SECTION 22 0813

TESTING PIPING SYSTEMS

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LANL MASTER SPECIFICATION SECTION

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

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| Rev. 10 Summary of changesRevised requirements for steam, condensate, and refrigeration piping.  |

NOTE: When connecting to existing piping, piping joints for B31.1 and B31.9 pressure systems shall be leak tested in accordance with the Engineering Standards Manual STD-342-100 Chapter 17, Pressure Safety, Section EXIST - Legacy System Requirements, 3.0 Modification or Maintenance of an Existing System (or successor, e.g., Section PS-SP).

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 verbiage 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 requirements of the ESM that are applicable, contact the ESM [Mechanical](http://engstandards.lanl.gov/POCs.shtml#mech) POC for building piping systems and [Civil](http://engstandards.lanl.gov/POCs.shtml#civil) POC 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.

Section 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 (B31.9)
			8. Steam and condensate utility distribution piping (B31.1)
			9. Refrigerant piping
			10. Vacuum piping
			11. Hazardous waste and vent double wall containment piping
			12. Laboratory gas piping
			13. Reverse Osmosis Water Piping
			14. Process Piping (B31.3)
			15. Category M Fluid Service Piping (B31.3)
			16. Non-Metallic Pipe (B31.3)
			17. Other Process Piping (B31.3)
	2. RELATED SECTIONS
		1. Section 01 3545, *Water Discharge Requirements*
		2. Section 01 4000, *Quality Requirements*
		3. Section 22 1100, *Facility Water Distribution*
		4. Section 22 1316, *Sanitary Waste and Vent Piping*
		5. Section 22 1413, *Facility Storm Drainage Piping*
		6. Section 22 1500, *Compressed Air Systems*
		7. Section 23 1123, *Facility Natural Gas Piping*
		8. Section 23 2113*, Hydronic Piping*
		9. Section 23 2215, *Steam and Condensate Heating Piping and Specialties*
		10. Section 23 2300, *Refrigerant Piping*
		11. Section 23 2500, *HVAC Water Treatment*
		12. Section 40 0504, *Process Piping*
	3. DEFINITIONS
		1. Refer to Section 01 4216, *Definitions.*

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Designer note:

In the listing below, designer must eliminate standards that are not applicable to the project, add standards that are applicable, and update code and standard edition years to match project code of record—or eliminate years and state that all shall be taken as latest.

This template was developed to meet the requirements for ASME 31 code editions listed. Application of this template to different editions of the ASME code(s) will require a detailed review of the code and ESM Chapter 17.

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* 1. REFERENCES
		1. ASME B31.1 – [2020], *Power Piping*
		2. ASME B31.3 – [2020], *Process Piping*
		3. ASME B31.5 – [2019], *Refrigerant Piping and Heat Transfer Components*
		4. ASME B31.8 – [2020], *Gas Transmission and Distribution Piping Systems*
		5. ASME B31.9 – [2020], *Building Services Piping*
		6. ASME PCC-2 – [2018], [*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, *Standard Practice for Leaks Using Bubble Emission Techniques*
		8. [ASTM E1003-13 (2018), *Standard Practice for Hydrostatic Leak Testing]*
		9. IAPMO 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, *Standard for Gauges, Indicating Pressure, for Compressed Gas Service*
		14. 40 CFR 82, *Protection of Stratospheric Ozone*
		15. 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: Owner’s Inspector shall be qualified per ASME B31.3 Section 340 and LANL’s Engineering Services – Facility Engineering (ES-FE). 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 approval that includes:
				1. Material of construction
				2. Design pressures
				3. Test pressures and duration of tests
				4. Test medium and method of achieving the test pressure
				5. Certification on calibration of pressure gauges
				6. Method to exclude personnel from the area containing the system to be tested. Include distance that personnel must be away from the hazard.
				7. Over-pressurization protection/prevention: Device make/model number, certification, pressure relief set point, point of installation in system, and calculation substantiating the selection.
		2. Informational Submittals
			1. Test Reports: Submit within 10 working days of successful test.
1. PRODUCTS
	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-2021, Section 318.
			1. Pressure gauges meeting Underwriters Laboratories (UL) per UL-404, “Standard for Gauges, Indicating Pressure, for Compressed Gas Service” Standard for Safety.
			2. Gauges shall have tempered safety glass or plastic face or shield and blowout back or plug.

