired with quick-disconnect devices for easy removal.
21

22 The interface device shall be equipped with individual touch-sensitive membrane key
23 switches.
24

25 Control center shall be capable of interfacing (via BACnet protocol) with the Johnson
26 "Metasys" Building Automation System. Required interface points shall provide for
27 remote chiller start/stop; reset of chilled water temperature; reset of current limit; and
28 status messages indicting chiller is ready to start, chiller is operating, chiller is shutdown
29 on a safety requiring reset, and chiller is shutdown on a recycling safety. Provide run
30 time meter and start counter. Reference attached schedule for additional points.
31

32 Provide hard-wired contact interface points for remote start, shutdown and alarm trouble
33 status for interfacing with the campus chilled water packaged pumping system.
34

35 The chiller shall have the necessary controls to allow the chiller to start with 60°F
36 condenser water temperature and 60°F. return chilled water temperature.
37

38 The chilled water controller of each chiller shall include variable water-flow
39 compensation capability to allow the chiller to respond quickly to accelerating or
40 decelerating water. The variable water-flow control algorithm shall automatically adjust
41 the control gain so that large changes in water-flow rate can be tolerated. The variable
42 water-flow compensation capability shall allow control of the leaving chilled water
43 temperature to within +/- 1.0 deg. F. at a water flow rate change of 10% per minute.
44

45 This option shall include factory mounted transducers to read the differential evaporator
46 water pressure (psid) and condenser water pressure (psid).

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1 The variable flow compensation option shall also display the following data on the chiller
2 control panel display:

- 3
- 4 1. Entering / leaving evaporator water pressure (psid)
- 5 2. Entering / leaving condenser water pressure (psid)
- 6 3. Evaporator differential pressure (psid)
- 7 4. Condenser differential pressure (psid)
- 8 5. Evaporator water flow rate (GPM)
- 9 6. Condenser water flow rate (GPM)
- 10 7. Evaporator capacity (Tons)

11 Starters shall be furnished for all auxiliary motors, such as oil pump, purge and transfer
12 unit.

13
14 All wiring shall meet or exceed the National Electrical Code (latest edition) and shall be
15 in metal conduit.

16
17 Insulation: The manufacturer shall provide field-installed insulation for each chiller, with
18 0.75" fire retardant flexible closed cell plastic type painted insulation, including heads on
19 evaporator.

20
21 Insulation shall be field-painted in the standard manufacturer's chiller color.

22
23 Vibration Isolation: Provide vibration isolation pads for each chiller according to isolator
24 manufacturer's recommendations.

25
26 Motors shall be single-speed, non-reversing squirrel-cage induction type, and shall be
27 suitable for voltage indicated herein. Motor stator shall be arranged for service or
28 removal without complete compressor disassembly or breaking of main refrigerant piping
29 connections. Full load operation of the motor shall not exceed nameplate rating. Motor
30 shall be built for connection to Wye-Delta type reduced-voltage starter.

31
32 Unit-Mounted Starter: **[designer to advise DECA of desired option]**

33
34 Unit-mounted starter for chiller compressor motor shall be closed transition, Wye-Delta
35 (Star-Delta) or solid state type starter in a NEMA 1 enclosure. Starter shall be capable
36 of handling the maximum locked rotor and maximum full load running currents for the
37 size chiller motor. Chiller starter continuous amperage rating shall not exceed the
38 maximum full load amperage rating of the motor provided by the chiller manufacturer.

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1 Provide an overload in each phase set at 104%-107% (per manufacturer's
2 recommendation) of the rated load amps of the connected motor. Overloads shall be
3 manual reset and shall de-energize the main contactor when over current occurs. The
4 overload shall be adjustable and selected for mid-range. The overload relays herein
5 before mentioned shall be ambient temperature compensated manual re-setting
6 bi-metallic type overload relays. Overloads may be electronic for solid-state starters.
7 Provide inherent low voltage protection and inherent motor protection against single
8 phasing and phase reversal on all three legs.

9
10 The Wye-Delta starter shall provide 58% starting voltage and shall limit amperage inrush
11 to 33% of locked rotor. Provide starter with the control features (current transformers for
12 load limiter, transformer for chiller controls, relays and interlocks) required by the chiller
13 manufacturer. Starters shall be braced for 65,000 symmetrical amps and shall be UL
14 listed and labeled. Provide inherent low voltage protection and inherent motor protection
15 against single phasing.

