SECTION 23 2300

REFRIGERANT PIPING

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LANL MASTER SPECIFICATION SECTION

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| Rev. 6 Summary of changes  Updated description in Article *Section Includes*. Added references to new NDE specification throughout section. Revamped Submittal requirements to standardize across piping specifications. Clarified when unlisted component evaluations are required in submittal space. Updated designer notes to provide additional useful information to designers. Significant revisions to Articles *Refrigerant Piping* and *Piping Fittings* to provide more accurate information in Part 2. Added Article *Seismic Performance Requirements* in Part 2. Clarified the use of approved alternatives for ASME B31.5 para. 538.4.3 Leak Testing in Article *Examination, Inspection and Testing*. Updated Part 3 to standardize across other piping sections and other minor editorial updates. |

Word file at <http://engstandards.lanl.gov>

This template was developed to meet the requirements for ASME B31.5-2022. Use with a different edition requires a detailed review of the code and ESM Chapter 17.

The designer is encouraged to review the ESM Chapters 6, 13, and 17.

This template must be edited for each project.  In doing so, specifier must add job-specific requirements.  Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  This section must also be edited to delete requirements for processes, items, or designs that are not included in the project—and specifier’s notes such as these.  To seek a variance from or alternate method to requirements in the section that are applicable, contact the ESM Mechanical [POC](http://engstandards.lanl.gov/POCs.shtml#mech) and/or Pressure Safety [POC](https://engstandards.lanl.gov/POCs.shtml#pressure). Please contact POCs with suggestions for improvement as well.

This specification does not address buried piping. It is strongly discouraged to bury refrigerant piping. It is the responsibility of the Designer to include provisions for corrosion control of buried piping if necessary. Consult other Sections such as 23 2113 *Hydronic Piping* for template information on buried piping.

Seismic: In order to edit this section for job-specific seismic requirements, refer to author notes that begin with “Seismic.” Also, see the flowchart and Seismic Specification Guide for Mechanical (posted on LANL specs [webpage](http://engstandards.lanl.gov/specs.shtml#40)) for guidance on properly editing this section.

When assembling a specification package, include applicable sections from all Divisions, especially Division 1, General Requirements.

This template was developed for ML-4 projects.  For ML-1, 2, and 3 applications, additional requirements might be necessary if increased confidence in procurement or execution is desired, and independent review is necessary. See ESM Chapter 1 Section Z10 specifications and quality sections.

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1. GENERAL
   1. SECTION INCLUDES
      1. Site and Building Refrigerant Piping
      2. Piping fittings
      3. Refrigeration Piping Components.
   2. RELATED SECTIONS
      1. Section 01 2500, *Substitution Procedures*
      2. Section 01 3300, *Submittal Procedures*
      3. Section 01 4000, *Quality Requirements – Non-nuclear*
      4. Section 01 4115, *Pressure Safety Submittals*
      5. Section 01 4444, *Offsite Welding, Brazing and Joining Requirements*
      6. Section 01 4455, *Onsite Welding, Brazing and Joining Requirements*
      7. Section 01 4525, *Nondestructive Examination (NDE) Requirements*
      8. Section 01 4631, *Welding, Brazing, and Soldering of ASME B31 Piping*
      9. [Section 01 8113.13, *Sustainable Design* [LEED v4 and]Guiding Principles 2020: *Requirements for water efficiency, energy efficiency, material composition, and indoor air quality requirements]*
      10. Section 07 8400, *Firestopping*
      11. Section 22 0529, *Hangers and Supports for Plumbing Piping and Equipment*
      12. Section 22 0554, *Identification for Plumbing, HVAC, and Fire Protection and Equipment*
      13. Section 22 0713, *Plumbing and HVAC Insulation*
      14. Section 22 0813, *Testing Piping Systems*

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In the listing below, designer shall eliminate code and standards that are not applicable to the project and add other code and standards that are. The referenced standards editions are based on the code of record ASME B31.5-2022 and ASME BPVC-2023. If the Code of Record for the project refers to a different version of ASME B31.5 & ASME BPVC, the designer is responsible to update the years/editions for the invoked standards. If the invoked standards editions do not comply with those referenced by the Code of Record, EOR needs to evaluate and verify those for equal or better. For the standards without an edition/year, the latest edition is to be used. In addition, the designer must ensure the code and standards editions align between sections in the project specification package and the project design drawings.

Note: ASCE 7 edition is based on Code of Record IBC 2021.

