

Edit for scroll or reciprocating compressors.

| SECTION 15683 - RECIPROCATING/SCROLL CHILLERS

PART 1- GENERAL

1.1 REFRIGERANTS:

- A. All refrigerants used for each condensing unit shall be on the latest EPA list of approved refrigerants & environmentally friendly.
- B. No CFC based refrigerants shall be used.

1.2 DESCRIPTION OF WORK:

- | A. Extent of reciprocating/scroll liquid chiller work required by this section is indicated on drawings and schedules, and by requirements of this section.
- | B. Types of reciprocating/scroll liquid chillers specified in this section include the following:
 - 1. Water-cooled.
 - 2. Condenserless.
 - 3. Packaged outdoor air-cooled.
 - 4. Heat recovery.
- C. Refer to other Division-15 sections for concrete pads, piping, piping specialties, pumps, and valves, which are required external to reciprocating chillers for installation.
- D. Refer to other Division-15 sections for field-installed automatic temperature controls required in conjunction with reciprocating chillers.
- E. Refer to Division-15 section "Vibration Control" for vibration control work required in connection with reciprocating chillers.
- F. Manufacturers shall be responsible to provide any information to the contractor prior to bidding which may impact the installed cost for the contractor including but not limited to:
 - 1. Power wiring sizing quantity and type of conductors.
 - 2. Control Power.
 - 3. Auxiliary piping connections.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of reciprocating chillers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience with projects utilizing reciprocating chillers similar to those required for this project.

- C. ARI Compliance: Test and rate reciprocating chillers in accordance with ARI Std 590, "Standard for Reciprocating Water-Chilling Packages."
- D. ASHRAE Compliance: Construct and install reciprocating chillers in accordance with ASHRAE Std 15, "Safety Code for Mechanical Refrigeration". Provide Energy Efficiency Ratio (EER) for reciprocating chillers not less than prescribed by ASHRAE Std 90A, "Energy Conservation in New Building Design".
- E. NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring for construction and installation of reciprocating chillers.
- F. ANSI/ASHRAE Compliance: Comply with ANSI 15 safety code requirements pertaining to unit construction of reciprocating chillers.
- G. ASME Compliance: Construct and test reciprocating air-cooled liquid chiller in accordance with ASME Boiler and Pressure Vessel Code, Section 8.
 - 1. Stamp cooler with ASME mark when cooler has been successfully tested in accordance with ASME Code. Pressure test cooler for refrigerant working side pressure of not less than 235 PSIG (1620 kPa), and water side pressure of not less than 150 PSIG (1034 kPa). Leak test cooled condenser coils at 150 PSIG (1034 kPa) and pressure test coils at 450 PSIG (3103 kPa).
- H. NEMA Compliance: Provide high-efficiency motors for reciprocating chillers which comply with NEMA Stds Pub/No.'s MG 1, 2, 3, 10, and 11.
- I. UL Compliance: Comply with applicable requirements of UL 465, "Central Cooling Air Conditioners", pertaining to construction and installation of reciprocating chillers. Provide reciprocating chillers, which are UL-listed and labeled.
- J. ANSI/UL 984: Safety standards for hermetic motor compressors.

1.4 SUBMITTALS:

- A. Each manufacturer shall describe in writing, how their company is addressing the CFC legislation issue. Provide equipment capable of accepting a substitute refrigerant. Provide description of alternative refrigerant including:
 - 1. Potential lifetime in years.
 - 2. Ozone depletion factor potential.
 - 3. Global warming potential.

The equipment provided shall provide the scheduled capacity when the substitute refrigerant proposed, the nominal equipment capacity reduction effects (if any), performance in KW/TON, the refrigerant change out procedure and long term maintenance effects the new refrigerant has on the equipment.

- B. Product Data: Submit manufacturer's technical product data, including rated capacities for chillers indicated, sound power levels, weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection.