16
17 Provide an ammeter and voltage meter mounted in chiller starter (or as a part of chiller
18 control panel). Each ammeter shall have a full-scale reading of 1000 amperes with a 5-
19 ampere load. Provide ammeters with selector switch for each phase. In conjunction with
20 each ammeter, provide a current transformer on one leg of each starter. This current
21 transformer is for use by the load limiter.

22
23 All bussing, conductors, control wiring, interlock wiring and connectors utilized in the
24 chiller starters shall be 98% conductivity copper.

25
26 Provide circuit-breaker/disconnect in each chiller starter.

27
28 Chillers shall operate with a minimum power factor of 95 percent. If power factor
29 correction devices are required to meet 95 percent, the manufacturer shall provide the
30 necessary labor and material to install power factor correction equipment for each chiller.
31 Correction equipment may be factory- or field-installed.

32
33 The chiller starter shall be factory-mounted.

34
35 Chiller starter shall be as manufactured by Square D, Westinghouse, General Electric,
36 Cutler-Hammer or the chiller vendor.

37
38 ADJUSTABLE FREQUENCY DRIVES:

39
40 Chiller using adjustable-frequency drives (AFD's) are acceptable, and may be proposed
41 at the vendor's option. If adjustable-frequency drives are proposed, the drive electrical
42 losses must be listed in the appropriate space on the Form of Proposal. Such drives
43 shall confirm to the following:

44
45 Basic Description:

46
47 The adjustable frequency controller (AFC) shall be solid state, with a Pulse-Width-
48 Modulated (PWM) output waveform. The AFD package as specified herein shall be

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1 enclosed in a single NEMA 1 enclosure, completely assembled and tested by the
2 manufacturer. The AFD shall employ a full-wave rectifier (to prevent input line notching),
3 DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the
4 output switching device (SCR's, GTO's and Darlington transistors are not acceptable).
5 The drive efficiency shall be 97% or better at full speed and full load. Fundamental
6 power factor shall be 0.95 at all speeds and loads.
7 All programmable settings shall be held in non-volatile memory and shall not be affected
8 by power outages, brownouts, power dips, etc.

9
10 Codes/Standards:

11
12 The controller and options shall comply with the applicable requirement of the latest
13 standards of ANSI; NEMA ICS-6 for controls and systems; National Electric Code NEC;
14 IEC 801-2, 801-4, 256-4.

15
16 Unit shall be braced for 65,000 symmetrical amps and shall be UL listed and labeled.

17
18 Quality Assurance:

19
20 The AFC controller shall be subject, but not limited, to the following quality assurance
21 controls, procedures and tests.

22
23 If other than the chiller manufacturer, the drive manufacturer shall have been actively
24 and continuously engaged in the production of adjustable frequency controllers for a
25 period of at least 10 years and have experience of at least 8 years in commercial
26 applications.

27
28 Adjustable Frequency Controller:

29
30 The AFC manufacturer shall provide, at minimum, the electromechanical construction,
31 basic features, adjustments, general options and modifications and special options as
32 outlined in this specification.

33
34 Basic Features:

35
36 The AFC shall have the following basic features:

37
38 The AFC shall incorporate a full alpha/numeric customer interface panel showing all
39 settings, parameters, operating screens, operating data, supervision information and
40 faults in plain English. Display may be incorporated with the chiller control panel.

41
42 The optional main input disconnect shall provide a positive disconnect between the
43 controller and all phases of the incoming A-C line. This disconnect shall be mounted
44 inside the controller enclosure and have through-the-door interlocking toggle with
45 provisions for padlocking.

46
47 Harmonic Distortion: The AFD shall not produce more than 5% total harmonic current
48 distortion, measured at the input lugs. If a filter or other correction device is required, the

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1 resulting electrical losses must be included in the AFC loss calculations in the bid form.

2
3 The chiller vendor shall test the current distortion for the installed chiller and provide a
4 written report of final distortion readings.

5
6 Protective Circuits and Features:

7
8 The AFC shall include the following protective circuits and features:

9
10 Fast-acting semiconductor fuses specifically sized for protection of the AFC.

11
12 Instantaneous Electronic Trip for the following faults:

13
14 Output phase-to-phase circuit condition

15
16 Total ground fault under any operating condition

17
18 High input line voltage

19
20 Low input line voltage

21
22 Service Conditions:

23
24 The AFC shall be designed and constructed to operate within the following service
25 conditions:

26
27 Continuous operation at an ambient temperature between 0°C. and 40°C.
28 Maximum altitude - 3300 feet. Maximum humidity (non-condensing) – 95%.

29
30 Alternating-current line variation of 414 (-10%) to 508 (+10%) volts; plus/minus
31 2% frequency.