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* 1. REFERENCES
     1. ASCE 7-[16], *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*
     2. ASHRAE 15-[2016], *Safety Standard for Refrigeration Systems*
     3. ASHRAE 34-[2016], *Designation and Safety Classification of Refrigerants*
     4. ASME B1.1-[2024], *Unified Inch Screw Threads (UN and UNR, and UNJ Thread Forms)*
     5. ASME B1.20.1-[2013(R2018)], *Pipe Threads, General Purpose (Inch)*
     6. ASME B16.18-[2021], *Cast Copper Alloy Solder Joint Pressure Fittings*
     7. ASME B16.22-[2021], *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*
     8. ASME B16.50-[2021], *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*
     9. ASME B31.5 – [2022], Refrigeration Piping and Heat Transfer Components
     10. ASME BPVC Section V-[2023], *Nondestructive Examination*
     11. ASME BPVC Section IX-[2023], *Qualification Standard for* *Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators*
     12. ASTM B280-[2018], *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
     13. AWS D1.1, *Structural Welding Code —Steel*
     14. NMAC, *New Mexico Administrative Code*
     15. SAE J513-[1999], *Refrigeration Tube Fittings - General Specifications*

1. SUBMITTALS
2. Submit the following in accordance with Section 01 3300, *Submittal Procedures.*
3. Action Submittals:
   * 1. Catalog data on pipe materials, fittings, valves, and accessories. Catalog Data: Include the manufacturer’s name, model number, parts list, and brief description of equipment and its basic operational features, i.e. data sheet, spec sheet, etc.

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When offsite only, delete submittals below regarding onsite welding. When onsite only, delete submittals below for offsite welding. For high-risk applications such as ML-1 or ML-2, add submittals for “Weld Filler Material Control Procedures” and “Filler Material Certified Material Test Reports CMTRs)” when required. Add “Post-Weld Heat Treatment Procedures” when required.

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* + 1. Per the requirements of Section 01 4444, *Offsite Welding, Brazing and Joining Requirements* and/or Section 01 4455, *Onsite Welding, Brazing and Joining Requirements*, submit:

1. Welding Procedure Specification (WPS) and supporting Procedure Qualification Record (PQR). [Note: For Onsite welding use of LANL WPS/PQR is the default; coordinate usage with the LANL CWI; no submittal required]
2. Welder Performance Qualification Records (WPQR) including continuity [Note: For Onsite, welders are tested by LANL who will produce WPQR and track continuity; this includes brazing, bonding and fusing; no submittal required]
   * 1. Per the requirements of Section 01 4525, Nondestructive Examination (*NDE) Requirements*, submit:
   1. Written Practice or Procedure for Qualification and Certification of NDE personnel.
   2. NDE Personnel Qualification Records
   3. NDE Procedures
   4. NDE Procedure Qualification Records
   5. NDE Report(s)
   6. NTIP submitted under Section 01 4525.
      1. Before fabrication, submit:
3. Proof of journeyman certificate of competence in accordance with NMAC 14.6.6.11
4. Leak Test plan submitted under Section 22 0813
5. Cleaning procedures for joint assembly preparation.
   * 1. After fabrication, submit examination records per ASME B31.5 536.2(d).
6. Informational Submittals:
   * + 1. Spare Parts and Maintenance Materials list
       2. Installation, Operation, & Maintenance Manual
       3. Warranties
       4. Provide “LANL Refrigerant Service Record Form”, EPC-CP-QP-0312 Attachment 1
7. QUALITY ASSURANCE

NDE/Inspection and Testing

* + - 1. Subcontractor shall perform inspection and testing to verify the conformance to the requirements in PART 2 of this Section.
      2. Subcontractor shall provide an Inspection and Test Plan indicating all testing and inspection functions to be performed, including hold points during fabrication and assembly, as well as during the Factory Acceptance Testing (FAT). Hold points are required during the fabrication process to allow inspection, verification, or approval by LANL before the Subcontractor does further work. LANL has the right to waive Hold Points at their discretion.
      3. NDE/Inspection and testing functions shall be performed by qualified personnel using documented procedures and per specified requirements.
      4. NDE/Inspection Records: Subcontractor shall appropriately record, submit, and maintain records documenting the inspection and/or test then submit the completed Inspection Record as part of the QA Document Package. The status of all planned and executed inspection and testing activities shall be logged and traceable to ensure that the required inspection and testing have been performed, and any items that have failed inspection or testing are not inadvertently installed or implemented.
    1. Qualifications
       1. Installer Qualifications
          1. Certify that all personnel have passed relevant qualification tests for joining processes involved and that certification is current.