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Designer Notes:

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 999 to 100 microns, a digital gauge shall be accurate to 10 microns. Vacuum test digital gauges also require test gauge calibration (for LANL-performed, to P330-2).

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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 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.
			3. The evacuation zone (exclusion zone) for pressure systems with contained energy greater than 1000 lbf-ft testing shall be determined per ASME PCC-2, [*Repair of Pressure Equipment and Piping*](https://ewb.ihs.com/#/document/CRGUGGAAAAAAAAAA?qid=637873590057475748&sr=re-1-10&kbid=4%7C20027&docid=943870644), Mandatory Appendix 501-II, *Stored Energy Calculations for Pneumatic Pressure Test*, and Mandatory Appendix 501-III, *Safe Distance Calculations for Pneumatic Pressure Test*, or equal.
		3. 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. Comply with ESM Chapter 17, *Pressure Safety*
			2. Specify tolerances; for example, test pressure to be -0 +15 psig.
			3. Provide a means for a controlled release of pressure. Removal of caps, plugs, or flanges is not allowed.
		4. Submit completed examination records after testing.
		5. Relief devices and other protective measures shall be utilized to protected 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. An air brake may be required to prevent a system from being exposed to external pressure.
		6. Temporary test systems must use flexible hoses, hose restraints, and whip checks meeting the requirements of ESM Chapter 17, Pressure Safety.
		7. Piping being tested shall remain exposed until LANL has approved the test results.
		8. Trenches may be backfilled between joints before testing to prevent movement of pipe during testing. Ensure that thrust blocks are sufficiently hardened before testing.
		9. Piping being tested shall not leak nor show any change in test pressure for duration specified unless otherwise noted.
		10. Where any portion of piping system is to be concealed before completion, the portion shall be tested separately as specified for the entire system.
		11. Ensure piping supports are in place.
		12. 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.
		13. 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–*Standard Practice for Hydrostatic Leak Testing* 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.
		14. Pneumatic (Air) Testing– B31.3 345.1(c) pneumatic testing is permitted where appropriate, with a maximum contained energy at test pressure is less than or equal to 1000 lbf-ft.

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Designer Note: Request ES-DO approval for testing when contained energy at test pressure is greater than 1000 lbf-ft.

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* + - 1. Use clean, dry air (prohibited for natural gas pipe testing) or inert gas as the test medium.
			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 *Standard Practice for Leaks Using Bubble Emission Techniques*, 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 addition to, replacement, alteration or relocation of, any piping, or pressure boundary, or in any cases where piping is set up temporarily for exhibition purposes.
	1. PRESSURE TESTING

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Designer Note:

When connecting to existing piping: Joints for B31.1, B31.3, B31.5, and B31.9 pressure systems shall be leak tested in accordance with the Engineering Standards Manual STD-342-100 Chapter 17, Pressure Safety, Section EXIST - Legacy System Requirements, 3.0 Modification or Maintenance of an Existing System (or successor, e.g., Section PS-SP).

Qualified examiners are not required for code leak tests except when specified by the code, for example B31.3 Category M Fluid Service.

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

Note: Test pressures and durations are being moved from this Section to the fluid-specific Sections as revisions are made; specifier may and should do the same in Project Specification when not yet moved by LANL. As such, once the fluid-specific Section contains test pressures and durations, delete pressure/duration/method from this Section and refer to applicable Section.

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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: Test with water per NFPA 13 at a minimum of 200 psig, or 50 psig in excess of the system working pressure, whichever is greater, for 2 hours and shall maintain that pressure without loss.
			3. For modifications to existing piping bring system up to operating pressure gradually. Visually examine the piping for leaks at one-half the system operating pressure. Perform a final examination at the system operating pressure. No leaking from the piping indicates that the system meets the requirement of the project.
		2. Plumbing Piping:
			1. Pumped Drain Piping (UPC Code of Record)
				1. Pumped Drain: Test with water at [ ] psig for 2 hours

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

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* + - 1. 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.
			2. Sanitary Sewer Piping Beyond Building Wall: See Section 22 1316, Sanitary Waste and Vent Piping, for test pressures and durations.
			3. Potable Water Inside Building: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations.
			4. Potable Water Site Main to Building Backflow Preventer: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations
			5. Non-potable Water: See Section 22 1100, *Facility Water Distribution*, for test pressures and durations.
			6. Stormwater Piping:
				1. See Section 22 1413, *Facility Storm Water 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
				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 (Less than 150 psig design pressure)
			1. See Section 22 1500, Compressed Air Piping, for test pressures and durations.
		3. Instrument Air (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 (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 (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: 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.
			1. Piping subject to external pressure shall be tested at 1.5 times the external differential pressure, but not less than 15 psig.

