PART 1: GENERAL

1.01 RELATED SECTIONS

A. Section 15010 – Basic Mechanical Requirements
B. Section 15050 – Basic Materials and Methods
C. Section 15790 – Coils

1.02 RELATED STANDARD DETAILS

A. Detail 3.3.1, Refrigerant Lines Wall Penetration Detail
B. Detail 3.3.2, Refrigerant Lines Trench Cross-Section

1.03 Cornell University is subject to numerous regulations controlling how refrigerants are managed. Any deviation may subject the University to fines and can compromise University permits. Resources and references are available on-line through the Environmental Health and Safety (EHS) website (http://sp.ehs.cornell.edu/Pages/Home.aspx). In addition, the Air Compliance Programs EHS Specialist is available for assistance by calling 607-255-8200. Cornell University General Requirements Section 01 35 45 Refrigerant Compliance is included at the end of this document for additional reference.

1.04 All projects requiring process refrigeration systems that require program temperature tolerances below ±4°F shall have an independent programming session to discuss and document the required operating parameters of the system(s). A questionnaire is available to be used as a guide to facilitate these discussions.

1.05 All refrigeration equipment submittals shall be forwarded to Facilities Engineering for review by an engineer and by a designated representative of the Facilities Management Air Conditioning and Refrigeration Trade Shop.

1.06 The Construction Contract Documents shall require a cost alternate price breakout for the provision of refrigeration equipment. The intent of this alternate cost is to provide an opportunity for the Cornell University project manager to source the refrigeration work directly and competitively to the Cornell University Facilities Management Refrigeration Shop.

1.07 All refrigeration work shall be done by EPA Section 608 certified refrigeration technicians. The Construction Contract Documents shall include wording requiring the Contractor to provide to the Owner a list of all service technicians with EPA certification numbers and level of certification. If the project includes work on refrigeration systems containing R-410a, the service technician must also have completed the supplemental R-410a safety technician certification. Copies of the EPA certification cards shall be submitted for those who will be working on the site prior to commencement of any refrigeration work.
1.08 All refrigeration equipment and associated appurtenances shall be designed, installed, and operated in accordance with the following:


B. United States Code (USC) Title 42, Chapter 85 Air Pollution Prevention and Control Subchapter VI Stratospheric Ozone Protection (Environmental Protection Agency Clean Air Act)

C. New York Chemical Bulk Storage (NY CBS) 6 NYCRR Part 595: Releases of Hazardous Substances


F. ANSI/ASHRAE 134-2005: Ventilating, Air Conditioning and Refrigerating Systems


I. ASHRAE Handbooks

J. New York State Building Codes

1.09 The following requirements shall augment the requirements listed in ASHRAE Standard 15–2010:

A. Leak Detection: For mechanical rooms that are required to be classified as refrigerating machinery rooms per the Standard, the design of the leak detection system shall be submitted to Facilities Engineering for review and approval. In addition to the requirements mandated by the Standard, an alarm output shall be provided with the leak detection system for connection and annunciation to the Building Automation and Control System.

B. Maintenance: Refrigeration systems shall be designed with consideration for maintenance ergonomics. Locating equipment in confined spaces, such as crawl spaces, shall be avoided. Instead, equipment shall be mounted to facilitate maintenance efforts to reduce maintenance costs and risk for injury.
C. Refrigerator Heat Rejection:

1. In the design of new facilities, a dedicated space shall be considered for refrigerated storage needs. Fan coil units or a dedicated process chilled water loop (with plate and frame heat exchanger that separates the loop from the main campus chilled water system) are the preferred methods for removing rejected heat energy.

2. In existing facilities, both existing process chilled water (separated from the campus loop with a plate and frame heat exchanger) and building air systems can be considered for heat rejection of the equipment. The capabilities of the system must be shown to provide sufficient heat rejection for the local load conditions.

D. Refrigerator Power: Emergency power requirements shall be established prior to installation. Critical long-term storage shall be provided with liquid nitrogen backup and/or emergency backup power. At a minimum, a dedicated power supply shall be provided for ultra-low temperature freezers.

1.10 RECORD DOCUMENTS

A. A complete control diagram and wiring connection diagram shall be permanently affixed to the inside of the compressor control cabinet and included in the Building Operating and Maintenance Manual. It shall include a material list of all refrigeration system control components and building automation control system interfaces for external control, system alarming, and monitoring.