Metallic Pipe: Welders and braziers shall be qualified per ASME BPVC Section IX and per [Section 01 4444, *Offsite Welding, Brazing and Joining Requirements*] [Section 01 4455, *Onsite Welding, Brazing and Joining Requirements]*.

Steel Support Welding: Qualify processes and operators to AWS D1.1/D1.1M.

* + - 1. Qualification of Examination Personnel shall be as given in Section 01 4525, *NDE Requirements*.
         1. Certifications of examination personnel shall be maintained for Inspector’s review.
      2. LANL Owner’s Inspector will be qualified per ASME B31.5 Section 537.4. LANL will act for DOE to designate Owner’s Inspectors or Designee.
      3. Proof of journeyman certificate of competence in accordance with NMAC 14.6.6.11
    1. Extent and Retention of Records
       1. The following shall be maintained by the fabricator for a minimum of 3 years:
          1. Procedure specification, procedure qualification, and performance qualification records
          2. Results of weld examinations other than visual
          3. Records of the testing of each piping system, which shall include the following information:

date

identification of piping system tested

testing medium

test pressure

signature of examiner and inspector.

PART 2 PRODUCTS

* 1. PRODUCT OPTIONS AND SUBSTITUTIONS

1. Alternate products may be accepted per Section 01 2500, *Substitution Procedures* and 01 4115, *Pressure Safety Submittals*.
2. Proposal of unlisted components as substituted components is strongly discouraged and shall be evaluated per Section 01 2500, *Substitution Procedures*. Substitutions will be allowed only if the Subcontractor can demonstrate that the product can meet the same code requirements of the item specified in the design. Costs associated with evaluation of substituted unlisted components shall be the responsibility of the Subcontractor.
   1. SEISMIC PERFORMANCE REQUIREMENTS

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The seismic exemptions noted below are based on ASCE 7-16. If the Code of Record for the project refers to a different version of ASCE 7, the Designer is responsible to check the seismic design requirements per that applicable edition.

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* 1. Piping systems with trapeze assemblies/rod hangers that meet the requirements per ASCE 7, Section 13.6.7.3 are seismically exempt.
  2. For piping systems not meeting the above exemptions, Structural EOR shall design seismic supports per [ESM Chapter 5, Structural, Section II](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm5); ASCE 7, Chapter 13; and ASME B31.5.

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Where more than one piping system material is specified, provide compatible system components and joints.

Provide unions or couplings at locations requiring servicing. Do not use direct-welded or threaded connections to equipment or major valves.

Provide flexible connectors at or near equipment where piping configuration does not absorb vibration.

Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

Slope horizontal piping 1/2 inch in 10 feet, and in direction of flow.

Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

Comply with ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

The following items should be considered during the design.

1. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
2. Install refrigerant service valves in suction and discharge lines of compressor.
3. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
4. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.
5. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top and provide electrical connection to solenoid valves.
6. Install thermostatic expansion valves as close as possible to distributors on evaporators and locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
7. Install filter dryers in liquid line between compressor and thermostatic expansion valve or in the suction line of the compressor. Additional filter dryer is not needed if one is provided with the condensing unit.
8. In process examination per ASME B31.5 paragraph 536.6.2 may be substituted for all or part of the substituted for all or part of radiographic examination on a weld-for-weld basis if specified in the engineering design and specifically approved by the Inspector.

Brazing reduces the tube rating to the fully annealed condition. Solder joints shall not be used.

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* 1. REFRIGERANT PIPING
     1. Copper tubing: ASTM B280, Type ACR, Alloy C12200, temper shall be soft annealed O60 or drawn general purpose H58.

