SECTION 23 23 00
REFRIGERANT PIPING AND ACCESSORIES

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work of this Section shall include, but is not limited to, the following:

1. Refrigerant piping
2. Fittings
3. Jointing materials
4. Unions and couplings
5. Valves, filter driers, gaskets, sight glass/moisture indicators
6. Flanges and flange gaskets
7. Brazing and jointing procedures
8. Cleaning of piping systems
9. Testing of piping systems

1.02 RELATED DOCUMENTS

A. Section 23 05 01 – HVAC General Provisions

B. Section 23 05 16 – Expansion Fittings and Loops for HVAC Piping

C. Section 23 05 19 - Meters, Gauges and Thermometers for HVAC

D. Section 23 05 29 – Hangers and Supports for HVAC

E. Section 23 05 48 – Vibration and Seismic Controls for HVAC

F. Section 23 05 53 – Systems Identification for HVAC

G. Section 23 07 00 – Insulation for HVAC

H. Section 23 81 26 – Split-System Air Conditioners

I. Section 23 81 29 – Multiple Evaporator DX Variable Capacity Split Systems

1.03 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

A. AHRI – Air Conditioning and Refrigeration Institute

B. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers

1. ASHRAE Std 15-2016 Safety Standard for Refrigeration Systems

C. ASME – American Society of Mechanical Engineers

1. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings

2.	ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
3.	ASME B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
4.	ASME B16.24	Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
5.	ASME B31.5	Refrigeration Piping and Heat Transfer Components

D. ASTM – American Society for Testing and Materials

1.	ASTM B32-08(2014)	Standard Specification for Solder Metal
2.	ASTM B88-16	Standard Specification for Seamless Copper Water Tube
3.	ASTM B280-16	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
4.	ASTM B813-16	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
5.	ASTM B828-16	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
6.	ASTM C534/C534M-16	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
7.	ASTM D1330-04(2015)e1	Standard Specification for Rubber Sheet Gaskets
8.	ASTM E84-17a	Standard Test Method for Surface Burning Characteristics of Building Materials
9.	ASTM E243-13	Standard Practice for Electromagnetic (Eddy Current) Examination of Copper and Copper-Alloy Tubes

E. AWS – American Welding Society

1.	AWS A5.8M/A5.8	Specification for Filler Metals for Brazing and Braze Welding
2.	AWS C3.4M/C3.4	Specification for Torch Brazing

F. ISO – International Organization for Standardization

1.	ISO 9001	Quality Management Systems

G. EU – European Union

1. EU Pressure Equipment Directive 2014/68/EU

1.04 QUALITY ASSURANCE

A. Comply with the applicable provisions and recommendations of the standards and codes listed in Paragraph 1.03 and the requirements of the listed related documents.

B. Brazing materials and labor to conform to ASME Code and applicable state Labor Regulations.

C. All brazers shall be certified by ANSI/ASME B31.1 Power Piping, ANSI/ASME 31.9 Building Services Piping or Qualification Tests in Section IX of the ASME Boiler and Pressure Vessel Code: Welding and Brazing Qualifications.

D. Each length of pipe, fitting, trap, fixture or device used in any piping system shall be stamped or indelibly marked with type, weight, quality and manufacturer's name or mark.

E. Provide 10 year warranty on insulation provided as part of a pre-insulated lineset.

1.05 SUBMITTALS

A. Submit the following for review:

1. Product data: Submit manufacturer's latest information on construction details, rated capacity data, operating characteristics and installation data.
2. Submit, for all equipment provided under this Section, dimensions, and accessories specific to this project that clearly differentiates between manufacturer-installed and field-installed wiring and location and size of all required field connections.
3. Submit manufacturer's installation instructions and parts list specific to this project, accessories and maintenance data.
4. Submit schedule indicating the ANSI, ASME, ASTM, Standard Specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
5. Submit ISO 9001 certifications where required by specifications.
6. Submit shop drawings indicating anchoring details, anchor points, guide details, etc.
7. Submit dimensioned drawings locating pipe penetrations through walls, slabs and other structural elements, anchor and guide locations, etc.
8. Submit pipe expansion and flexibility calculations.
9. Submit test reports on all systems tested. Tests required by Authorities Having Jurisdiction over the work shall be submitted on appropriate forms to the satisfaction of such authorities.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Copper tube: Mueller Industries, Cerro, or approved equal

