SECTION 22 0813

TESTING PIPING SYSTEMS

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LANL MASTER SPECIFICATION SECTION

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| Rev. 12 Summary of Changes   Cited other Sections for test pressure and durations, revised Article *Submittals* in Part 1, added specific requirements for Flexible Hose Restraints in Article *Field Quality Control* in Part 3, corrected ESM Chapter 17 references and other minor editorial changes. |

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

Comply with the [LANL Engineering Standards Manual (ESM) STD-342-100 Chapter 17, *Pressure Safety*, Section PS-REQUIREMENTS, 10.3 *Pressure and Leak Testing*.](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm17)

When connecting to existing piping, piping joints shall be leak tested in accordance with the LANL Engineering Standards Manual (ESM) STD-342-100 Chapter 17, *Pressure Safety*, PS-REQUIREMENTS, 10.3 *Pressure and Leak Testing* paragraph B. *Modifications to Existing System*. For leak testing of radiological contaminated systems, see LANL Engineering Standards Manual (ESM) STD-342-100 Chapter 17, *Pressure Safety*, PS-REQUIREMENTS, 10.3 *Pressure and Leak Testing* paragraph C. *Modifications to Radiological Contaminated Existing Systems*. This includes the bagging of vacuum joints where bags are used to cover the joint to verify the joint is leak free as part of an initial service leak test of the joint. The bag is then evaluated using standard radiological processes to verify there is no contamination before the gas is removed.

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.  The Section must also be edited to delete requirements for processes, items, or designs that are not included in the project -- and specifiers notes such as these.  This template is written to meet requirements contained in the LANL Engineering Standards Manual (ESM). To seek a variance from or alternate method to requirements in this section that are applicable, contact the ESM Pressure Safety [POC](https://engstandards.lanl.gov/POCs.shtml#pressure), ESM Mechanical [POC](http://engstandards.lanl.gov/POCs.shtml#mech) for building piping systems and Civil [POC](http://engstandards.lanl.gov/POCs.shtml#civil) for utility piping systems. Please contact applicable POC with suggestions for improvement as well.

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 and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Ch 1 Section Z10 Specifications and Quality topics.

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1. GENERAL
   1. SECTION INCLUDES
      1. Pressure testing of the following systems:
         1. Fire protection piping
         2. Plumbing piping (sewer lines, water lines, rainwater lines)
         3. Natural gas piping
         4. Compressed air piping
         5. Instrument air piping
         6. Hydronic piping
         7. Steam and condensate building service piping
         8. Steam and condensate utility distribution piping
         9. Refrigerant piping
         10. Vacuum piping
         11. Laboratory gas piping
         12. Process Piping
   2. RELATED SECTIONS
      1. Section 01 3300*, Submittal Procedures*
      2. Section 01 3545, *Water Discharge Requirements*
      3. Section 01 4000, *Quality Requirements – Non-nuclear*
      4. Section 01 4216*, Definitions*
      5. [Section 11 5311.18, *Glovebox Atmosphere Regenerable Purification Systems]*
      6. Section 21 1300, *Fire-Suppression Sprinkler Systems*
      7. Section 22 1100, *Facility Water Distribution*
      8. Section 22 1316, *Sanitary Waste and Vent Piping*
      9. Section 22 1413, *Facility Storm Drainage Piping*
      10. Section 22 1500, *Compressed-Air Systems*
      11. Section 23 1123, *Facility Natural-Gas Piping*
      12. Section 23 2113*, Hydronic Piping*
      13. Section 23 2215, *Steam and Condensate Heating Piping and Specialties*
      14. Section 23 2300, *Refrigerant Piping*
      15. Section 23 2500, *HVAC Water Treatment*
      16. Section 33 5100, *Natural-Gas Distribution*
      17. Section 33 6300, *Steam Energy Distribution*
      18. Section 40 0504, *Process Piping*

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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 codes of record ASME B31.1-2024, ASME B31.3-2022, ASME B31.5-2022, ASME B31.8-2022, ASME B31.9-2020, UPC-2021, NFPA 13-2019, NFPA 24-2019, and NFPA 54-2021. If the Codes of Record for the project refers to a different version of the above-mentioned, 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.