B. A complete and separate refrigeration system schematic shall be provided, including a material list of all refrigeration components with part name, manufacturer, and part number clearly indicated. All refrigerant line sizes shall be indicated.

C. The Contractor shall provide complete equipment documentation for each piece of equipment containing refrigerants, including the following information:

1. Equipment ID tag number
2. Equipment location (Room number)
3. Date of installation / acceptance (for warranty)
4. Name of EPA certified technician
5. Technician certification level, with copy of certification card
6. Type of equipment
7. Equipment manufacturer, model number, serial number
8. Type of refrigerant
9. Actual system charge, per circuit (in pounds)
D. The Contractor shall also provide a copy of complete manifests, invoices, or other documentation demonstrating that any refrigerant removed from the project by the Contractor was disposed of appropriately or reclaimed by an EPA-certified Reclaimer.

PART 2: PRODUCTS

2.01 REFRIGERANT AND REFRIGERANT ACCESSORIES

A. Liquid line filter-dryers and moisture indicator (sight glass) shall be included in all systems. All filter connections are to be soldered and a full line size bypass with isolation valves shall be installed.

B. Thermal expansion valve systems are preferred over capillary tubes for field-assembled systems.

C. A receiver shall be provided for refrigerant on all pump-down systems.

D. New refrigeration systems shall not use chlorofluorocarbon (CFC) refrigerants. The use of hydrochlorofluorocarbon (HCFC) refrigerants shall be limited to installations where no other commercial alternative exists. It is also preferred to avoid the use of R-407C.

E. Capillary tubing associated with sensing lines shall be provided with silicon vibration damping at all coiled excess locations. Provide silicone damping on two sides of each coil.

F. On all centrifugal or screw chillers, provide a pump-out unit and receiver for refrigerant charge transfer and storage.

G. When a rupture disc is required, it shall always have a relief valve with sniffer connection downstream such as the Henry Technologies “Sentry” Rupture Disc Assembly. The assembly shall have an extra port available to allow the installation of a pressure switch that shall be installed to alarm upon a refrigerant release, which shall alarm to the Building Automation and Control System (BACS). Please contact Facilities Engineering for further direction if the facility does not have a BACS.

2.02 CONTROLS

A. Systems that operate all year shall be provided with automatic control components or system design to prevent liquid refrigerant slugging and associated compressor failures. On systems having reciprocating compressors, pump down systems are preferred with short cycle control monitoring.
B. All new process (built up) refrigeration systems shall be provided with high and low pressure safety cutout switches. The high-pressure switch shall not reset automatically, and the status shall be integrated into the campus Building Automation and Control System for alarm monitoring.

C. All compressor start circuits shall have an adjustable, solid-state time delay to prevent compressor short cycling.

D. All hot gas bypass, head pressure and suction pressure controls, or evaporator pressure regulator designs must be approved by Facilities Engineering.

E. Low Ambient Temperature Controls shall be provided on all systems with condensers or condensing units located outdoors requiring year around operation.

F. Controls for environmental chambers with a temperature tolerance of ± 0.9°F (± 0.5°C) shall have a constant run operation that includes hot gas bypass with de-superheat, hot gas injection or compressor unloading. For chambers with a less strict tolerance requirement, a constant run operation shall also be included; however, for maximum flexibility and to minimize energy consumption, the system shall be provided with the capability to allow the system to switch from constant run to a duty-cycle operation that would include a pump down or cycle off controls.

2.03 COMPRESSORS

A. Compressor type shall be selected with careful consideration of the refrigeration system application.

1. Field Assembled Systems: Scroll compressors are preferred for field-assembled systems such as walk-in cooler and environmental growth chambers applications. In existing facilities, provide new compressors and associated components to match the existing equipment and facilitate maintenance using the established parts inventories.

2.04 CONDENSERS

A. Indoor air-cooled condensing units should be remotely located in a mechanical room space that is ventilated with outside air (provides heat in winter and is inexpensively ventilated all year).

B. Heat rejection for refrigeration systems should be accomplished in the most economically efficient manner possible, subject to local constraints, physical limitations, and life cycle costs. Lowest first cost should not dictate the method by which refrigeration systems are applied. Where chilled water is readily available, it can be used for heat rejection; however, an isolation plate and frame heat exchanger must be installed to prevent condenser fouling. Multiple refrigeration installations may be the best candidates for this type of application. Single pass, domestic water-cooled installations shall not be installed.
C. If chilled water is used, a back-up domestic water-cooling system with removable spool pieces and backflow preventers on the domestic water are acceptable for critical applications.