B. Copper tube linesets: Mueller Industries, Cerro, or approved equal

C. Brazing fittings: Mueller Industries, Cerro, or approved equal

D. Valves: Mueller Industries, Parker, Henry, or approved equal

E. Filter driers: Mueller Industries, Parker, Henry, or approved equal

F. Sight glass/moisture indicators: Mueller Industries, Emerson, or approved equal

G. Flange gaskets: Mueller Industries, Cerro, or approved equal

H. Solders: Silverflo by Canfield, Stay-Safe Bridgit by Harris, or approved equal

I. Brazing materials: Safety-Silv 45 by Harris, Sil Can 45 by Canfield, or approved equal

J. Testing of piping systems: American Gas & Chemicals Leak-Tec 372G, Parker Virginia

Gas Leak Locator

2.02 SCHEDULE OF PIPING SYSTEMS

Service	Material	Type	Weight
Refrigerant (up to3/4 inch)	Copper tube	ACR	Hard, capped and nitrogen filled
Refrigerant (3/4 inch to 4 inch)	Copper tube	Type K	Hard
Refrigerant line sets	Copper	Soft anneal	--

2.03 SCHEDULE OF PIPING FITTINGS

Service	Size	Material	Type	Weight
Refrigerant	Up to 3/4 inch	Wrought copper	Silver solder, copper-phosphorus alloy	Standard
Refrigerant	3/4 inch to 4 inch	Wrought copper	Brazed	Standard

2.04 HARD PIPE

A. Copper tubing, ASTM B88 or ASTM B280 (ACR):

1. Wrought copper, soldered or brazed joint fittings, ASME B16.22, in sizes available with AWS A5.8/A5.8M or ASTM B32 filler metals per Article 2.4, C.
2. Cast bronze solder-joint fittings, ASME B16.18, only in sizes not available in wrought copper.
3. Cast bronze, flanged unions, ASME B16.24, 150 pounds per square inch class, 2.5 inches and larger.
4. Copper tubing flared fittings: Bronze castings for flared type joints, ASME B16.26.
5. Refrigerant piping shall be cleaned, dehydrated and capped by the piping manufacturer.

2.05 JOINT MATERIALS

A. Solder filler metals: ASTM B32, lead-free silver bearing alloys. Include water-flushable flux according to ASTM B813.

1. Nominal solder composition:

a. Silver: 0.05 to 0.15 percent
b. Copper: 2.5 to 3.5 percent
c. Nickel: 0.05- 2.0 percent
d. Antimony: 4.5- 5.5 percent
e. Balance of material: tin

2. Mechanical properties of bulk solder:

a. Solidus: 460 degrees F
b. Liquidus: 630 degrees F

c. Elongation: 48 percent
d. Tensile strength (Cu to Cu): 14,000 psi
e. Color: bright silver

B. Brazing alloy: AWS A5.8/A5.8M, Bag-5, silver alloy for refrigerant piping, unless otherwise indicated.

1. Nominal brazing alloy composition:

a. Copper 30 percent
b. Zinc: 25 percent
c. Silver: 45 percent

2. Mechanical properties of brazing alloy:

a. Solidus: 1,225 degrees F
b. Liquidus: 1,370 degrees F
c. Fluidity rating: 6.5
d. Color: silver to light yellow

2.06 PIPING LINESETS

A. Copper Tubing, ASTM B88: UL listed for 700 psi at 250 degrees F using R410A.

B. Linesets shall be available in continuous lengths from 10 to 100 feet in single or dual pipe configuration.

C. Linesets shall be factory purged with dry nitrogen and capped to ensure a clean and non-oxidized tube prior to installation.

D. Insulation: ASTM C-534 & ASTM E-84 fire & smoke rating. Insulation shall be flexible in all thicknesses and consist of closed cell elastomeric foam that is resistant to mold & mildew and contain a UV retardant to minimize ultraviolet degradation.