1. Manufacturer: [Mueller/Streamline]
2. Model Number: Nitrogenized ®ACR Tube (Refrigeration Service Tube)
3. Design Temperature Range: 80 degrees F to 122 degrees F (low side to high side temp per ASME B31.5)
4. Pressure Rating: 430 psig minimum
5. Size (OD): 1/8 inch through 1 3/8 inch OD shall use ACR Type L or Type K, above 1 3/8 up to 2 5/8 inches OD shall use Type K.
6. Location: Above grade
   * 1. Copper-iron tubing: ASTM B280, Alloy C19400
        1. Manufacturer: [Mueller/Streamline XHP]
        2. Maximum Operating Temperature: 250 degrees F.
        3. Pressure Rating: 1885 psig
        4. Size (OD): For piping 1-1/2 inch OD and greater
        5. Location: Used on the high pressure side of [R410A] [R-454B] [R-32] systems.
   1. PIPING FITTINGS
      1. Copper Braze Fittings (up to 430 psi design pressure)
         1. Fittings conforming to ASME B16.50, ASME B16.18 or ASME B16.22.
         2. Location: [Above grade] [Below grade]
         3. Manufacturer: [Muller/Streamline ACR]
      2. Copper Braze Fittings (above 430 psi design pressure)
         1. Fittings conforming to ASME B16.50, ASME B16.18 or ASME B16.22.
         2. Location: [Above grade] [Below grade]
         3. Manufacturer: [Muller/Streamline XHP]
      3. Copper Flare Fittings
         1. Fittings conforming to SAE J513
         2. Description: A 45-degree flare flared body and nut for use with annealed copper tubing. Materials are SAE CA360 (half-hard), CA345, CA350 or CA377 (forged) brass with CA377 nuts. Fittings may have a combination of ASME B1.1 UNF (5/16 to 7/8 inch) or UNS 1 1/16 inch and ASME B1.20.1 NPT tapered threads (1/8 through ¾ inch). Fittings are available based on outside tube diameter.
         3. Location: [Above grade] [Below grade]
         4. Size: [3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4] inch tube outside diameter
         5. Temperature Range: -65 degrees to +250 degrees F
         6. Pressure Rating: 550 psig
         7. Manufacturer: [Parker]
      4. Flame-Free Press Fittings
         1. Manufacturer: Parker-Sporlan
         2. Model Number: ZoomLock MAX
         3. Temperature Range: -40 degrees to +250 degrees F
         4. Pressure Rating: 600 psig
         5. Size: ¼ inch through 1-3/8 inch
            1. Only the following fittings are permitted: Couplings, Slip Couplings, Caps, SAE Flares (Only ¼ inch through ¾ inch permitted), 90 Elbows (1-3/8 inch not permitted), 45 Elbows (1/4 inch 45 Elbows not available)
         6. Shall only be used with hard drawn copper tube. Soft annealed coil tube is not permitted.

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Specify required refrigeration specialty components such as filter-dryers, solenoid valves, expansion valves, moisture and liquid indicators, strainers, pressure regulators, etc., to suit project. Items must meet the ASME B31.5 requirements for components.

All components in Article *Refrigeration Piping Components* are either standard piping components (listed items) per ASME B31.5 para. 526 or have previously LANL-approved unlisted component evaluations in accordance with ASME B31.5 para. 504.7.

The types of components shown may be a non-exhaustive list. Any substitutions or additions shall be ASME B31.5 compliant. All previously LANL approved ASME B31.5 components are available in [LANL ESM Ch. 17](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm17).

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* 1. REFRIGERATION PIPING COMPONENTS

1. Solenoid Valve: Brass valve, Pilot operator, MKC-2 coil kit, synthetic to metal main port, stainless steel pin to synthetic seal pilot port, stainless steel stem and plunger assembly, piston disc.
   * + 1. Manufacturer: Sporlan
       2. Model Number: E series HP
       3. Pressure rating: 700 psig
       4. Size: 3/8 inch through 1-1/8”
2. Ball Valve Forged Brass Body, Polished Brass or Carbon Steel Ball
   * + 1. Manufacturer: Superior Refrigeration Products
       2. Model Number: WA, WAS, WBS, MST
       3. Temperature Range: -40 degrees to 325 degrees F
       4. Pressure Rating: 800 psig
       5. Size: 1/4 inch through 4-1/8 inch.
3. Moisture and Liquid Indicator, Sight Glass
   * + 1. Manufacturer: Sporlan
       2. Model Number: "See-All"
       3. Temperature Range: -50 degrees to 149 degrees F
       4. Pressure Rating: 650 psig
       5. Size: 1/4 inch through 2-1/8 inch.
4. Thermostatic Expansion Valve Fill Valve Machined brass bar body, brass port machined into body, stainless steel pin and pushrod, maximum external leakage – 0.10 oz/yr at 300 psig.
   * + 1. Manufacturer: Parker-Sporlan
       2. Model Number: Type [R] [ER] [SR]
       3. Pressure Rating: 450 psig
       4. Size: [Specify inlet/outlet sizes], SAE J513 flare ends.
5. Metal Hose - Vibration Elimination, by size and material; Bronze hose and braids, female copper tube ends.
   * + 1. Manufacturer: [Universal Hose & Braid] [Parker]
       2. Model Number: [ ]
       3. End Connection: Inside conforms to ASME B16.18 and ASME B16.22.
       4. Pressure Rating: 450 psig minimum
       5. Size: 1/8 inch through 1-1/4 inch.

