

SECTION 15650
REFRIGERATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Reciprocating Compressors (Hermetic).
2. Reciprocating Compressors (Open Drive).
3. Water Cooled Condensing Units.
4. Air Cooled Condensing Units.
5. Reciprocating Chillers (Water Cooled) (Remote Condenser).
6. Water Cooled Condensers.
7. Air Cooled Condensers.
8. Centrifugal Water Chiller.
9. Cooling Tower (Induced Draft, Vertical Discharge).
10. Remote Sump Tank.
11. Cooling Tower Sump Filtration System.

B. Related Sections:

1. Section 15010 - Basic Mechanical Requirements.
2. Section 15050 - Basic Mechanical Materials and Methods.
3. Section 15240 - Mechanical Sound and Vibration Control.
4. Section 15250 - Mechanical Insulation.
5. Section 15511 - Hydronic Piping and Specialties.
6. Section 15531 - Refrigerant Piping and Specialties.
7. Section 15548 - HVAC Water Treatment.
8. Section 15651 - Computer Room Air Conditioning.
9. Section 15950 - Controls.

10. Section 15990 - Testing, Adjusting and Balancing.

1.02 REFERENCES

- A. American National Standards Institute (ANSI).
- B. Air Conditioning and Refrigeration Institute (ARI).
- C. American Society of Mechanical Engineers (ASME).
- D. Cryogenic Society of America (CSA).
- E. Cooling Tower Institute (CTI).
- F. National Electrical Code (NEC).
- G. Underwriter's Laboratories, Inc. (UL).

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. General:

- a. Design and specify refrigeration systems and equipment in accordance with "Energy Conservation Standards" stipulated in Section 15010 - Basic Mechanical Requirements.
- b. Every effort should be made to specify equipment which does not require any CFC refrigerants, including R-11, R-12, R113, or R114, or R-500. HCFC refrigerants such as R-22 and R123 are discouraged.

LEED EA_p3: CFC Reduction in HVAC & R Equipment & EA_c4: Ozone Protection:

Use HFC refrigerants where possible.

- c. Specify that isolation valves shall be provided by manufacturer in order to allow servicing of major components (e.g., compressor, receiver, condenser, filter-dryer, expansion valve) with no loss of refrigerant the filter-dryer shall have a 3-valve arrangement with bypass.
- d. Review with University the equipment-mounted gages desired for diagnosis and service.
- e. Specify that Contractor needs to label the amount of refrigerant in the system in pounds, as required by UMC.
- f. Demolition: Specify that all refrigerant be removed, recovered and reclaimed prior to demolition of any equipment containing refrigerant such as; rooftop units, split system condensing units, air conditioning units and chillers. Specify that contractor notify University Refrigeration Shop supervisor prior to commencing demolition

work. University personnel will either remove refrigerant from equipment or direct contractor to remove refrigerant. All handling of refrigerant will be by certified refrigeration technicians, approved by the U.S. EPA. The refrigerant and refrigerator shall be returned to the CU refrigeration shop.

- g. Compliance: Specify that the contractor shall comply with Colorado Department of Health Regulation 15 and all applicable EPA rules and regulations regarding the purchase, disposal and handling of refrigerants.

2. Compressors over 100-ton capacity:

a. Motors and Starters:

- 1) Dual winding, wye-delta design with matching two-step, closed transition, time-delay starting switch gear is preferred. (An auxiliary timer in the starting circuit is required).
- 2) Specify that timer be set to limit starts to a minimum of 30 minutes apart, or greater as recommended by the manufacturer.
- 3) An auto-transformer with reduced voltage start is an acceptable alternate starter.
- 4) All motors shall have heat sensors in the wind- windings for thermal protection.

b. Full-running protection:

- 1) Specify compressors equipped with high and low pressure safety cut out, external overload protection, and inherent thermal protection, and low oil pressure.
- 2) Manual reset type safeties which cause an electrical lock-out of the starting circuit when it has tripped, with an indication of which safety device has operated.

c. Gages and Lubrication:

- 1) Not required if unit equipped with micro-processor control which shows pressure at control panel.
- 2) Forced-feed lubrication system with filter, cooler and visual inspection port in the oil reservoir.

d. Heaters:

- 1) Specify crankcase heaters wired on a separate electrical circuit.
- 2) Specify oil pump starter wired on a separate electrical circuit.

e. Purge:

- 1) Specify purge units to eliminate the non-condensable gases on units using R-11, R-113, R-114 or similar refrigerants where evaporator pressure is below atmospheric pressure.

f. Refrigerant Transfer:

- 1) Unit should have provisions for pump out/down into unit-mounted receiver if application warrants it. (University authorization required.)

g. Pressure Relief:

- 1) Show on Drawings, safety valve pressure relief piping vented to outdoors in accordance with ANSI/ASHRAE Standard 15-78. Pressure relief valves shall be self-closing, resealing type.

h. Ethernet Interface

- 1) Provide interface for connection to the campus ethernet network.