- D. Provide templates for anchor bolt placement in concrete pad. Deliver templates to concrete installer so work by others is not delayed.
 - E. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
 - F. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Divisions 1 and 15.
 - G. Maintenance Data: Submit maintenance data and parts list for each reciprocating chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Divisions 1 and 15.
- 1.5 DELIVERY, STORAGE, AND HANDLING:
- A. Handle reciprocating chillers and components properly to prevent damage, breaking, denting and scoring. Do not install damaged reciprocating chillers or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading reciprocating chillers, and transporting them to final location.
 - B. Store reciprocating chiller and components in clean dry space. Protect from weather, dirt, fumes, water, construction debris, and physical damage. Storage temperatures for unit controls are not to exceed 185 deg.F (85 deg.C).
- 1.6 WARRANTY:
- A. Provide (5) five year motor/compressor replacement warranty in addition to the 1 year warranty required under Section 15010. Warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

Select scroll or reciprocating.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Water-Cooled Scroll/Reciprocating Chillers:
 - a. Bohn Heat Transfer Div; Gulf + Western Mfg Co.
 - b. Corporation.
 - c. McQuay Group; McQuay-Perfex Inc.
 - d. Trane Company.
 - e. York Div; Borg-Warner Corporation.
 - 2. Condenserless Reciprocating Chillers:
 - a. Corporation.
 - b. McQuay Group; McQuay-Perfex Inc.
 - c. Trane Company.
 - d. York Div; Borg-Warner Corporation.

3. Outdoor Air-Cooled Scroll/Reciprocating Liquid Chillers:

- a. Bohn Heat Transfer Div; Gulf + Western Mfg Co.
- b. Corporation.
- c. McQuay Group; McQuay-Perfex Inc.
- d. Trane Company.
- e. York Div; Borg-Warner Corporation.

4. Heat Recovery Reciprocating Chillers:

- a. McQuay Group, McQuay-Perfex Inc.
- b. Trane Co.

2.2 WATER-COOLED SCROLL/RECIPROCATING LIQUID CHILLERS:

Select either reciprocating or scroll type compressors, use higher working pressure(s) ratings for scroll and 3600 rpm for scroll, 1750 rpm for reciprocating compressors.

- A. General: Provide factory-assembled and tested scroll/reciprocating water-cooled liquid chillers as indicated, consisting of compressors, condenser, evaporator, thermal expansion valve, and control panel. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide full operating charge of refrigerant and oil.

Select pressures.

- C. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 300/225 PSIG minimum, and water side working pressure of 150/300 PSIG minimum, in accordance with ASME Pressure Vessel Code. Insulate with 3/4" thick minimum flexible unicellular insulation with maximum K-value of 0.28. Provide water drain connections and bulb wells for temperature controller, low-temperature cutout, and inlet/outlet temperature sensors.
 - 1. Multiple-Compressor Units: Provide independent multiple refrigerant circuits with gasketed evaporator heads.

Select pressures.

- D. Condenser: Provide shell-and-tube design with seamless integral-fin copper tubes expanded into tube sheets, with tubes mechanically cleanable and replaceable through removable headers. Design, test, and stamp for refrigerant side working pressure of 450/300 PSIG minimum, and water side working pressure of 300/150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Provide safety relief valve with pressure rating not to exceed condenser shell side working pressure. Provide integral subcooler circuit.
 - 1. Multiple-Compressor Units: Provide independent multiple refrigerant circuits.
- E. Compressor: Provide direct-drive, 1750/3600 RPM, accessible hermetic, multicylinder reciprocating/scroll compressor with multistep capacity control. Provide crankcase heater and suction strainer. Mount compressor on vibration isolators within chiller housing.