2.05 PIPING & JOINTS

A. Piping material shall be ASTM B280, Type ACR, nitrogenized, clean, dry and capped. Soft copper can be used with approval from Facilities Engineering.

B. Joints shall be ASME B16.22 wrought-copper, with silver brazing alloy as follows:

1. Copper to copper joints shall be brazed with a copper-phosphorous brazing alloy containing a minimum of 15% silver and conforming to AWS A5.8, BCuP5 (15% Ag, 80% Cu, 5% P).

2. Dissimilar metals shall be brazed with a silver brazing alloy containing a minimum of 45% silver and conforming to AWS 5.8, BAg-5 (45% Ag, 30% Cu, 25% Zn).

C. 90˚ fittings shall be of the long radius type. Close Ruff or Street elbows are not permitted on any installation.

D. All pipe sizes and routings shall be clearly shown on the mechanical drawings. All trap locations and reduced suction risers, when required, shall be clearly denoted.

E. All coil connections shall be shown as part of a system refrigerant flow diagram or as a separate detail.

F. Systems requiring field run piping shall have a system refrigerant flow diagram.

PART 3: INSTALLATION

3.01 PIPING

A. Refrigeration systems shall be installed per manufacturer’s recommended instructions.

B. All refrigerant lines must be supported by strut channel hangers and supports. All liquid and suction lines must be clamped securely to the strut channel. All discharge piping to and from remote air cooled condensers shall also be clamped per manufacturer’s recommendations to minimize vibrations. Clamp assemblies shall be refrigeration cushion clamps (for example, Hydra-Zorb).
C. Refrigeration lines shall be installed in accordance with MSS SP-69, with the following recommended spacing:

<table>
<thead>
<tr>
<th>LINE SIZE</th>
<th>MAXIMUM SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8 OD &amp; smaller</td>
<td>5'</td>
</tr>
<tr>
<td>1-1/8 OD</td>
<td>6'</td>
</tr>
<tr>
<td>1-3/8 OD</td>
<td>7'</td>
</tr>
<tr>
<td>1-5/8, 2-1/8 OD</td>
<td>8'</td>
</tr>
<tr>
<td>2-5/8 OD</td>
<td>9'</td>
</tr>
<tr>
<td>3-1/8 OD</td>
<td>10'</td>
</tr>
</tbody>
</table>

D. A piping support shall be installed within 12-inches of each horizontal elbow and equipment connection.

E. When installing components such as vibration eliminators, ball valves, etc., the manufacturer’s instructions for brazing or soldering must be followed (wrapping device in wet cloth, etc.). A nitrogen purge shall be used at all times during brazing or soldering to prevent oxidation on the inside of the tubing.

F. Joints in non-accessible areas shall be minimized. An inspection panel shall be provided at all joint locations unless otherwise approved by Facilities Engineering.

G. Quick connect couplings are not allowed.

H. Service ports caps shall be hex. Thumb caps are unacceptable.

3.02 LEAK TESTING

A. The high side and low side of each completed refrigeration piping system shall be pressure tested at a pressure not less than the lower of the system design pressures, or the setting of the pressure relief device protecting the high side or low side of the system.

B. The testing media shall be dry nitrogen. The Contractor shall perform the leak test before insulating, evacuating and charging, in the presence of a representative from the Cornell University Facilities Management Air Conditioning and Refrigeration Trade Shop.

C. Isolate the compressor from the leak test by firmly closing the suction and discharge valves.

D. Where pressure relief valves are installed, position the three-way dual shut-off valves so that full test pressure is applied to both relief valves.

E. Do not attempt to repair any leak while the system is pressurized. If any leaks are found, relieve the test pressure and perform repairs, and then recharge the system.
F. Once system is charged, make note of the ambient temperature and then allow the system to remain under pressure for 24 hours. The maximum pressure drop shall be 5 psig in 24 hours, at constant ambient temperature. For every 10 °F drop in ambient temperature from the start of the test, the maximum pressure drop may decrease by 3 psig.

G. Leak testing shall be performed in the presence of a representative from the Cornell University Facilities Management Air Conditioning and Refrigeration Trade Shop. Sign off on acceptance of leak testing is required before commencing evacuation and charging of the system.

