1. This information provides guidelines for the design and construction of refrigeration systems for heating, ventilating and cooling (HVAC) equipment. Additional requirements for refrigeration piping and insulation, and temporary facilities and controls are covered in other parts of these standards or are available from the Facilities Management (FM) project representative.

2. FM project representative, FM, and Technical Maintenance shall approve selection of materials, means, and methods. Unless otherwise approved, the design intent requires means and methods that provide minimal disruption to adjacent building activities and operations.

3. When working in or adjacent to occupied buildings, require means and methods that protect occupants from exposure to noise, dust, traffic and other hazards.

4. FM project representative shall inform FM and other campus departments or groups affected by the work.

5. General:
   a. See “DIVISION 20 General Mechanical” for restrictions and approval requirements for mechanical cooling systems.
   b. If mechanical cooling is required for a new facility, consider studying a “free cooling” alternative in the Energy Life Cycle Cost Analysis.
   c. For projects in existing buildings, if sufficient capacity is available in an existing chilled water system, chilled water shall be used as the cooling medium for any new or renovated spaces.
   d. Require all new cooling systems to provide efficient year round operation for both high summer loads and partial winter process loads.
   e. Avoid glycol additives for freeze protection. If a glycol system is unavoidable, require virgin polypropylene glycol (30%) as the standard freeze protection medium additive for water systems. Prohibit recycled product.
   f. Prohibit condenser water systems using once-through domestic, potable water wasted to the sanitary system.
   g. All installations must meet accessibility criteria for servicing and equipment replacement.

6. Refrigerants and safety:
   a. Refrigerants and refrigeration equipment shall meet the requirements of the Federal Clean Air Act and the Washington State Clean Air Act and shall meet all ASHRAE 15 Safety Standards (latest edition).
   b. All proposed replacement refrigerants shall be approved by the FM project representative, FM, and Technical Maintenance.

7. Refrigerant piping:
   a. See “DIVISION 20 Basic Methods and Materials”.
   b. Require adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls or ceilings, sized to permit installation of full-thickness insulation.
   c. Arrange piping to allow inspection and service of compressor and other equipment.
   d. Install valves and specialties in accessible locations to allow for service and inspection.
   e. Require dryers, sight glasses, gage taps, check valves, thermostatic expansion valves and thermostatically controlled solenoid valves.
   f. Insulation: See “DIVISION 23 Mechanical Insulation.” Protect insulation with covering
when exposed to UV radiation.

8. **Chiller:**
   a. Require a factory assembled and tested package unit consisting of a compressor, a condenser, an evaporator (cooler), a refrigerant flow-control device, complete package controls, and control panel.
   b. Where water cooled chillers are provided, prefer rejecting heat to a fluid cooler, with options for heat recovery provided for an air system on larger systems. Cooling tower is a second alternative.
   c. Avoid air cooled chillers with remote condensing units.
   d. Prohibit systems with field installed refrigerant lines between the evaporator (inside unit) and condensing unit (outside unit).
   e. Acceptable manufacturers: Trane, Multistack.
   f. Provide manufacturer’s packaged control system.
   g. If one of the core processes is dehumidification a modulating compressor and turn down capacity.

9. **Evaporator:**
   a. Evaporator shall be shell and tube design with seamless copper tubes. Design, test and stamp in accordance with ASME Pressure Vessel Code. Provide water drain connection and bulb wells for temperature controller and low temperature cutout.

10. **Compressor:**
    a. Prefer centrifugal compressors for quiet operation
    b. Prefer modular centrifugal compressor for ultimate efficiency at partial loads.
    c. Rotary screw or scroll compressors may be acceptable if minimum noise and efficiency requirements are met (provide sound proofing design and cost). Submit proposed system for approval by the FM project representative, FM, and Technical Maintenance.
    d. Require all compressors and components to be readily accessible.
    e. Require efficient capacity control appropriate for the application.
    f. Provide maximum noise criteria for compressors as recommended by ASHRAE.
    g. Require vibration analysis and eddy current testing for all installations.
    h. Provide flexible connectors at the inlet and discharge connections of compressors.
    i. Operating and safety controls shall include high and low pressure cutouts, oil cutout, compressor winding thermostat cutout, and 3-leg compressor overload protection.
    j. Unit shall have automatic, non-recycling pump-down and timing device to prevent excessive compressor cycling.