32
33 Refrigerant Vapor Detection

34
35 Refrigerant monitor and system will be furnished and installed by the Owner outside of
36 this contract.

37
38 **[note: DECA will purchase refrigerant vapor detection system directly from an
39 appropriate vendor – DO NOT include furnishing this device under the installation
40 contract]**

41
42 Self-Contained Breathing Equipment

43
44 Additional safety and breathing equipment, required by ASHRAE 15 – 1994 and located
45 outside the limits of the mechanical room, will be furnished and installed by the Owner.

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1 CHILLERS Nos. 1, 2 & 3 - Three (3) centrifugal machines required (parameters are for
2 each machine)

3
4 **[note: designer to advise DECA of required design parameters below]**

5
6 Nominal Capacity

7
8 Cooling capacity, minimum (full load, zero tolerance): 400 Tons.

9
10 Evaporator

11
12 Chilled water flow 600 GPM (maximum)
13 240 GPM (mimimum)
14 Pressure drop (maximum) 20.0 Ft.
15 Entering water temperature 58.0 deg. F.
16 Leaving water temperature 42.0 deg. F.
17 Maximum tube velocity 12.0 FPS
18 Water side working pressure 150 PSIG
19 Fouling factor 0.00010
20 Number of passes (vendor's option)

21
22 Condenser

23
24 Condenser water flow 1200 GPM
25 Pressure drop (maximum) 28.0 Ft.
26 Entering water temperature 85.0 deg. F.
27 Leaving water temperature 95.0 deg. F.
28 Maximum tube velocity 12.0 FPS
29 Water side working pressure 150 PSIG
30 Fouling factor 0.00025
31 Number of passes (vendor's option)

32
33 Electrical characteristics:

<u>Chiller</u>	<u>Starter</u>
460v/3 ph/60 Hz	460 volt

34
35
36 Sound Table:

37
38 % Load dB,A Weighted
39 100 86
40 25 89
41

1 **PART 3 - EXECUTION**

2
3 **FACTORY ACCEPTANCE TESTING**

4
5 Each chiller shall be run-tested in accordance with ARI Standards using an ARI-
6 approved test stand in the manufacturer's factory or laboratory. The test shall simulate
7 full- and part-load conditions to check performance (capacity and energy consumption),
8 noise, vibration and operating/safety controls.
9

10 The Engineer and Owner's Representative shall be notified to review the installation, and
11 the Owner's Representative shall witness the factory test. The Owner will witness testing
12 only during normal working hours.
13

14 The vendor shall submit for approval before scheduling the testing procedures including
15 the following:
16

- 17 • Data sheets showing the acceptable maximum/minimum points as well as the
- 18 anticipated values.
- 19 • The test load points with guaranteed KW/ton (include corrections for open-drive
- 20 motors and/or variable-speed drives as well as fouling factors).
- 21 • Test equipment.
- 22 • Overall schedule
- 23 • Test stand layout.
- 24 • Activity schedule
- 25 • Vibration testing methods
26

27 Unless the test results are in complete conformance with the requirements stated herein,
28 the Owner will not accept the chillers or authorize the chillers to be shipped from the
29 factory.
30

31 If the equipment fails to perform within allowable specified tolerances, the manufacturer
32 may make necessary revisions to the equipment and retest as required. If necessary to
33 extend the testing period by additional day(s), and/or make return trip(s) to the test site,
34 the manufacturer shall assume all expenses incurred by the Owner and/or his
35 representative to witness the retest.
36

37 **Full Load Capacity Test:** Chiller shall be tested at full load to verify the tonnage
38 produced and the KW/Ton consumed. The chiller shall meet or exceed 100% of
39 the specified minimum cooling tons required. No ARI tolerances will be
40 acceptable for the specified minimum cooling tons.
41

42 **Full Load Efficiency Test:** The chiller shall meet 100% of the maximum KW-per-
43 ton value that manufacturer submitted on the life cycle cost bid form. No ARI
44 tolerances will be acceptable for the full load KW-per-ton value.
45

46 **Partial-Load Efficiency Tests:** Chiller shall be tested at
47 three additional partial-load points, chosen in advance by the owner from the

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1 points listed in the Form of Proposal. No ARI tolerances will be acceptable for
2 the partial-load KW/ton values.

3
4 Maintain constant leaving chilled water temperature and entering condensing
5 water temperature as listed in the energy cost analysis chart of the Form of
6 Proposal.