3.03 EVACUATION AND CHARGING

A. After completion of the piping pressure test, the refrigeration system shall be evacuated and dehydrated with a vacuum pump. The following procedure shall be used unless otherwise recommended:

1. Connect an accurate high vacuum gauge to the system. The gauge shall have a range of 0-1000 microns Hg.

2. Connect a vacuum pump to both the high and low side of the system. Leave the compressor suction and discharge service valves closed. Start the vacuum pump.

3. Operate the vacuum pump until the system is evacuated to 500 microns Hg.

4. Break the system vacuum with dry nitrogen. Open the compressor suction and discharge services valve and re-evacuate the system to 500 microns Hg.

5. After the system has been twice evacuated to 500 microns Hg, close the vacuum pump suction valve and stop the pump. Allow the system to stand under a vacuum for a minimum of 30 minutes. If no rise in pressure has taken place after 30 minutes, the system may be charged.

6. Unless more stringent requirements are recommended by the manufacturer, refrigerant shall be charged in strict accordance with 40 CFR, Part 82. The Contractor shall provide a full charge of refrigerant required to develop the system to its full rating. Cylinders shall be weighed as necessary so that an accurate check of system charge can be recorded for each system. This record should be turned over to the Cornell University Facilities Management Air Conditioning and Refrigeration Trade Shop for inclusion in the refrigerant compliance database.

7. During the warranty period, the Contractor shall replace, at no cost to the University, all refrigerant lost due to equipment failure or system leaks.
8. The Contractor shall provide the initial charge of lubricating oil for all refrigeration equipment and related apparatus.

9. Evacuation and charging shall be performed in the presence of a representative from the Cornell University Facilities Management Air Conditioning and Refrigeration Trade Shop. Sign off on acceptance of evacuation and charging is required.

3.04 VIBRATION ISOLATION

A. Manufacturer’s recommendations shall be followed in all cases.

B. All vibration eliminators shall be installed parallel to the compressor crankshaft.

3.05 START-UP AND CHECK-OUT

A. In addition to the manufacturer’s recommended start-up procedures, the following parameters are to be recorded once the system is stabilized. These readings are to be turned over to an authorized representative of Cornell and included in the Operation and Maintenance Manual when start-up is completed.

1. Compressor voltage (all phases)
2. Compressor current (all phases)
3. Compressor suction pressure/temperature (and superheat)
4. Compressor discharge pressure/temperature
5. Evaporator coil suction superheat (not to exceed 10°F)
6. Outside air temperature

B. Final acceptance will only be made after inspection by Cornell authorized representatives from Facilities Engineering and the Facilities Management Air Conditioning and Refrigeration Trade Shop.

C. All filter-driers and replaceable core filter elements shall be replaced by the Contractor thirty (30) days after system start-up.

3.06 REFRIGERANT PIPING INSULATION

A. It is preferred to insulate refrigeration piping with pre-formed tubular expanded closed-cell elastomeric insulation, with a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E84. Insulation thickness shall be a minimum of 1-inch thick, and shall be adhered to 100% of the pipe surface.

B. Refrigerant suction piping is required to be insulated in its entirety, including all accessories that are a part of the refrigerant suction piping (for example, valves, vibration isolators, P-traps and filters).
C. Refrigerant hot gas bypass piping is required to be insulated in its entirety.

D. Insulation must be of the proper size for the piping that it is to be installed on.
   1. Insulation installed on horizontal runs of refrigerant piping will require that an insulation protection shield be installed between the insulation and the pipe hanger.
   2. All seams and joints in the insulation will be required to be sealed with the proper adhesive, for the product being used, to provide a continuous vapor barrier.
   3. Piping clamps that are in contact with the suction line are required to be covered with insulation.
   4. Insulated piping that passes through a wall is required to be protected in a piping sleeve.
   5. All thermostatic expansion valve sensor bulbs are required to be covered with insulation.

E. Insulation that will be exposed to the weather or direct sunlight (for example, within greenhouses) shall be protected with one of the following materials:
   1. Installation of a vinyl covering.
   2. Installation of an aluminum jacket. Jacketing shall be installed using banding or adhesive; use of screws is not acceptable.
   3. Application of a water based latex enamel finish as recommended by the insulation manufacturer that is anti-microbial, resistant to mold and mildew, and UV resistant.

END OF SECTION
PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall be responsible and accountable for compliance with the EPA Clean Air Act (CAA) Section 608, 40 CFR Part 82 and any state or local codes for all refrigerant-related work. In general, an EPA-certified technician shall perform any activity involving refrigerant-containing equipment that includes: (1) attaching and detaching hoses and gauges to and from refrigerant containing equipment to measure pressure; (2) adding refrigerant to, or removing refrigerant from equipment; or (3) any other activity that violates the integrity of a refrigerant containing circuit (for example any activity where a refrigerant containing circuit is ‘opened’ in any manner).