3. Compressors of 60 to 100 ton capacity:

- a. Semi-hermetic, reciprocating type, helical rotor or scroll.
- b. Full running protection as described for larger compressors.
- c. Crankcase heaters.
- d. Oil reservoir sight glass.
- e. Replaceable refrigerant filter-dryers in liquid line.
- f. Hydraulic capacity control by cylinder unloading for adjustments to load fluctuations.
- g. Positive unloaded start.
- h. An adequate discharge muffler.
- i. Internal vibration isolation to provide minimum vibration transmission.
- j. Closed transition starting switch-gear, determined by the electrical requirements for the particular sizes of motors. Part-winding start is acceptable.
- k. As described on larger air-cooled units, specify a receiver on the condenser and provisions for pumping the full refrigerant charge into the receiver. If condenser will hold the full charge, this is an acceptable alternative.
- l. Extended 5 year warranty on compressor(s).

4. Compressors under 60 but over 15 ton capacity:

- a. Hermetic or semi-hermetic reciprocating, scroll or helical rotor.

- b. Inherent thermal overload protection for motors.
 - c. Crankcase heaters.
 - d. Oil reservoir sight glass.
 - e. Replaceable refrigerant filter-dryers.
 - f. Hydraulic capacity control by cylinder unloading or staging of multiple compressors.
 - g. Positive unloaded start.
 - h. Adequate discharge muffler.
 - i. Internal vibration isolation.
 - j. Closed transition starting switchgear determined by the electrical requirements for the particular sizes of motors.
 - k. A receiver on the condensers and provisions for pumping the full refrigerant charge into the receiver. If condenser will hold the full charge, this is an acceptable alternative.
 - l. Extended 5 year warranty on compressor(s).
5. Compressors between 7-1/2 and 15 ton capacity:
- a. Same requirements as 15 to 60 ton compressors except that cylinder unloading and unloaded start features are not required on the small units.
6. Compressors below 7-1/2 tons capacity:
- a. Same requirements as 7-1/2 to 15 ton compressors except that gages are not required.
7. Condensers:
- a. Select air cooled condensers with sufficient capacity to compensate for altitude deration of 5400 feet and 105 F inlet air temperature.
 - b. A horizontal blow with a weather protecting shroud designed to prevent possible blade icing and unbalance during cold weather is required.
 - c. Arrange water-cooled condensers so that tubes can be rodded without hindrance from walls, piping, or equipment.
8. Cooling Towers:
- a. Specify the following for induced-draft towers:

- 1) Steel, galvanized except as noted.
- 2) A propeller type fan, on which blade pitch can be adjusted.
- 3) A gear reducer drive for anything beyond 10 horsepower, if applicable.
- 4) Motors situated outside the tower's humid airstream.
- 5) Fill manufactured of fire-retardant PVC material (minimum 15 mil. thickness).
- 6) Hot return water basin covers.
- 7) Safety railings and ladder to fan deck.
- 8) Safety cage on ladder.
- 9) Oversized sump outlet for gravity flow to inside remote sump.
- 10) Extended lube and oil fill lines with sight glass or dipstick.
- 11) Stainless-steel hardware, and brass or stainless-steel fittings, throughout within wet area.
- 12) Vibration switch.

b. Specify, in addition, the following for forced-draft towers:

- 1) "Baltibond" (Baltimore Air Coil Trademark) or equivalent coating.
- 2) Stainless-steel sump with blow-through prevention kit.
- 3) If installed indoors, tower shall be stainless steel throughout, with relief dampers made of stainless steel with stainless steel "knuckles."