1. Lubrication: Provide reversible, positive-displacement oil pump. Provide oil charging valve, oil level sight glass, oil filter, and magnetic plug or strainer, arranged to ensure adequate lubrication during starting, stopping, and normal operation.
 2. Motor: Provide suction gas-cooled motor with high temperature thermostat protection.
 3. Oil Sump Heater: To evaporate refrigerant returning to crankcase during shut down, energize when compressor is not operating.
- F. Capacity Modulation: Provide step capacity control by means of cylinder unloaders and compressor staging, from return water temperature.
- G. Refrigerant Circuit: Provide the following for each refrigerant circuit:
1. Liquid line solenoid valve.
 2. Filter dryer.
 3. Liquid line sight glass and moisture indicator.
 4. Thermal expansion valve.
 5. Suction and discharge line service valves.
 6. Compressor discharge service valve.
 7. 1/4" flare charging port.
 8. Insulated suction line.
- H. Control Panel:
1. Locate on the chiller, factory wired a [NEMA 1] unit control panel, containing both a starter section and a controls section with point power correction.
 2. Provide the following devices in starter section:
 - a. Access for power wiring.
 - b. Factory wired single point power hook-up to terminal block. / non-fused disconnect switch.
 - c. Three-phase solid-state overload protection.
 - d. Customer wired grounding lug.
 - e. Control power transformer with primary and secondary fused protection.
 - f. Factory wired across-the-line starter on compressor motors 20 hp or smaller.
 - g. Factory wired part winding starter, with solid state fixed off/on timers on all compressor motors over 20 hp.
 - h. Non-recycling compressor overloads.
 - i. Phase loss/reversal/imbalance and undervoltage/ overvoltage minter on main power connection. A 15% under voltage condition for 4-5 seconds will shut unit off and require manual reset.
 3. Provide the following devices on control panel face:
 - a. System start/stop switch.
 - b. Compressor running indication lights or digital display.
 - c. High and low pressure cutout lights or digital display.
 - d. Motor overload lights or digital display.
 4. Provide the following safety controls diagnostic display so there is automatic shutdown of the machine and requires manual reset:

- a. Low chilled water temperature.
 - b. High condenser refrigerant discharge pressure.
 - c. Low suction pressure.
 - d. Chilled water flow detection.
 - e. Motor current overload and phase loss.
 - f. High motor winding temperature.
 - g. Relay or contact for emergency shutdown.
 - h. Low oil pressure cut-off.
5. Provide the following safety controls diagnostic display so there is automatic shutdown of the machine with automatic reset:
- a. Over voltage.
 - b. Under voltage.
 - c. Phase reversal.
 - d. Chill water flow interlock.
6. Provide the following operating controls:
- a. Machine automatically sheds compressors to prevent automatic shut-down in the event of low evaporator refrigerant temperature, high condenser refrigerant pressure, motor current overload, and high refrigerant discharge temperature.
 - b. Time of day scheduling that turns chiller on and off using a contact closure from field supplied clock.
 - c. Pump-out mode at unit shut-down.
 - d. If unit is dual circuited, provide automatic circuit to circuit lead-lag capability and provide a defeat switch to disable changeover of the lead-lag function.
 - e. KW demand limiting that disables second compressor on each refrigeration circuit using a contact closure.
 - f. Solid state lockout timer to prevent compressor short-cycling.
 - g. Suction and discharge refrigerant pressure gauges.
 - h. Cycle counter and operating hour meter.
 - i. Microprocessor-based leaving chilled water temperature PID (proportional, integral, derivative) controller.

Edit for the following accessories.

- I. Accessories: Provide the following accessories:
 1. Hot gas bypass valve, factory-piped and wired.
 2. Load limit thermostat, if required.
 3. Acoustically lined enclosure.
 4. Vaporproof chilled water flow switch.

5. Suction, discharge, and oil pressure gages.
6. Compressor suction and discharge service valves.

Select type of vibration isolator or specify in 15240.

7. Vibration isolators of the following type:
 - a. Spring isolators with vertical restraint springs.
 - b. Equipment rails and vertically-restrained spring isolators.
 - c. Fabricated equipment base and spring isolators.
8. Antirecycle timer if protection against liquid slugging is not provided.
9. Manual pumpdown switch.
10. Condenser water temperature sensors.
11. Building automation system interface.

2.3 CONDENSERLESS RECIPROCATING CHILLERS:

- A. General: Provide factory-assembled and tested condenserless reciprocating liquid chillers as indicated, consisting of compressors, evaporator, thermal expansion valve, and control panel. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide holding charge of refrigerant and compressor operating charge of oil.
- C. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Provide removable heads on both ends. Design, test, and stamp for refrigerant side working pressure of 225 PSIG minimum, and water side working pressure of 150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Insulate with 1/2" minimum flexible unicellular insulation with maximum K- value of 0.28. Provide water drain connection and bulb wells for temperature controller and low temperature cutout.
 1. Multiple-Compressor Units: Provide independent multiple refrigerant circuits.
- D. Compressors: Provide direct drive, 1750 RPM, accessible hermetic, multicylinder reciprocating compressors with multistep capacity control. Provide crankcase heater and suction strainer. Start compressor unloaded for single compressor units. Mount compressors on vibration isolators within chiller housing.
 1. Lubrication: Provide reversible, positive-displacement oil pump. Provide oil filter and magnetic plug or strainer, arranged to ensure adequate lubrication during starting, stopping, and normal operation.
 2. Motor: Provide suction gas-cooled motor with high temperature thermostat protection.
- E. Capacity Modulation: Provide step capacity control by means of cylinder unloaders and/or compressor staging, from return water temperature.
- F. Refrigerant Circuit: Provide the following for each refrigerant circuit:

1. Liquid line solenoid valve.
2. Filter dryer.
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion valve.
5. Compressor discharge and suction service valves.
6. 1/4" flare charging port.
7. Insulated suction line.

Design Note: Provide electrical engineer chiller manufacturer's starter wiring information.

G. Control Panel:

1. Locate on the chiller, factory wired a NEMA 1 unit control panel, containing both a starter section and a controls section with point power correction.
2. Provide the following devices in starter section:
 - a. Top access for power wiring.
 - b. Factory wired single point power hook-up to terminal block. / non-fused disconnect switch.
 - c. Three-phase solid-state overload protection.
 - d. Customer wired grounding lug.
 - e. Control power transformer with primary and secondary fused protection.
 - f. Factory wired across-the-line starter on compressor motors 20 hp or smaller.
 - g. Factory wired part winding starter, with solid state fixed off/on timers on all compressor motors over 20 hp.
 - h. Non-recycling compressor overloads.
 - i. Phase loss/reversal/imbalance and undervoltage/ overvoltage minter on main power connection. A 15% under voltage condition for 4-5 seconds will shut unit off and require manual reset.
3. Provide the following devices on control panel face:
 - a. System start/stop switch.
 - b. Compressor running indication lights or digital display.
 - c. High and low pressure cutout lights or digital display.
 - d. Motor overload lights or digital display.
4. Provide the following safety controls diagnostic display so there is automatic shutdown of the machine and requires manual reset:
 - a. Low chilled water temperature.
 - b. High condenser refrigerant discharge pressure.
 - c. Low suction pressure.
 - d. Chilled water flow detection.
 - e. Motor current overload and phase loss.
 - f. High motor winding temperature.
 - g. Relay or contact for emergency shutdown.
 - h. Low oil pressure cut-off.
5. Provide the following safety controls diagnostic display so there is automatic shutdown of the machine with automatic reset:
 - a. Over voltage.

- b. Under voltage.
 - c. Phase reversal.
 - d. Chill water flow interlock.
6. Provide the following operating controls:
- a. Machine automatically sheds compressors to prevent automatic shut-down in the event of low evaporator refrigerant temperature, high condenser refrigerant pressure, motor current overload, and high refrigerant discharge temperature.
 - b. Time of day scheduling that turns chiller on and off using a contact closure from field supplied clock.
 - c. Pump-out mode at unit shut-down.
 - d. If unit is dual circuited, provide automatic circuit to circuit lead-lag capability and provide a defeat switch to disable changeover of the lead-lag function.
 - e. KW demand limiting that disables second compressor on each refrigeration circuit using a contact closure.
 - f. Solid state lockout timer to prevent compressor short-cycling.
 - g. Suction and discharge refrigerant pressure gauges.
 - h. Cycle counter and operating hour meter.
 - i. Microprocessor-based leaving chilled water temperature PID (proportional, integral, derivative) controller.
- H. Accessories: Provide the following accessories:
- 1. Hot gas bypass valve, factory-piped and wired.
 - 2. Load limit thermostat, if required.
 - 3. Acoustically lined enclosure.
 - 4. Vaporproof chilled water flow switch.
 - 5. Suction, discharge, and oil pressure gages.

Select type of vibration isolator.

6. Vibration isolators of the following type:
- a. Spring isolators.
 - b. Equipment rails and vertically-restrained spring isolators.
 - c. Fabricated equipment base and spring isolators.
7. Antirecycle timer.
8. Timed periodic pumpout.

9. Hot gas muffler.
10. Alarm package, field-installed, including audible alarm and pilot lights indicating loss of evaporator flow, low temperature, compressor malfunction, power ON, and compressor ON.