B. Refrigerant and oil shall be recovered from any equipment that does not meet the definition of a small appliance in 40CFR Part 82 Subpart F before removal and subsequent disposal. Small appliances (as defined in 40CFR Part 82 Subpart F) may be removed from the site with the charge (refrigerant) intact, provided it is properly labeled and handled in such a manner so as to prevent damage to coils. Small Appliances are defined in 40CFR Part 82 Subpart F as: Any appliance that is fully manufactured, charged, and hermetically sealed in a factory with five (5) pounds or less of a Class I or Class II substance used as a refrigerant, including, but not limited to, refrigerators and freezers (designed for home, commercial, or consumer use), medical or industrial research refrigeration equipment, room air conditioners (including window air conditioners and packaged terminal air heat pumps), dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

C. All new equipment installed shall utilize non-CFC refrigerants.

1.2 SUBMITTALS

A. Prior to starting construction, demolition, or service work Contractor shall provide to Owner a list of all service technicians with EPA certification numbers and level of certification. (Copies of EPA certification cards are acceptable for those who will be working on the site.)

1.3 RECORD DOCUMENTS

A. Contractor shall provide to the Owners Representative all Service Invoices (or equivalent service documentation acceptable to owner) for all work performed by EPA-certified Technicians. Service Invoices (or equivalent documentation) shall include the following information at a minimum for each piece of refrigerant containing equipment serviced:

- Date of Service
- Name of EPA-Certified Technician
- Technicians Certification Level
- Type of Equipment Serviced
- Equipment Manufacture
- Equipment Model and Serial Number
• Description of Service Performed
• Date Leak Discovered (if applicable)
• Date Leak Repaired (if applicable)
• Date Follow-Up Leak Test Performed (if applicable)
• Type of Refrigerant
• Normal System Full Charge (in pounds)
• Amount of Initial Refrigerant Charge Recovered During Service
• Amount of Recovered Refrigerant Returned to System
• Type of Additional Refrigerant Added to System
• Amount of Additional Refrigerant Charged to System
• System Charge at End of Service

B. Contractor shall provide to Cornell’s Environmental Health and Safety Office and Air Conditioning & Refrigeration (ACR) Shop, via the Owner’s Representative, complete equipment documentation including: make, model number, serial number, refrigerant type and full refrigerant charge (quantity), equipment ID tag number and location (room number) for all equipment installed that does not meet the definition of a small appliance (40CFR Part 82).

C. Contractor shall provide Owners Representative a copy of complete manifests, invoices, or other documentation showing any refrigerant removed from the project by the contractor was disposed of appropriately or reclaimed by an EPA-certified Reclaimer.

PART 2 – PRODUCTS – NOT USED

PART 3 – EXECUTION

3.1 LEAK TESTING

A. All new equipment not meeting the definition of a small appliance, including packaged equipment, factory charged, field charged, split systems or field-constructed systems with field-installed refrigerant piping shall be leak tested prior to or during startup. Leak testing shall utilize appropriate electronic leak-testing equipment.

B. Leak testing shall be conducted by an EPA-certified technician. The contractor shall provide written verification of the leak testing and results.

C. If a leak is detected, the following procedure shall be followed:

1. Notify the Owner’s Site Representative (who will notify the Refrigerant Compliance Coordinator).
2. Document the leak.
3. Repair the leak.
4. Document the procedures followed.
5. Leak test to verify the leak was repaired.

6. Schedule and provide a 30-day follow-up verification leak test witnessed by a designated HVAC technician.

7. Document follow-up leak testing.

8. Repeat the above process if follow-up leak is detected.

3.2 DEMOLITION PROCEDURE FOR EQUIPMENT REMOVED BY CONTRACTOR

A. The Contractor, in contractor-provided refrigerant recovery cylinders, shall take ownership of the recovered refrigerant and transport off site to a proper disposal company or certified reclamer.

B. Service Invoices, as described in RECORD DOCUMENTS, shall be provided.

C. The Contractor technician shall tag the unit that the refrigerant was removed.

D. Once an EPA-certified technician has removed the refrigerant and tagged the unit, a non-certified person may perform the remainder of the demolition.

***END OF SECTION 01 35 45***