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* 1. REFERENCES
     1. ASME B31.1 – [2024], *Power Piping*
     2. ASME B31.3 – [2022], *Process Piping*
     3. ASME B31.5 – [2022], *Refrigerant Piping and Heat Transfer Components*
     4. ASME B31.8 – [2022], *Gas Transmission and Distribution Piping Systems*
     5. ASME B31.9 – [2020], *Building Services Piping*
     6. ASME PCC-2 – [2022], [*Repair of Pressure Equipment and Piping*](https://ewb.ihs.com/#/document/CRGUGGAAAAAAAAAA?qid=637873590057475748&sr=re-1-10&kbid=4%7C20027&docid=943870644)
     7. ASTM E515-[11(R2022)], *Standard Practice for Leaks Using Bubble Emission Techniques*
     8. ASTM E1003-[13(R2022)], *Standard Practice for Hydrostatic Leak Testing*
     9. IAPMO Uniform Plumbing Code (UPC) – [2021]
     10. NFPA 13 – [2019], *Standard for the Installation of Sprinkler Systems*
     11. NFPA 24- [2019], *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
     12. NFPA 54 – [2021], *National Fuel Gas Code*
     13. UL 404, *Pressure-Indicating Gauges for Compressed Gas Service*
     14. 49 CFR 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*
  2. SUBCONTRACTOR REQUIREMENTS
     1. Notify LANL Subcontract Technical Representative (STR) at least 24 hours (1 working day) in advance of testing to arrange for onsite inspection by LANL Inspector (a hold/witness point).

NOTE: LANL Owner’s Inspector shall be qualified per ASME B31.3 Paragraph 340 and LANL’s Engineering Services Division. LANL shall act for DOE to designate Owner’s Inspectors or Designee.

* + 1. For discharge requirements of water used for pressure testing, follow Section 01 3545, *Water Discharge Requirements*.
    2. Notify LANL STR immediately in the event of any accidental discharge.
  1. SUBMITTALS
     1. Action Submittals
        1. Test plan for potable water, sanitary sewer, and other systems outside the scope of LANL Engineering Standards Manual (ESM) STD-342-100 Chapter 17, Pressure Safety.
           1. Pressure and Leak Testing procedures
           2. Material of construction
           3. Sketch of the testing apparatus and connection locations
           4. Sketch extents of system being tested
           5. Test pressures and duration of tests
           6. Test medium
           7. Requirements for calibration of pressure gauges as applicable (calibration certificates to be provided with test reports)
        2. Test plan for pressure systems in the scope of ESM Ch. 17, *Pressure Safety*.
           1. Pressure and Leak Testing procedures
           2. Material of construction
           3. Sketch of the testing apparatus and connection locations
           4. Sketch extents of system being tested
           5. Design pressures
           6. Test pressures, including permissible tolerance on test pressure range
           7. Duration of pressure or leak test
           8. Test medium
           9. Requirements for calibration of pressure gauges as applicable (calibration certificates to be provided with test reports)
           10. Method to exclude personnel from the area containing the system to be tested. Include distance that personnel must be away from the hazard.
           11. Over-pressurization protection/prevention: Device make/model number, certification designation (e.g., “UV” stamp), pressure relief set pressure, point of installation in system, and calculation substantiating the selection.
     2. Informational Submittals
        1. Test Reports: Submit within 10 working days of successful test. Include calibration reports for pressure gauges as applicable.

1. PRODUCTS

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Digital gauges are allowed provided they provide at least the same accuracy and calibration as analog (mechanical) gauges.

Vacuum testing digital gauges shall bound by a decade — e.g., if the level of vacuum required for the testing is 100 microns, a digital gauge shall be accurate to 10 microns. Vacuum test digital gauges also require test gauge calibration (for LANL self-performed work, to P330-2).