9. Remote Sump Tank (if used):

a. Incorporate the following requirements in sump tank design:

- 1) Allow minimum water level of 4 feet of suction head under operating conditions or greater if required to meet NPSH of pump.
- 2) Provide a minimum of 150 percent of drain down storage capacity in addition to above operating level.
- 3) Drain down capacity to consist of volume of cooling tower water retention plus all piping exposed to freeze conditions.
- 4) Design vortex breaker and screen at suction outlet.
- 5) Provide maximum separation between sump intake and suction outlet to minimize entrained air entering pump suction.
- 6) Design overflow drain capacity equal to system drain down flow rate.
- 7) Provide for maintenance drain down.
- 8) Design separate water chamber for steady make-up water float control to minimize fatigue on control valve due to wave action in tank.
- 9) Provide taps on tank for sump filtration cleaning system.
- 10) If tower drain pipe to sump exceeds one floor level, provide balancing valve at sump inlet to provide steady flow to minimize pipe vibration, sound and air entrainment in water flow.
- 11) Include inspection ladder on tank to monitor water conditions.
- 12) Provide adequate ventilation in sump room to control humidity.

10. Cooling Tower Sump Filtration System:

- a. To improve and maintain good water conditions in condenser water, specify and show on Drawings a pumped system to recirculate water from sump through a filter and back to sump.

b. Sidestream filters are preferred.

11. DX Condensers:

a. For units requiring operation down to -30 F, provide low ambient control package to allow start-up and positive head pressure control.

PART 2 - PRODUCTS

2.01 RECIPROCATING COMPRESSORS (HERMETIC)

A. Manufacturer:

Bohn
Bristol
Carrier
Copeland
Tecumseh
Trane
York

B. Unit performance certified in accordance with latest edition of ARI Standard 520.

C. Unit construction in accordance with ANSI B9.1 Safety Code.

D. Factory wired control panel in accordance with NEC.

2.02 RECIPROCATING COMPRESSORS (OPEN DRIVE)

A. Manufacturer:

Bohn
Carrier
Trane
York

2.03 WATER-COOLED CONDENSING PACKAGE UNITS

A. Manufacturer:

Bohn
Carrier
McQuay
Trane
York

B. Unit performance certified in accordance with latest edition of ARI Standard 520.

- C. Unit construction in accordance with ANSI B9.1 Safety Code and ASME Code.
- D. Factory wired control panel in accordance with NEC.

2.04 AIR-COOLED CONDENSING UNITS

- A. Manufacturer:

Submit recommendation

- B. Unit performance certified in accordance with latest edition of ARI Standards 210 and 270.
- C. Unit construction in accordance with ANSI B9.1 Safety Code and ASME Code.
- D. Factory wired control panel in accordance with NEC.

2.05 RECIPROCATING CHILLER (WATER COOLED and/or REMOTE CONDENSER)

- A. Manufacturer:

Submit recommendation

- B. Unit performance certified in accordance with latest edition of ARI Standard 590.
- C. Unit construction in accordance with ANSI B9.1 Safety Code and ASME Code.
- D. Factory wired control panel in accordance with NEC.
- E. Units UL Listed and CSA certified.

2.06 WATER-COOLED CONDENSERS

- A. Manufacturers:

Bohn
Carrier
Refrigeration Services
Trane
York

- B. Unit performance certified in accordance with latest edition of ARI Standard 450.
- C. Unit construction in accordance with ANSI B9.1 Safety Code and ASME Code.

2.07 AIR-COOLED CONDENSERS

- A. Manufacturers:

Submit recommendation

- B. Unit performance certified in accordance with latest edition ARI Standard 460.

- C. Unit construction in accordance with ANSI B9.1 Safety Code.
- D. Factory wired control panel in accordance with NEC.
- E. Units UL Listed and CSA certified.
- F. In units with multiple fans, isolate each fan section.

2.08 CENTRIFUGAL OR ROTARY-SCREW WATER CHILLER

A. Manufacturers:

Carrier
McQuay (with sound abatement kit)
Trane
York

- B. Chiller performance rated in accordance with latest edition of ARI Standard 550.

2.09 COOLING TOWER (INDUCED DRAFT, VERTICAL DISCHARGE)

A. Manufacturers:

Tower-Tech
Baltimore Aircoil
Evapco
Marley
CCT

- B. Capacity rating in accordance with CTI Standards. Include altitude effects.

2.10 REMOTE SUMP TANK

- A. Furnish and install welded stainless-steel or fiberglass sump tank of size and capacity shown on Drawings.

2.11 COOLING TOWER SUMP FILTRATION SYSTEM

A. Manufacturer:

Submit recommendation.

- B. Description: Pumped recirculation of water from cooling tower sump or drain-down sump through filter and back to sump as shown on drawings. Include use of distribution piping to sweep floor of tower sump towards the outlet.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. In general, for project specifications, remove in Part 1, paragraph 1.03 "System Description" sub-paragraph A, "Design Requirements" of this Design Guide and use list to expand on specific requirements of installation for each product specified.

END OF SECTION