11. **Condensers:**
    a. Prefer a fluid cooler for heat recovery option. Cooling tower for large systems without heat recovery is 2nd alternative. Heat recovery should include a heating coil in the nearest air handling unit.
    b. Roof mounted air cooled condenser (dry cooler) with closed propylene glycol condenser water loop piped to indoor evaporator is acceptable for small process loads. Prefer Liebert Mini-Mate.

12. **Cooling towers/Fluid coolers:**
    a. Provide a factory assembled roof mounted, induced draft cooling tower complete with casing, louvers, access doors, fans, motors, basins, water distribution system, fill, drift eliminators, heaters and complete factory installed and tested control package.
    b. Unit must be capable of handling multiple chillers at variable flow rates. Include VSD.
c. Provide motors with lifting lugs.

d. Provide maximum noise criteria for cooling towers/ fluid coolers.

e. Preferred manufacturer: Marley, BAC (Baltimore Air Coil).

f. Require water treatment in the condenser water circuit approved by the University.

13. Air cooled condensing units:
   a. When approved by FM, provide factory assembled and tested air cooled condensing unit consisting of casing, compressor, condensers, coils condenser fans, motors, and unit controls.
   b. Locate units outside.
   c. Unit shall be equipped with factory installed low ambient control for year round operation.
   d. Condenser coil shall be seamless copper tubing with aluminum fins.
   e. Provide a separate and independent refrigeration circuit for each compressor.
   f. Condenser fans shall be propeller type.
   g. Provide maximum noise criteria for compressors as recommended by ASHRAE.

14. Testing, adjusting and charging the refrigerant systems:
   a. All refrigeration piping system testing shall be witnessed by the engineer and the FM project representative prior to insulating.
   b. Pressure test refrigeration piping system with nitrogen. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
   c. Remake leaking joints using new materials and retest until satisfactory results are achieved.

15. Startup and testing chiller:
   a. Require equipment to be fully charged with refrigerant prior to startup and testing.
   b. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.
   c. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.
   d. Require a factory-authorized service representative to provide startup service and training (minimum eight hours) for owner’s maintenance personnel.
   e. Testing is not complete until done at the appropriate summer outdoor condition is verified. Chiller testing in the winter is not acceptable.

16. Building management system interface:
   a. Require factory-installed hardware and software to enable the system Building Automation Control System (BACS) to monitor and control chilled-water set point and chiller-control displays and alarms.
   b. Chiller manufacturer shall provide interface device compatible with existing Siemens controls system. See “DIVISION 23 - Mechanical Control Systems” standard.
   c. Chiller manufacturer shall provide factory technician for a minimum of eight hours to test chiller interface to the BACS after installation is complete.

17. Minimum equipment performance data required on project drawings:
   a. Chiller evaporator coil: Total cooling capacity (tons); chilled water flow quantity (gpm); entering and leaving water temperature; maximum water pressure drop (ft H₂O)
   b. Chiller condenser coil: Condenser water flow quantity (gpm); entering and leaving water temperature; maximum water pressure drop (ft H₂O).
   c. Chiller compressor: Type of refrigerant; type of compressor; number of compressors; number of refrigerant circuits; efficiency at full load (kw/ton) and part load values (IPLV, NPLV, SPLV).
d. Cooling tower/fluid cooler: Location; type; number of cells; tons per cell; water flow quantity (gpm); entering and leaving water temperature; design ambient wet bulb temperature; sump heater capacity and heat source; number of fans; fan rpm; fan cfm.

e. Maximum sound data.

End