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* 1. MATERIALS
     1. Furnish instruments, equipment, material, and labor necessary to conduct tests.
     2. Calibrate testing equipment at reasonable intervals with devices of accuracy traceable to National Institute of Standards and Technology (NIST). Test pressure shall be within the calibration range.
     3. Test gauges used shall be per IAPMO UPC, Section 318.
        1. Pressure gauges meeting UL 404.
        2. Gauges shall have tempered safety glass, plastic face, or shield; and blowout back or plug.

1. EXECUTION
   1. FIELD QUALITY CONTROL
      1. Perform piping pressure test before water treatment, cleaning, or flushing to avoid possible discharge of chemicals due to pipe or joint failure during a pressure test. Refer to Section 23 2500, *HVAC Water Treatment*.
      2. Barricade the area around the system to be tested to ensure personnel do not enter the area during the pressure test.
         1. Preliminary leak testing is allowed per the code of record but must be defined in the test plan.
         2. Personnel, including the personnel performing the test, shall not enter the evacuation zone (exclusion zone) while the system is being pressurized. Leak testing is only allowed after the hold period for the test has been complete and the pressure reduced, as allowed by the code of record.

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ASME PCC-2 contains a calculation for both blast wave and fragmentation distances. Blast shielding may be used to reduce the evacuation zone provided they are adequate for the application and protect from direct and indirect fragments.

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* + - 1. The evacuation zone (exclusion zone) for pressure systems with contained energy greater than 1000 lbf-ft testing shall be determined per ASME PCC-2, Mandatory Appendix 501-II, and Mandatory Appendix 501-III, or equal.
    1. All examination records (blank forms) and pressure and/or leak test plans must be complete (except for results) and submitted prior to testing. Plans shall:
       1. Specify tolerances; for example, test pressure to be -0 +15 psig.
       2. Provide a means for a controlled release of pressure, for example, using a vent or drain valve. Removal of caps, plugs, or flanges to vent pressure is not allowed.
    2. Submit completed Test Reports, after testing.
    3. Relief devices and other protective measures shall be utilized to protect against over pressurization during the testing, per code of record requirements. This is applicable to pneumatic, hydrostatic, and hydro-pneumatic testing.
       1. Relief devices shall have a set pressure and capacity calculation to verify and prevent the system from exceeding the test pressure constraints of the code of record.
       2. The relief device shall not be adjustable and shall be sealed at the required set pressure.
       3. A vacuum breaker valve may be required to prevent a system from being exposed to external pressure.
       4. Subcontractor shall calculate the required size of the relief or vacuum protection required.

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See [ESM Chapter 17, Pressure Safety, PS REQUIREMENTS, 8.11 Flexible Hoses, and 8.12 Flexible Hose Restraints](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm17) for additional information.

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* + 1. Temporary test systems that use flexible hoses, hose restraints, and whip checks must meet the requirements:
       1. External Restraints: Flexible tubing and hoses over 12 in. and in service pressure greater than 150 psig must be constrained at both ends or shielded in case of end-connector failure. The maximum separation distance between flexible hose restraints must not exceed 6-ft. intervals
       2. [Internal Restraints: Flexible hoses that are self-arresting with an internal valve enclosed within each hose end do not require hose restraint because these hoses do not whip.]
    2. Piping being tested shall remain exposed until LANL Inspector has approved the test results.
    3. Trenches may be backfilled between joints before testing to prevent movement of pipe during testing. Ensure that thrust blocks are sufficiently hardened before testing.
    4. Piping being tested shall not leak nor show any change in test pressure (with accommodation for atmospheric conditions as allowed) for duration specified unless otherwise noted. It is required that the pressure supply source be closed and the gauges monitored during pressure or vacuum decay test to verify a leak free system. It is recommended for other types of tests.
    5. Where any portion of piping system is to be concealed before completion, the portion shall be tested separately as specified for the entire system.
    6. Ensure piping supports are in place.
    7. Test pressure shall not exceed the maximum allowable test pressure for any vessel, pump, valves, or other component in the system. Isolate system gages, sensors, and similar components from pressure tests so instruments and devices are not damaged.
    8. Hydrostatic (Water) Testing:
       1. Use potable water as test medium. Do not fill system until the LANL STR has approved the source of water supply.
       2. Provide vents at high points to release trapped air while filling system.
       3. Provide drains at low points for complete removal of test liquid.
       4. Follow ASTM E1003 for detecting leaks [and] [or] [use other enhanced detection methods like pressure decay or vacuum decay techniques.]
       5. After the test duration reduce pressure to design pressure and visually examine the system for leaks.
       6. Drain system if there is a potential for freezing, e.g., no heat in building, coil in outside air stream, and similar situations.
       7. Install vacuum breaker valves as necessary to prevent buckling of piping when draining system.
    9. Pneumatic (Air) Testing– pneumatic testing is permitted where appropriate, with a maximum stored energy at test pressure less than or equal to 1000 lbf-ft.