7
8 **BEARING VIBRATION TEST** – The vendor shall test, monitor, record, and analyze the
9 vibration levels of each chiller bearing on the following occasions:

- 10
11 • As part of factory acceptance testing
12 • After initial installation/start-up
13 • At least two (2) months prior to the end of the chiller warranty period.
14

15 **Vibration Test Methods:** The vendor shall monitor and record the vibration levels
16 of the horizontal and vertical axes of all chiller bearings. Additionally, the vendor
17 shall monitor and record the axial vibration levels of outboard chiller bearings.
18 The vendor shall permanently locate all transducer attachment points on the
19 chiller during the factory acceptance tests. These transducer attachment points
20 are to be used during subsequent vibration monitoring tests performed in the
21 field. The vibration test shall be a narrowband test. The results shall be reported
22 in peak velocity (in./sec.) vs. frequency.

23
24 **Vibration Test Procedures:** All vibration tests shall be performed in accordance
25 with approved vibration test procedures. The vendor shall submit both factory
26 acceptance test and field test procedures to the owner for review/concurrence
27 with the equipment submittals. The vibration test procedures shall identify the
28 test equipment setup and test methods to be utilized.

29
30 **Documentation and Analysis:** The vendor shall summarize the results of each
31 vibration test in a vibration test report. The final test report shall compare the
32 results of field tests with the test results obtained from factory acceptance testing.
33 The vendor shall provide the owner with a written assessment of the acceptability
34 of the test results and recommend how often future vibration tests should be
35 performed in order to monitor chiller performance in a cost-effective manner.
36 The vendor shall also identify vibration levels that are considered by the vendor
37 to warrant specific corrective actions.

38
39 **Sound Pressure Test** -- Each chiller shall have sound tests conducted at the factory prior
40 to shipment to confirm the Sound Pressure Levels as listed herein. All data must be
41 measured and presented in strict accordance with ARI Standard 575-94.

42
43 The sound data points shall be measured simultaneously during the factory
44 verification of capacity and efficiency. Sound tests will be run at 100% and 25%
45 load points. If the 25% load point is not one selected by the owner for
46 acceptance, an additional test at 25%/85 deg. EWT will be performed for sound
47 testing only. The chiller must not surge during this test condition.
48

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1 In the event that a chiller does not meet the submitted dBA sound pressure level,
2 the manufacturer must, at his expense, provide sufficient attenuation to the
3 machine to meet the submitted value. This attenuation shall be applied in such a
4 manner that it does not hinder the operation or routine maintenance procedures
5 of the chiller.

6
7 If the unit cannot be modified to meet the submitted sound levels, unit will be
8 rejected.

9
10 Final Testing Report: Provide to the Owner's representative and the Consulting
11 Engineer a factory-certified test report, certifying that the proposed chillers perform as
12 specified.

13
14 PRODUCT DELIVERY AND HANDLING

15
16 Handle water chiller and components carefully to prevent damage, breaking, denting and
17 scoring. Do not ship damaged water chiller or components; replace with new.

18
19 Ship the entire refrigerant charge in separate containers.

20
21 INSTALLATION

22
23 Supervision: Inspect the chillers for "as-arrived" condition and confirm suitable condition
24 for installation. Supervise unloading of the chillers by the installing contractor.

25
26 Coordination: The vendor shall have a service technician present when the chiller
27 components are rigged into the mechanical room by installing contractor. The installing
28 contractor shall have a representative present when the chiller is disassembled and
29 reassembled by vendor, when required for ingress.

30
31 Start-Up:

32
33 Chiller and accessories shall be installed, tested, evacuated, dehydrated and charged
34 under the direct supervision of a manufacturer-trained service engineer ("factory
35 engineer"). The factory engineer shall be present at all progress meetings and be
36 present during all erection, calibration, evacuation/charging and the initial operation of
37 each water chiller.

38
39 Furnish and install the initial charge of refrigerant and oil.

40
41 Test and adjust chiller controls and safeties. Lubricate rotating parts. Verify that motor
42 amperage conforms to manufacturer's data.

