SECTION 23 64 16 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.
2. Packaged, portable refrigerant recovery units.
3. Heat-exchanger, brush-cleaning system.
4. Motor controllers.
5. Charge of refrigerant and oil.
6. Accessories.

B. This applies to chillers that are greater than or equal to 100 tons.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code, Section VIII, Division 1, “Rules for Construction of Pressure Vessels”.
2. Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications”.
3. B31.1, “Power Piping”.
4. B31.5, “Refrigeration Piping and Heat Transfer Components”.

B. Air-Conditioning and Refrigeration Institute (ARI):

1. Standard 550/590, “Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle”.
2. Standard 575, “Method of Measuring Machinery Sound Within an Equipment Space”.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. Standard 15, “Safety Standard for Refrigeration Systems”.
2. Standard 147, “Reducing the Release of Halogenated Refrigerants from Refrigerating and Air Conditioning Equipment and Systems”.
3. Standard 90.1, “Energy Standard for Buildings Except Low-Rise Residential Buildings”.

D. National Fire Protection Association (NFPA)

1. Standard 70, National Electrical Code (NEC)

E. American Gear Manufacturers Association (AGMA)

F. American National Standards Institute (ANSI)

G. American Society for Testing and Materials (ASTM)

H. Institute of Electrical and Electronics Engineers (IEEE)

I. National Electrical Manufacturers Association (NEMA)

J. Underwriters Laboratories (UL)

K. Occupational Safety & Health Act (OSHA) I International Building Code (IBC) 2009

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to California Building Code.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 40 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 55 deg F.
3. Performance Tolerance: Comply with the following in lieu of ARI 550/590:
    a. Allowable Capacity Tolerance: Zero percent.
    b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.
    c. Flow and temperature to follow ARI 550/590 Standards

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:
    a. Complete chiller including refrigerant and oil charge.
    b. Complete compressor and drive assembly including refrigerant and oil charge.
    c. Refrigerant and oil charge.
    d. Parts and labor including the refrigerant.
    e. Loss of refrigerant charge for any reason.

2. Warranty Period: Five (5) years.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator, condenser, and heat-reclaim condenser.
7. Characteristics of safety relief valves.
8. Minimum entering condenser-fluid temperature.
9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

D. Certificates: Provide certificate from manufacturer.

E. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Source quality-control reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals. Include start-up instructions, maintenance data, parts lists, controls, accessories, and troubleshooting guide.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Carrier.**

B. **Trane.**

C. **York.**

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.

B. Compressor:

1. Casing: Cast iron, precision ground.

2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

C. Drive: Direct- or gear-drive, open or hermetic design using an electric motor as the driver.

1. Gear Drives: For chillers with gear drives, provide single or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards. Temperature rise of gears shall not exceed 70 deg F above ambient at full load.

2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.

3. Seals: Seal drive assembly to prevent refrigerant leakage.

D. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. For chillers with open drives, provide motor with open-dripproof enclosure.
5. Provide motor with thermistor or RTD in single motor winding to monitor temperature and report information to chiller control panel.
6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
7. Provide lifting lugs or eyebolts attached to motor.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range. Operating speed shall be below the first critical speed.

1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Sound Attenuation: Compressors shall be provided with Sound Attenuation package to reduce to low frequency noise levels.

I. Capacity Control: Modulating, VFD and/or variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature.
4. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
5. Provide external electric guide-vane operator and linkage.
6. Seal points where guide-vane operating mechanism passes through the compressor casing to prevent refrigerant leakage.

J. Oil Lubrication System: Consisting of oil reservoir pump, filtration, cooler, factory-wired power connection, motor controllers and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, cost down, and standby conditions including power failure.
2. Manufacturer's standard method to remove refrigerant from oil.
3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.
8. Oil flow must be proven for compressor to run.
9. Oil pump shall be submerged in the oil reservoir to assure a positive oil supply.

2.4 REFRIGERATION

A. Refrigerant:

1. Type: R-134a; ASHRAE 34, Class A1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigerant Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system.

E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell. Purge System:

1. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
2. Factory wire to chiller's main power supply and system complete with controls, piping

and refrigerant valves to isolate the purge system from the chiller.

3. Construct components of non-corrodible materials.

4. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.

5. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to ARI 580.

6. Operation independent of chiller.

F. Positive-Pressure System:

1. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (adjustable) up to a pressure that remains within the vessel design pressure limits.

2. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.

2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.

3. Material: Copper.

4. Nominal OD: Per manufacturer.

5. Minimum Wall Thickness: Per manufacturer.

6. External Finish: Per manufacturer.

7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 3/4-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection. See FINISH later.

2.6 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: Per manufacturer.
5. Minimum Wall Thickness: Per manufacturer.
6. External Finish: Per manufacturer.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 3/4-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection. See FINISH later.

2.7 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 1-1/2 inches.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Provide removable insulations covers for water boxes.

2.8 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.

3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of liquid tight or flexible metallic conduit.

2.9 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 14X, with hinged full-front access door with lock and key.

D. General: Comply with the requirements of Division 26.

E. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

F. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

G. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, AC line power to a fixed DC voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the AC line.

2. Regulator shall provide full digital control of frequency and voltage.

3. Inverter section shall change fixed dc voltage to variable-frequency, variable AC voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

H. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

I. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V AC, plus 10 percent or 506 V maximum.

2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:
    a. Ambient Temperature: 0 to 50 deg C.
    b. Relative Humidity: Up to 90 percent (noncondensing).
    c. Altitude: sea level.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for 7 seconds.
7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

J. Internal Adjustability Capabilities:
1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: 2 seconds to a minimum of 60 seconds.
4. Deceleration: 2 seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

K. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.

11. Sustained overload exceeding 100 percent of controller rated current.
12. Starting a rotating motor.

L. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

M. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

N. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.
13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

O. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

Q. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

R. Cooling: Air, refrigerant, or water cooled.

S. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

T. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.10 COATING

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 4 mils.
2. Provide baked phenolic coating finish with a total dry film thickness of at least 6 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be manufacturer's standard.

2.11 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field mounting location before installation.
2. Pressure Differential Switches:
    a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
    b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
    c. Set Point: Screw type, field adjustable.
    d. Electrical Connections: Internally mounted screw-type terminal blocks.
    e. Switch Enclosure: NEMA 250, Type 4.

f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

B. Chillers shall be provided with BACNet Controls including BACNet interface communication card. The Control panel shall provide mapping out all points, and the Chiller manufacturer shall allow enough time to assist the Control Company to map all the chiller points.

C. Sound Barrier:

1. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.

2. Provide for repeated installation and removal without use of tape or calk.

3. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.

4. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.

5. Form covers around control devices, gauges, conduit, piping, and supports without degrading sound-barrier performance.

6. Continuously lap all exposed seams at least 2 inches for better sound containment.

7. Permanently label each section of cover to indicate its location, description, size, and number sequence.

8. Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

D. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to LAWA service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

E. Quick Start B with Uninterruptible Power Supply (UPS)

1. Quick Start shall enable the chiller to restart in 15 seconds the power is restored. Quick Start minimizes the time to restart and loads the chiller as quickly as possible, to rapidly achieve the leaving chiller water temperature setpoint. The main objective is to provide minimum down time and the fastest restart/loading as possible. Once the chiller is running and close to setpoint, it will return to standard chiller YK control

2.12 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.

b. Reduction in capacity from design to minimum load in steps of 10 with condenser fluid at design conditions.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. For chillers located indoors, rate sound power level according to ARI 575.

PART 3 - EXECUTION

3.1 GENERAL

A. The chillers will be delivered to the designated rigger's yard. Contractor shall coordinate shipment, receive, inspect and accept responsibility for equipment. Any damage or deficiency shall be resolved by Contractor directly with manufacturer and/or hauler, with no recourse to the LAWA.

B. Delivery and rigging of chillers will be staged based on the construction schedule. Contractor shall protect equipment, transport to the site, rig into place, install, pipe, wire and test equipment in accordance with drawings, specifications and manufacturer's recommendations. Contractor shall coordinate any requirements directly with the manufacturer.

C. Consult equipment supplier regarding rigging requirements. If disassembly is required, both disassembly and reassembly shall be done by the Contractor in strict compliance with the manufacturer's instructions, under supervision of chiller manufacturer's representative, and shall not void any warranties.

3.2 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 CHILLER INSTALLATION

A. Equipment Mounting: Install chiller on concrete bases using restrained spring isolators if required.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Charge chiller with refrigerant and fill with oil if not factory installed.