2.4 OUTDOOR AIR-COOLED LIQUID CHILLERS:

- A. General: Provide factory-assembled and tested outdoor air-cooled reciprocating liquid chillers as indicated, consisting of compressors, evaporator, condensers, thermal expansion valves, and control panels. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide full operating charge of refrigerant and oil.
- C. Housing: Housing shall be minimum 14-gauge welded galvanized steel frame with 14 and 16 gauge galvanized steel panels and access doors with corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts and components.

Select pressure rating 150 lb recip/300 lb scroll compressor.

- D. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 225 PSIG minimum, and water side working pressure of 150/300 PSIG minimum, in accordance with ASME Pressure Vessel Code. Provide one water pass with series of internal baffles. Insulate with 3/4" minimum flexible unicellular insulation with maximum K-value of 0.26. Provide water drain connection and bulb wells for temperature controller and low-temperature cutout.
 1. Heater Tapes: Provide electrical resistance heater tape on evaporator to protect against freezing at -20 deg.F (- 29 deg.C) ambient at no-flow condition.
 2. Multiple-Compressor Units: Provide independent multiple refrigerant circuits with gasketed evaporator heads.
- E. Condenser: Construct coils with configured aluminum fins mechanically bonded to seamless copper tubing. Provide integral subcooling circuit with liquid accumulators. Leak test coils with air under water at 425 PSIG air pressure. Provide protective grilles over exposed coil faces.
 1. Multiple-Compressor Units: Provide multiple circuited condenser coils.
 2. Condenser Fans: Provide propeller fans, direct or belt [] driven, draw-through design, statically and dynamically balanced. Provide permanently lubricated ball-bearing motors with overload protection. Provide protective grille over air discharge.

Select temperature for low ambient control.

3. Low Ambient Control: Provide head pressure control, designed to operate at temperatures down to [0] deg.F (-18 deg.C).

Specify minimum no. of steps.

- F. Compressors: Provide direct drive 1750/3600 RPM, multicylinder scroll/reciprocating compressors with crankcase heater; either semi-hermetic or hermetic, with a minimum [] steps of capacity control, provided by cylinder unloading or compressor staging, or combination of both. Mount compressors on vibration isolators within chiller housing.
1. Lubrication: Provide oil pump, oil filter, oil level sight glass, and oil charging valve.
- G. Capacity Modulation: Provide step-control by means of cylinder unloading and/or compressor staging, from return water temperature.
- H. Refrigerant Circuit: Provide for each refrigerant circuit the following:

Use multiple circuits on larger sizes.

Provide multiple independent separate refrigerant circuits with a minimum of two.

1. Liquid line solenoid valve.
2. Filter dryer.
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion valve.
5. Insulated suction line.
6. Suction and discharge valves.

Design Note: Provide electrical engineer chiller manufacturer's starting wiring information.

- I. Controls and Control Panels:
1. Locate on/near chiller, factory wired/NEMA 1 unit control panel, containing both a controls section as well as a starter section.
 2. Provide the following devices in starter section:
 - a. Top access for power wiring.
 - b. Factory wired single point power hook-up to terminal block. /unit mounted, non-fused disconnect switch.
 - c. Three-phase solid-state overload protection.
 - d. Customer wired grounding lug.
 - e. Control power transformer with primary and secondary fused protection.
 - f. Factory wired part winding/across-the-line starter with solid state fixed off/on timers on all compressor motors.
 - g. Non-recycling compressor overloads.
 - h. Phase loss/reversal/imbalance and undervoltage monitor on main power connection. a 15% under voltage condition for 4-5 seconds will shut unit off and require manual reset.
 3. Provide the following devices in the control panel:
 - a. Compressor run lights.