# PART 3 EXECUTION

1. PREPARATION
   * 1. Square, ream pipe and tube ends. Remove burrs.

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Consult manufacturer’s recommendation for the use of acids and cleaning agents to prevent damage.

Ensure safeguards are taken to protect personnel from hazards of cleaning, which may include but not be limited to flying particulates, corrosive chemicals, and harmful vapors.

A suitable chemical and/or mechanical cleaning method shall be used, if necessary, to clean all surfaces to be fabricated.

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* + 1. Cleaning:
       1. Remove scale and dirt on inside and outside before assembly.
       2. Cleaning will consist of removing all non-adhering material such as loose scale, sand, weld spatter particles, rust, cutting chips, grinding residue, etc. from the inside of the piping assembly by suitable means. This level of cleaning will allow the presence of mill scale and surface rust.
       3. [specify any special cleaning requirement]
    2. Prepare piping connections to equipment with unions.
    3. Fastener materials shall be free of nicks, burrs, chips, dirt, and damage (inspect threads, shank, and nuts). All damaged fasteners must be replaced.

1. INSTALLATION
   * 1. General:
     2. Install piping in conformance with ASME B31.5.
     3. No pipe or tube bends are allowed. Fittings are to be used instead of bends.
     4. Piping systems include all piping components (including pressure retaining portions of instruments), pipe fixtures, clamps, and supports, instrument mounting plates and their attachment to structural framework.
     5. Welding, brazing, or soldering shall be in accordance with Section 01 4631, *Welding, Brazing and Soldering of ASME B31 Piping.*
     6. Unless noted otherwise on the isometric drawing, field fit-up welds shall include 6 inches of pipe beyond the length required.
     7. Weld/braze joints shall meet the approved WPS/BPS joint requirements.
     8. Label piping system in accordance with Section 22 0554, *Identification for Plumbing, HVAC, and Fire Piping and Equipment*.
     9. Insulate piping system in accordance with Section 22 0713*, Piping and HVAC Insulation*. Provide clearance for installation of insulation and access to valves and fittings.
     10. Support piping system in accordance with Section 22 0529, *Hangers and Supports for Plumbing Piping and Equipment*. Do not anchor the pipe. Allow piping to slide and expand or contract with temperature.
     11. [Sleeve and caulk pipes penetrating exterior walls or interior bearing walls. Provide waterproof installation for exterior walls. Provide UL/FM approved through-penetration firestop system when penetrating fire rated barriers (e.g., walls, floors, etc.). See Section 07 8400, *Firestopping*.]
     12. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
     13. For multiple openings in piping mains, the distance between their centers shall be at least the sum of their inside diameters.
     14. Branch connections shall utilize fittings (tee, lateral, or cross) in accordance with listed codes.
     15. Install piping to maintain headroom and neither interfere with use of space nor take more space than necessary.
     16. Group piping whenever practical at common elevations.
     17. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
     18. All valves shall be installed in accordance with the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance. Install valves with stems upright or horizontal, not inverted.
     19. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 1/2 inch in 10 feet, and in direction of flow.
     20. Install pressure gauges vertically.
     21. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect open ends with temporary plugs, caps, or residue-free tape.
     22. Install flexible connections for [\_\_\_\_\_\_\_\_\_] where shown on drawings.
     23. Welding, brazed, or soldered joints:
         1. Welded, brazed, or soldered joining of piping/tubing and components shall be per Section 01 4631, *Welding, Brazing and Soldering of ASME B31 Piping*.
         2. When brazing/welding or soldering piping/tubing to a valve, follow manufacturer’s instructions to prevent heat damage to valve internals.
     24. 45 Degree Flare (SAE J513)
         1. Cut tubing squarely and clean tube end thoroughly to remove burrs.
         2. Place nut onto tube. Place threaded end of nut toward end of tube.
         3. Flare tube end with flaring tool to provide 45 degree flare.
         4. No scratches, breaks, or other mars at sealing surface of flare shall be permitted.
         5. Clamp tube flare between nut and nose of fitting body by screwing nut on finger-tight. Tighten with a wrench an additional 1/4 turn for a metal-to-metal seal.
     25. Flame-free press fittings assembly per manufacturer’s installation instructions.
2. EXAMINATION, INSPECTION AND TESTING
   * 1. All welding, brazing and soldering: Inspected, examined, and tested in accordance with Section 01 4631, *Welding, Brazing, and Soldering of ASME B31 Piping* [and Section 01 4525, *Nondestructive Examination (NDE) Requirements*].
     2. Externally the pressure system will be free of weld slag, flux, and weld spatter.
     3. Contact LANL Owner’s Inspector to determine the initial inspection points (minimum hold points).
     4. LANL Owner’s Inspector shall have access to any and all design, fabrication, manufacture, heat treatment, assembly, erection, examination, testing, records, documentation and other project information or activities to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design and to perform the role defined in ASME B31.5.
     5. LANL Owner’s Inspector is the final authority on acceptance of the project examination or test.
     6. Examination activities to verify the quality of the work must be performed by personnel other than those who performed the activity being examined. Such persons must not report directly to the immediate supervisors responsible for work being examined.
     7. The fabrication documentation must have evidence of the examination, the evidence must be maintained in the pressure system documentation package submitted to the pressure safety officer.
     8. Pressure test and leak test piping per Section 22 0813, *Testing Piping Systems*.
        1. Prior to the pressure test, a preliminary test up to 25 psig using dry nitrogen gas may be applied as a means of locating major leaks per ASME B31.5 para. 538.4.2(b).
        2. Pressure test and leak test the refrigerant piping at the following pressures:

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| Refrigerant | Minimum  Design Pressure (psig) | Pressure Test (psig) | Leak Test (psig) |
| R-410A | High Side 430  Low Side 235 | High Side 475  Low Side 260 | High Side 450  Low Side 250 |
| R-407C | High Side 307  Low Side 166 | High Side 340  Low Side 185 | High Side 325  Low Side 175 |
| R-134A | High Side 177  Low Side 87 | High Side 200  Low Side 100 | High Side 180  Low Side 90 |
| R-404A | High Side 320  Low Side 235 | High Side 355  Low Side 260 | High Side 330  Low Side 240 |
| R-454B | High Side 405  Low Side 220 | High Side 450  Low Side 250 | High Side 420  Low Side 240 |
| R-32 | High Side 435  Low Side 250 | High Side 480  Low Side 280 | High Side 450  Low Side 260 |

NOTE: It is acceptable to test the low side of the refrigeration system at the high side test pressure if all low side components are rated for the high side design pressure.

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* + - * 1. If testing of the low side and the high side are done at different pressures, provide positive isolation of the two sides using factory installed isolation valves and/or service valves that are provided as part of the equipment.
        2. High side pressure test: [ ] psig +/- [ ] psig.
        3. Low side pressure test: [ ] psig +/- [ ] psig.
        4. High side leak test: [ ] psig +/- [ ] psig.
        5. Low side leak test: [ ] psig +/- [ ] psig.
      1. Pressure test per ASME B31.5 para. 538.4.2 with dry nitrogen gas for a minimum of [10] minutes. Test the high and low side of each system at not less than the pressure noted above for test pressure. Record test with a calibrated pressure gauge. Do not exceed 130% of the design pressure listed above.
         1. Do not use oxygen, acetylene, or other flammable/combustible gases or gas mixtures for leak testing.
      2. After the pressure test is complete, perform a system leak test at the pressures listed in the table above, per ASME B31.5, para. 538.4.3 Leak Test, with personnel qualifications as defined by ASME B31.5, para. 536.3 Examination Personnel Qualification and Certification.

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The application of the ASHRAE 15- paragraph 9.13.6.1 Leak Testing Protocol provides the same or greater level of leak detection as does ASME B31.5 paragraph 538.4.3 Leak Test. Any of the three methods shown below for leak testing may be used to satisfy the leak testing requirement.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

* + - * 1. Bubble leak testing per ASME B31.5, 538.4.3
        2. Pressure testing per ASHRAE 15, 9.13.6.1
        3. Vacuum testing per ASHRAE 15, 9.13.6.1
    1. After successful completion of pressure and leak tests, remove pressurization gas and evacuate system to [value req’d by manf.] [500] microns to remove moisture and non-condensables. After this level is reached, remove the vacuum pump, and verify that there is no appreciable rise (rise above 1000 microns) after 30 minutes.
    2. Fully charge completed system with refrigerant after testing. If startup is not within 24 hours, temporarily pressurize to 5 psig with system refrigerant.

END OF SECTION

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Do not delete the following reference information:

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THE FOLLOWNG STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 23 2300 Rev. 6, dated January 8, 2025.