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Request approval for testing when stored energy at test pressure is greater than 1000 lbf-ft in accordance with ESM Ch. 17, Section PS-REQUIREMENTS, Section 10.3. Stored energy may be calculated based on ASME PCC-2, Mandatory Appendix 501-II, *Stored Energy Calculations for Pneumatic Pressure Test*.

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* + - 1. Use clean, dry air or inert gas as the test medium. Air is prohibited for natural gas distribution pipe testing.
      2. Prior to application of full air test pressure, apply a preliminary test of not more than 10 psig to reveal possible major leaks.
      3. After preliminary test, raise pressure in stages not more than 25 percent up to full test pressure, allowing at least 10 minutes for equalization of strain and detection of major leaks at each intermediate stage. Hold final test pressure for time specified.
         1. If test pressure is 25 psig or less, pressure can be raised in a single increment.
      4. Use ASTM E515, for detecting leaks [and] [or ] [use other enhanced detection methods like pressure decay or vacuum decay techniques.]
      5. After the test duration [reduce pressure to design pressure and] visually examine the system for leaks.
    1. If piping does not pass test or leaks are found repair and retest as required by Article [3.3] Retesting.
    2. Retesting is not required in cases where it does not include:
       1. Addition, replacement, alteration, or relocation of any piping or pressure boundary
       2. In any cases where piping is set up temporarily for exhibition purposes.
  1. PRESSURE OR LEAK TESTING

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When connecting to existing piping, piping joints shall be leak tested in accordance with the [*ESM Chapter 17, Pressure Safety, PS REQUIREMENTS, 10.3 Pressure And Leak Testing paragraph B. Modifications to Existing System*](https://engstandards.lanl.gov/ESM_Chapters.shtml#esm17)

Qualified examiners are not required for code leak tests except when specified by the code, for example ASME B31.3 para. 345.8 sensitive leak tests, 345.2.4(b) Externally Pressured Piping, and B31.5 538.4.3 Leak Test.

The designer has the discretion to require qualified examiners and examination procedures.

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* + 1. Fire Protection Piping:
       1. Below Grade: Test with water per NFPA 24 at a minimum of 200 psig, or at 50 psig in excess of the system working pressure, whichever is greater for 2 hours. Piping shall maintain test pressure +/- 5 psi for the duration of the test and there shall be no visible signs of leakage.
       2. Above Grade: Refer to Section 21 1300, *Fire Suppression Sprinkler Systems*, for above-ground piping testing requirements.
    2. Plumbing Piping (UPC Code of Record):

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Test pumped drain piping to 1.5 times operating pressure, 25 psig minimum.