- b. System start-stop switch.
 - c. Low pressure lockout lights.
 - d. Terminal strips.
 - e. Central micro-processor
 - 1) Leaving fluid setpoint.
 - 2) Delta T setpoint.
 - 3) # of stages.
 - f. Control power fuses.
 - g. Motor protection/oil failure controller.
 - h. Indicating lights for load limit.
 - i. Stages of unit unloading.
4. Provide the following safety controls arranged so that operating any one will shut down machine and require manual reset:
- a. Low chilled water temperature switch.
 - b. High discharge pressure switch for each compressor.
 - c. Low suction pressure switch for each compressor.
 - d. Oil pressure switch.
 - e. Current overload.
 - f. Motor temperature.
5. Provide the following safety controls so there is automatic shutdown of the machine with automatic reset:
- a. Over voltage.
 - b. Under voltage.
 - c. Phase reversal.
 - d. Chilled water flow interlock.
 - e. Condenser water flow interlock.
6. Provide the following operating controls:
- a. Multi-step chilled water temperature controller, which cycles compressor and activates cylinder unloaders.
 - b. Five minute off timer prevents compressor from short cycling.
 - c. Part winding/Across-the-line solid state start timer.
 - d. Provide automatic circuit to circuit lead-lag capability to allow for equal run time per compressor.
 - e. Periodic pump-out timer to pump down on chilled water flow and high evaporator refrigerant pressure.
 - f. Load limit thermostat to limit compressor loading on high return water temperature.
 - g. Power supply monitor to protect unit by stopping compressor on phase loss, phase reversal, incorrect phase sequence, and low voltage.
 - h. Cycle counter and operating hour meter.
7. Provide pre-piped gauge board with pressure gauges for suction and discharge refrigerant pressures, and oil pressures for each compressor.

Carefully select the following options.

8. Provide alarm package with test button and indicating lights which indicate control circuit is energized and compressor is running, and will sound an audible alarm and light an indicating light upon detection of compressor malfunction, low chilled water temperature, or evaporator water flow failure.
9. Provide remote mounted microprocessor-based panel that allows multiple units to operate in series or parallel.
10. Provide chilled water reset algorithm in the microprocessor that resets leaving water temperature based on [ambient] or [zone] temperature. Provide field installed sensor.
11. Provide a field installed ice panel add-on control that enables the chiller to make ice during off-peak hours and make standard temperature chilled water during high-energy demand hours.

J. Accessories: Provide the following accessories:

1. Hot gas bypass valve, factory-piped and wired.
2. Load limit thermostat, if required.
3. Vaporproof chilled water flow switch.
4. Suction and discharge gages.
5. Oil pressure gages except for hermetic compressors.

Select type of vibration isolator or specify in Section 15240.
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6. Vibration isolators of the following type:
 - a. Spring isolators.
 - b. Equipment rails and vertically-restrained spring isolators.
 - c. Fabricated equipment base and spring isolators.
7. Low ambient dampers for 0°F ambient start-up and run.
8. Copper condenser fins.

2.5 HEAT RECOVERY RECIPROCATING CHILLERS:

- A. General: Provide factory-assembled and tested reciprocating water-cooled liquid chillers as indicated, consisting of compressors, condenser, evaporator, receiver, thermal expansion valve, control valves, and control panel. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide full operating charge of refrigerant and oil.
- C. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 225 PSIG minimum, and water side working pressure of 150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Insulate with 1/2" minimum flexible unicellular insulation with maximum K-value of 0.28. Provide water drain connection.