2.07 VALVES

A. Ball valves:

1. Maximum abnormal pressure: 775 psig
2. Continuous operating temperature: minus 40 to 300 degrees F
3. Compatible with all CFC, HCFC and HFC refrigerants and oils
4. Full port construction to match line size ID
5. Internally equalized ball design
6. Rupture-proof encapsulated stem

B. Packless diaphragm valves:

1. Maximum abnormal pressure with forward flow: 700 psig
2. Maximum abnormal pressure with reverse flow: 300 psig,
3. Continuous operating temperature: minus 40 to 300 degrees F
4. Compatible with all CFC, HCFC and HFC refrigerants and oils
5. UL recognized, conforms to PED 97/23/EC
6. Forged brass body with full size openings for maximum flow and minimum

pressure drop
7. Diaphragms for positive isolation
8. Thermally stable handwheel for operation in wide temperature ranges

C. Pressure relief valves (PRVs):

1. PRVs shall be designed to reseat after discharge. Relief valves shall operate automatically when the system pressure exceeds the valve set pressure and exerts a force on the valve disc that overcomes the opposing internal spring force.
2. Selection of a relief valve shall be based on the discharge capacity required for the system or vessel, based on the size of the equipment and the refrigerant being used. Minimum settings for valves shall be at least 25 percent above the designed maximum operating pressure, with additional consideration for high ambient temperatures. Sizing valves to the maximum allowable setting shall minimize the possibility of seepage or early discharge.
3. If allowed by local codes, valves may open with allowable tolerances within a 3 percent range of stamped set pressure, with full discharge capacity realized at 10 percent above the actual opening pressure.
4. Relief valves shall conform to the ANSI/SHARAE 15, and designed and manufactured in accordance with ASME Section VIII Division I. Certified specific capacities shall be identified by the ASME and National Board NB stamps on each valve. The valves shall comply with European Union Pressure Equipment Directive (PED 97/23/EC), and exhibit the appropriate EC marking and identification number.
5. Continuous operating temperature: minus 40 to 300 degrees F
6. Compatible with all CFC, HCFC and HFC refrigerants and oils

D. Check valves:

1. Maximum abnormal pressure: 700 psig
2. Continuous operating temperature: minus 40 to 300 degrees F
3. Pressure to open: less than 1 psi
4. Compatible with all CFC, HCFC and HFC refrigerants and oils
5. UL recognized, conforms to PED 97/23/EC
6. Neoprene seat for positive isolation and pulsation dampening
7. Designed for maximum flow and minimum pressure drop

2.08 FILTER DRIERS

A. Liquid line:

1. Maximum abnormal pressure: 700 psig
2. Maximum working temperature: 160 degrees F
3. Compatible with all CFC, HCFC and HFC refrigerants and oils, and refrigerants requiring XH-11 desiccant
4. UL/cUL Listed, conforms to Pressure Equipment Directive 97/23/EC
5. Solid core design
6. High retention filter for removal of particulate as small as 25 microns
7. High pressure shell and connections
8. Powder paint finish
9. 100 percent copper connection for solder models

B. Suction line:

1. Maximum abnormal pressure: 508 psig
2. Maximum working temperature: 160 degrees F
3. Compatible with all CFC, HCFC and HFC refrigerants and oils, and refrigerants requiring XH-11 desiccant
4. UL/cUL Listed, conforms to Pressure Equipment Directive 97/23/EC
5. Solid core design, composed of 70 percent activated alumina/ 30 percent molecular sieves for moisture and acid removal
6. High retention filter for removal of particulate as small as 25 microns
7. High pressure shell and connections
8. Powder paint finish approved for marine applications

C. Replaceable core shells:

1. For use in liquid and suction lines
2. Compatible with all fluorinated refrigerants
3. Powder coat withstands 500 hour salt spray per ASTM B 117
4. Pressure rating of 775 psi
5. UL listed and CE certified
6. RoHS compliant
7. Slotted aluminum lid for ease of assembly
8. Stainless steel bolts and brass plug
9. O-ring seal for ease of assembly and removal
10. Replacement o-ring and carriage kits available
11. Maximum working temperature: 160 degrees F

2.09 SIGHT GLASS/ MOISTURE INDICATORS

A. Hermetically sealed:

1. Maximum abnormal pressure:
2. Continuous operating temperature: minus 40 to 185 degrees F
3. Compatible with all CFC, HCFC and HFC refrigerants and oils
4. UL recognized, conforms to Pressure Equipment Directive 97/23/EC
5. Solid brass construction, hermetically sealed
6. Design for maximum flow and minimum pressure drop
7. Large viewing window and indicator for better visibility
8. Provide accurate identification of system conditions