D. Install separate devices furnished by manufacturer and not factory installed.

E. Install piping adjacent to chiller to allow service and maintenance.

F. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, thermometer, and plugged tee with pressure gauge. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gauge, and drain connection with valve. Make connections to chiller with a mechanical coupling.

G. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, thermometer, and plugged tee with pressure gauge. Connect to condenser outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gauge, and drain connection with valve. Make connections to chiller with a mechanical coupling.

H. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

I. For chillers equipped with a purge system, extend purge vent piping to the outdoors.

J. Miscellaneous Unit Water Piping: Provide a water supply manifold piped to the compressor oil cooler and the unit-mounted refrigerant recovery unit condenser. The supply manifold shall be complete and include valves, sight glasses, thermometers and other devices to verify sufficient water flow.

K. Miscellaneous Unit Refrigerant Piping: Provide all interconnecting refrigerant piping between the chiller, refrigerant recovery unit, compressor and condenser, and remote refrigerant storage vessel, if required.

L. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written

instructions.

2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gauges are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 TRAINING

A. Train LAWA Maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

B. Provide minimum 12 hours (3 shifts) of classroom and hands on training to LAWA Maintenance personnel.

3.6 FACTORY PERFORMANCE TESTS

A. Manufacturer shall conduct factory performance test for each chiller in accordance with ARI 550/590, to verify design capacity and part load capacity points indicated on Bid form. LAWA and/or LAWA's representative (2 persons) may elect to witness tests. Notify LAWA and/or LAWAs representative of test date at least 2 weeks in advanced. There will be zero tolerance on capacity and NPLV, other parameters are per ARI 550/590 tolerance.

B. Before shipment of chillers, all records and certifications approving testing requirements shall be submitted to and approved by LAWA.

C. Defective work or material shall be replaced or repaired, as necessary, and inspection and test repeated. Repairs shall be made with new materials. Run new performance test in accordance with ARI standard.

D. If chiller assembly fails to meet design capacity and a minimum of 15% more capacity at

lower condenser water temperature, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet design capacity.

E. If chiller assembly fails to meet any of part load performance data supplied by manufacturer with his bid, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet all of design and part load performance data or to assess penalty charge equal to 10 years operating cost differential. This differential is to be determined by using part load data included in bid form and data obtained from performance test, subtracting bid data annual operating cost from test data annual operating cost, and multiplying difference by ten. Penalty charge shall apply to all chillers.

F. All design conditions and part load performance data shall be evaluated with 480 volt, 3-phase, 60 hertz power supplied to chiller.

G. Conduct test at approved ARI certified test facility of the manufacturer.

H. Instrumentation used for testing must be calibrated within 6 months of test date and traceable to National Bureau of Standards. Documentation verifying NBS traceability shall be submitted to LAWA.

1. Performance test shall be two-point test for one chiller. Points will be selected at time of test. Points will be selected from submitted performance from 25 to 100% of capacity.

3.7 COMMISSIONING

A. The manufacturer shall be present during all commissioning events. The anticipated schedule is for commissioning to occur during the last six to eight weeks during construction just prior to the anticipated end of construction. Include 40 hours of field time to perform the commissioning requirements.

B. A factory-authorized representative shall perform the startup service.

1. Fill out startup checklists and attach copy with Contractor Startup Report.

C. Complete installation and startup checks according to manufacturer's written instructions and check for the following items:

1. No physical damage to unit.
2. Unit is level.
3. Chiller vibration isolation and flexible pipe connections are installed.
4. Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
5. Chilled and condenser water pipes have been connected to correct ports.
6. Labels and safety instructions are clearly visible.
7. Oil levels are as recommended by manufacturer.
8. Refrigerant charge is sufficient and chiller has been leak tested.
9. Shipping skids, blocks and straps are removed.

10. Refrigerant pressure relief is vented to outside.
11. Thermometers and pressure gauges are installed.
12. Controls and safety interlocks are installed and connected.
13. Pumps are installed, connected and operational.

D. Check and record performance of chiller protection devices.

E. Check and record performance of chilled and condenser water flow and low temperature interlocks.

F. Operate chiller for run-in period as recommended by manufacturer.

G. Check static deflection of vibration isolators, including deflection during chiller startup and shutdown.

1. Check refrigerant charge. Check oil level.

3.8 CLEANING

A. After completion of system installation, start-up, testing and prior to commissioning, completely and thoroughly clean up the chillers from any foreign material and construction dirt and dust.

END OF SECTION 23 64 16