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1 After the chiller has been thoroughly tested and is running, the factory engineer will
2 provide 24 hours operation based on three 8-hour days for each chiller. The factory
3 service engineer shall log all operating conditions each hour during the 24 hours of
4 operation and submit the logs to the Engineer for his review and approval.
5

6 The 24 hours will include instructing the Owner's representative and familiarizing the
7 Owner in the correct means of logging all pressures and temperatures in connection with
8 the chiller. The manufacturer's service engineer shall visit the job three (3) times per
9 year during the Warranty period: summer, spring, or fall and winter after acceptance for
10 any adjustments necessary for proper operation.
11

12 Demonstration for Owner: Provide two separate sessions with the factory engineer to
13 demonstrate and train Owner's personnel as specified below:
14

15 Start chiller and verify performance. Demonstrate operation to Owner.
16

17 Train Owner's personnel on procedures and schedules for startup, shutdown,
18 troubleshooting, servicing, and preventive maintenance.
19

20 Review data in operating and maintenance manuals.
21

22 Schedule training with the Owner through the Engineer with at least 7 days'
23 notice.
24

25 WARRANTY
26

27 Warranty: Warranty services for the chiller equipment, as specified herein, are to be
28 performed directly for the owner. The installing contractor is only responsible for
29 warranty items that are directly associated with the installation (i.e. not the chiller
30 performance).
31

32 The manufacturer shall provide a five-year parts and labor warranty for the entire chiller
33 assembly, including starter and controls.
34

35 The warranty shall commence upon substantial completion for each chiller.
36

37 The manufacturer's representative will have a service engineer available to service any
38 breakdown in 24 hours after notification, and the number of trips will not be limited during
39 the warranty.
40

41 Shared-Refrigeration Circuits with Dual Compressors: For dual compressor chiller
42 designs where two compressors share a single (common) refrigeration circuit, the entire
43 refrigerant and oil charges and both compressor/motor assemblies shall be replaced in
44 the event of a failure of either compressor/motor assembly.

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1 Refrigerant Loss: The manufacturer shall replace at no expense to the Owner any loss
2 of refrigerant and oil (unless due to negligence of the Owner) during a five-year period
3 from the date of substantial completion.
4

5 MAINTENANCE AGREEMENT
6

7 The chiller manufacturer shall include a five-year maintenance agreement for each of the
8 chiller(s). The maintenance agreement shall include a minimum of three (3) eight-hour
9 inspections each year of operation for each of the chiller(s). The costs for all materials,
10 parts, oil, oil filters, refrigerant, gaskets, shaft seals, O-rings, couplings, etc., for each
11 year maintenance agreement shall be included. Each inspection shall include a written
12 standardized service and maintenance report indicating all items checked and serviced.
13 Signed reports shall be submitted to the Owner for review and approval at the end of
14 each inspection. Reports shall note any irregularities in operation of each system and
15 tracked over time in an attempt to predict component replacement and/or downtime.
16

17 Each Yearly Maintenance Service shall include the following:
18

19 Electrical System Check: Operational verification of relays, overload dashpot fluid level,
20 starter contacts, tightening of power wiring, and megohmmeter test of compressor
21 motor(s), and overload calibration.
22

23 Machine Safety Control Check: Calibration of all unit safety control devices.
24

25 Lubrication System Service: All oil filter changes, inspection of oil heater, oil cooler,
26 pressure regulator, and heater controls, to be performed at end of first cooling season
27 and each year thereafter.
28

29 Purge Service: Provide service as recommended by the purge unit manufacturer's
30 written recommendations, including replacement of dryers and cores.
31

32 Refrigerant Charge Service: The chiller shall be checked for proper refrigerant charge at
33 each of the specified inspections. Refrigerant shall be added as required at no charge to
34 the Owner.
35

36 Shaft Seal Service: The compressor motor shaft seal(s) of open motor driven chillers
37 shall be tested for refrigerant and excessive oil leakage in the presence of the Owner at
38 each of the specified inspections. "Excessive" is defined as exceeding 8 oz. of
39 oil/refrigerant per 1000 hours of operation.
40

41 Drive Alignment Service: The alignment of open-drive chillers and couplings shall be
42 checked at each of the specified inspections.
43

44 Speed-Increasing Gear Set Service: The speed-increasing gear set shall be checked at
45 each of the specified inspections.
46

47 Condenser Tube Service: Condenser heads shall be removed at both ends of the chiller.
48 Tubes and tube sheets shall be inspected for fouling.

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- 1 Oil Analysis Service - After the first cooling season, and annually thereafter, oil analysis
2 shall be performed, measuring acid, moisture, and wear metals content. The
3 manufacturer shall review the laboratory results and submit a written report.
4
- 5 Refrigerant Analysis Service - An analysis of the refrigerant shall be performed annually
6 measuring acid, moisture content, and check for system contamination. The
7 manufacturer's field supervisor shall make a review of the laboratory results and a
8 written report shall be submitted.
9
- 10 Vibration Analysis Service – After the first cooling season, and annually thereafter, a
11 vibration test/analysis shall be performed per the above referenced Bearing Vibration
12 Testing procedures. The manufacturer shall review the results and submit a written
13 report.
14
- 15 END OF SECTION 236414-3