B. Replaceable Element

1. Maximum abnormal pressure: 700 psi
2. Continuous operating temperature: minus 40 to 185 degrees F
3. Compatible with all CFC, HCFC and HFC refrigerants and oils
4. UL recognized, conforms to Pressure Equipment Directive 97/23/EC
5. Copper construction
6. Design for maximum flow and minimum pressure drop
7. Large viewing window and indicator for better visibility
8. Provide accurate identification of system conditions

PART 3 – EXECUTION

3.01 SYSTEMS INSTALLATION

1. Clean, dehydrate, and cap refrigerant piping. Ensure that entire system is clean and dry during installation. Clean tubing by means of swab saturated in methyl alcohol. Draw through tubing as many times as necessary to thoroughly clean and dry interior of tubing and to eliminate formation of copper oxide.
2. Before refrigerant lines are silver brazed, flush all air from tubing and pass slow-running stream of dry nitrogen through system during brazing process. Purge lines completely and maintain nitrogen flow at steady rate of not less than three cubic feet per hour.
3. Refrigeration piping shall be installed in accordance with the requirements of AHRI (ARI), ASHRAE and ASTM.
4. All solder joints shall be ASTM Grade 4 or 5 and have a melting point of approximately 1,250 degrees F. Solder impurities shall not exceed 0.15 percent. Tubing shall be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before soldering. Avoid prolonged heating and burning during soldering. Purge all lines with nitrogen during soldering. Provide manual shut-off and check valves as required. After brazing, interior of refrigerant lines must be clean and bright.

B. Any joints showing evidence of overheating, cracking, poor penetration, or other defects of fit-up or workmanship shall be replaced at the Contractor's expense.

1. Comply with EPA regulations (40 CFR Part 82, Subpart F) under Section 608 of the Clean Air Act. No refrigerant shall be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.
2. Install core in filter dryer after leak test but before evacuation.
3. Evacuate refrigerant system with vacuum pump until temperature of 35 degrees F is indicated on vacuum dehydration indicator.
4. During evacuation, apply heat to pockets, elbows, and low spots in piping.
5. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
6. Break vacuum with refrigerant gas; allow pressure to build up to 2 psi.
7. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.
8. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
9. Slope refrigerant piping as follows

    a. Install horizontal hot gas discharge piping with ½-inch per 10 feet downward slope away from the compressor.
    b. Install horizontal suction lines with ½-inch per 10 feet downward slope to the compressor, with no long traps or dead ends that may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
    c. Liquid lines may be installed level.

10. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
11. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect

refrigerant piping system components.

12. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.
13. Install moisture/liquid indicators in lines larger than 2⅛ inch OD, using a bypass line.
14. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.
15. Install flexible connectors at the inlet and discharge connection of compressors.

3.02 FIELD QUALITY CONTROL

A. General:

1. Any deviation from the cleaning, installation, testing, and certification requirements herein shall be approved in writing by the Architect.
2. All materials and workmanship shall be subject to inspection and examination by the Architect at any place where fabrication or erection occurs.
3. The Architect reserves the right to reject all or any part of the system that does not conform to the requirements herein. Rejected materials or equipment shall be returned at the Contractor's expense for re-cleaning and certification.
4. The Architect reserves the right to remove random samples of the installed work sufficient to establish the quality of materials and workmanship. If such samples indicate materials and workmanship do not meet the contract specification, the Contractor shall be required to replace or re-clean the installed work at no expense to the Owner. The Owner shall reimburse the Contractor on a time and materials basis for such work if the system proves to be installed to specification.
5. All testing shall be done in the presence of the Owner's Representative.
6. Upon completion of this work, all systems shall be adjusted for use. Should any piece of apparatus or any material or work fail in any of the required pressure tests, it shall be immediately removed and replaced by new materials. The defective portion of the work shall be replaced by new materials. The defective portion of the work shall be replaced by the Contractor in the presence of the Owner at no expense to the Owner.
7. Test gauges shall be installed and test medium source connections shall be made to convenient process connections. After completion of testing, the gauges and source connection shall be removed and the specified process attachments replaced.

B. Leak test refrigerant piping systems by charging to a pressure of 10 psig with an HFC refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 300 psig with dry nitrogen. Rap all joints with a mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

C. After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1,500 microns while the system ambient temperature is above 60 degrees F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two hours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.

D. Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant in the system. If refrigerant is added to the system through the suction side of the compressor, charge in vapor form only.

1. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

E. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

1. Inspections performed
2. Procedures, materials, and gases used
3. Test methods used
4. Results of tests

END OF SECTION 23 23 00