Typical domestic water and sanitary are:

* Pneumatic option for Sanitary test is at 5 psig
* Hydrostatic Domestic Water test is at 80 psig
* Pneumatic option for Domestic Water test is at 50 psig

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* + - 1. Pumped Drain Piping: Test with water at [25] psig for 2 hours.
      2. Sanitary Waste and Vent Piping Within Building to Building Wall, including condensate drain line from cooling coils: See Section 22 1316, *Sanitary Waste and Vent Piping*, for test pressures and durations.
      3. Sanitary Sewer Piping Beyond Building Wall: See Section 22 1316, *Sanitary Waste and Vent Piping*, for test pressures and durations.
      4. Potable Water Inside Building: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations.
      5. Potable Water Site Main to Building Backflow Preventer: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations
      6. Non-potable Water: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations.
      7. Stormwater Piping:
         1. See Section 22 1413, *Facility Storm Drainage Piping*, for test pressures and durations of piping within building and within 5 feet outside of the building.
         2. Stormwater Piping Beyond 5 feet of Building: Completely fill system with water and let stand for at least 1 hour before inspection starts, then visually inspect to ensure that all joints are tight.
    1. Natural Gas Piping
       1. Service piping downstream of regulator stations or meters
          1. See Section 23 1123, *Facility Natural-Gas Piping*, for test pressures and durations.
       2. Distribution piping
          1. See Section 33 5100, *Natural Gas Distribution*, for test pressures and durations.
    2. Compressed Air Piping (Less than 150 psig design pressure)
       1. See Section 22 1500, *Compressed-Air Piping*, for test pressures and durations.
    3. Instrument Air Piping (Less than 150 psig design pressure)
       1. See Section 22 1500, *Compressed-Air Piping*, for test pressures and durations.
    4. Hydronic Piping (heating hot water, chilled water, tower water, condenser water, make-up water and equipment drains)
       1. See Section 23 2113, *Hydronic Piping*, for test pressures and durations.
    5. Steam and Condensate Building Service Piping (ASME B31.9):
       1. See Section 23 2215, *Steam and Condensate Heating Piping and Specialties*, for test pressures and durations
    6. Steam and Condensate Utility Distribution Piping Systems (ASME B31.1):
       1. See Section 33 6300, *Steam Energy Distribution*, for test pressures and durations.
    7. Refrigerant Piping:
       1. See Section 23 2300, *Refrigerant Piping*, for leak and pressure test pressures, durations, and allowable methods.
    8. Vacuum Piping (outside the scope of ESM Chapter 17, Pressure Safety):
       1. Evacuate to 1mm Hg (1 Torr or 1000 microns) measured with an electronic manometer or thermocouple gauge. After 2 hours, if vacuum level has risen to no higher than 2.5 mm Hg (2.5 Torr or 2500 microns), the leak test is acceptable.
    9. Laboratory Gas Piping (ASME B31.9):

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Test laboratory gas piping between 1 to 1.25 times design pressure. (Note: ASME B31.9 paragraph 937.4.5 only requires the test pressure to be maintained for a minimum of 10 minutes).

NOTE: If the code of record for the lab gas is ASME B31.3 (e.g., if a flammable/toxic gas), then test per the following paragraph titled *Process Piping* (ASME B31.3)

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* + - 1. Test piping with oil-free, dry cylinder nitrogen at [ ] psig +/- [ ] psig, not to exceed 150 psig, per ASME B31.9, paragraph 937.4 for at least 10 minutes.
    1. Process Piping (ASME B31.3):
       1. See Section 40 0504, *Process Piping*, for test pressures and durations.
  1. RETESTING
     1. If piping does not pass the test or leaks are found, locate leak, safely vent pressure, and then repair leaks. Removal of caps, plugs, or flanges to vent pressure is not allowed.
     2. Repair by tightening, repair, or replacement, as appropriate. Make repairs to piping with new materials. Caulking on screwed joints, cracks, or holes is not acceptable.
     3. Where repairs or additions are made to the piping system pressure boundary following the pressure test, retest the affected piping.
     4. Repeat retesting until satisfactory results are obtained. Notify LANL STR at least 24 hours (1 working day) in advance to arrange for onsite witnessing by LANL Owner’s Inspector of the piping retesting (a hold/witness point).

END OF SECTION

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Do not delete the following reference information:

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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 22 0813 Rev. 12, dated January 8, 2025.