- D. Condenser: Provide shell-and-tube design with seamless integral-fin copper-nickel tubes expanded into tube sheets. Design, test and stamp for refrigerant side working pressure of 450 PSIG, and water side working pressure of 150 PSIG, in accordance with ASME Pressure Vessel Code. Provide 450 PSIG safety relief valve on condenser. Provide subcooler circuit in condenser. Factory-mount condenser on reciprocating chiller, connected by single compressor discharge line to remote air-cooled condenser for parallel refrigerant flow.
- E. Compressors: Provide direct drive 1,750 RPM, multicylinder reciprocating compressors with crankcase heater; either semi-hermetic or hermetic, but with minimum steps of capacity control as scheduled, provided by cylinder unloading or compressor staging, or combination of both. Mount compressors on vibration isolators within chiller housing.
- F. Capacity Modulation: Provide step capacity control by means of cylinder unloaders and/or compressor staging, from return water temperature.
- G. Refrigerant Circuit: Provide for refrigerant circuit, factory-mounted, the following:
1. Liquid line solenoid valve.
 2. Filter dryer.
 3. Liquid line sight glass.
 4. Thermal expansion valve.
 5. Compressor discharge service valve.
 6. 1/4" flare charging port.
 7. Insulated suction line.
 8. Hot gas muffler.
 9. Refrigerant shutoff valves around refrigerant controls and components.
- H. Receiver: Provide factory-mounted liquid line receiver; designed, tested, and stamped for working pressure of 450 PSIG, in accordance with ASME Pressure Vessel Code. Provide 450 PSIG safety relief valve, and 2 sight glasses.
- I. Control Panel: Provide control panel for compressor, factory-wired for external connection only. Provide 2- sections in panel, electrical and refrigeration.
1. Refrigeration Section: Provide the following:
 - a. High-pressure cutout.
 - b. Low-pressure cutout.
 - c. Motor protection.
 - d. Oil-pressure cutout.
 - e. Low chilled water temperature cutout.
 - f. Chilled water temperature controller.
 2. Electrical Section: Provide the following:
 - a. Power controls for part-voltage or full voltage start.
 - b. Control power transformer for 115V control voltage.
 - c. Terminal strip.
 - d. Pumpdown control relay.
 - e. Compressor starter relay.
 - f. Reset relay.
 - g. Nonrecycling compressor overload relay.
 - h. Time delay relay.
 - i. Interlocks for remote air-cooled condenser con
- J. Accessories: Provide the following accessories:

1. Hot gas bypass valve, factory-piped and wired.
 2. Load limit thermostat, if required.
 3. Acoustically lined enclosure.
 4. Chilled water flow switch.
 5. Suction, discharge, and oil pressure gages.
 6. Vibration isolators of the following type:
 - a. Spring isolators.
 - b. Equipment rails and vertically-restrained spring isolators.
 - c. Fabricated equipment base and isolators.
 7. Anti-recycle timer and timed periodic pumpout.
- K. Auxiliary condenser, factory-mounted, connected by single compressor discharge line for parallel refrigerant flow.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Installer must examine areas and conditions under which reciprocating chillers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF RECIPROCATING CHILLERS:

- A. General: Install reciprocating chillers in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Support: Install floor-mounted units on reinforced concrete pad. Furnish anchor bolts, which are to be inserted in concrete pad to Concrete Installer.
- C. Support: Install roof-mounted units on structural steel mechanical equipment stand. Anchor unit to stand with removable type fasteners.
1. Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook of Accepted Roofing Knowledge, Detail "N".
 2. Mechanical equipment stand is specified in Division 5; not work of this section.
- D. Chilled Water Piping: Refer to Division-15 section "Hydronic Piping". Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch, flexible pipe connector, drain valve, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, balancing cock, flow meter, thermometer, flexible pipe connection, pressure gage, drain valve, and union or flange.
- E. Condenser Water Piping: Refer to Division-15 section "Condenser Water Piping". Provide flanged or union connections to condenser, arranged to allow removal of condenser heads. Connect inlet to condenser with shutoff valve, thermometer, plugged tee, pressure gage, flexible pipe connector, and union or flange. Connect outlet to condenser with shutoff valve,

flow meter, thermometer, drain valves and shutoff valve, strainer, plugged tee, flexible pipe connector, and union or flange.

- F. Refrigerant Piping: Refer to Division-15 section "Refrigerant Piping". Provide piping between chiller and condenser as indicated, and in accordance with installation instructions of both chiller and condenser manufacturers.
 - G. Relief Piping: Provide relief piping as indicated from refrigerant pressure relief rupture disc on chiller to outside building atmosphere; size piping as recommended by chiller manufacturer, and terminate with gooseneck facing down.
 - H. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to manufacturer and equipment installer.
 - I. Control: Furnish field-installed automatic temperature control requirements to Control Installer.
 - J. Start-up: Chiller start-up shall be by factory authorized service representative in accordance with manufacturer's recommendations. Test controls and demonstrate compliance with requirements. Replace damaged, or malfunctioning, controls and equipment and retest.
 - 1. Do not place chillers in sustained operation prior to initial balancing of mechanical systems, which interface with the reciprocating chillers.
- 3.3 TRAINING OF OWNER'S PERSONNEL:
- A. Provide services of manufacturer's technical representative for two 8-hour days to instruct Owner's personnel in operation and maintenance of reciprocating chillers.
 - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 15683