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Note: ASME B31.3 paragraph 345.2.2 only requires the test pressure to be maintained a minimum of 10 minutes. Sensitive leak test for double-wall containment piping is required to meet ASME Case 180. ASTM E1003 Section 10 Pressure Drop method must be held for 100 minutes minimum (recommend 200 minutes) for this method.

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* + 1. Hazardous Waste and Vent Double-Wall Containment Piping Including Fire:
			1. Inner Pipe and Vent: Test with water at 5 psig +/- [ ] psig for [10] minutes or for sensitive leak testing including requirements specified in manufacturer’s written instructions. [Test per ASME B31.3]
			2. Outer Pipe: Test with air at [5] psig +/- [ ] psig for [30] minutes including requirements specified in manufacturer’s written instructions.

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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 at 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 modify this para. to meet B31.3 testing requirements. B31.3 pneumatic test pressure shall be between 1.1 and 1.33 times design pressure.

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* + 1. Laboratory Gas Piping (Building Piping):
			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.
		2. Reverse Osmosis (RO) Water Piping:
			1. RO piping shall be leak tested with potable water at 1.5 times system design pressure +/- [ ] psig per ASME B31.3 para. 345.4 and shall show no drop in pressure in a two-hour period. Calibrated gauges are required.
			2. Upon completion of the leak testing, all piping installed shall be cleaned with chlorinated water (sodium hypochlorite, 500 ppm) for a four-hour period. After the four-hour cleaning, drain the chlorinated water and thoroughly flush piping with deionized water.
		3. Process Piping (B31.3):

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When multiple process piping systems are present, specify testing requirements for each individual system below or, preferably, in applicable fluid-specific Section.

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* + - 1. Category Normal process piping shall be hydrostatically leak tested at [120] psig +/- [ ] psig per ASME B31.3 para. 345.4. Leak test shall be maintained for at least 10 minutes, and all joints and connections shall be examined for leaks as required in paragraph 345.2.2 (a). ASME B31.3 para. 345.5 pneumatic leak tests within the limitations of Laboratory Gas [3.1.L] above are acceptable when hydrostatic leak tests are impracticable.
			2. Category D piping shall be tested per ASME B31.3, 345.7.
		1. Category M Fluid Service Piping (B31.3):
			1. Category M Fluid Service Piping shall be leak tested at [  ] psig +/- [  ] psig per [354.4][345.5] and sensitive leak tested per ASME B31.3, Paragraphs M345 and 345.8.
			2. A qualified examiner with a procedure that can demonstrate sensitivity not less than 10-3std cc/s is required for the sensitive leak test.
		2. Non-Metallic Pipe (B31.3):
			1. Test non-metallic (plastic) pipe per ASME B31.3, para. A345; however, PVC and CPVC piping shall not be pneumatically tested.
		3. Other Process Piping (B31.3):

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For any process fluids not addressed above, test pressure and duration may be specified here.

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* + - 1. Perform hydrostatic and/or pneumatic testing, using the test pressures and durations listed below. Hydrostatic testing shall not be performed on piping designed to carry gases. Testing shall be performed per the requirements in ASME B31.3, Section 345.
	+ Hydrostatic testing (150% of design pressure) at \_\_\_\_psig +/- [ ] psig for \_\_\_ minutes [10 is minimum].

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* + Pneumatic testing (110% of design pressure) at \_\_\_\_ psig +/- [ ] psig for \_\_\_ minutes [10 is minimum].
		- 1. Piping subject to external pressure shall be tested at 1.5 times the external differential pressure, but not less than 15 psig +/- [ ] psig.
			2. Other evaluations such as pressure/vacuum decay may be performed, but shall not be used as a substitute for the code leak test or sensitive leak test required for Category M fluid service.
			3. For new construction attachment to existing systems, the final weld connecting piping systems or components which have been successfully tested need not be leak tested, but shall be examined in-progress and 100% radiographic or 100% ultrasonic examined as a closure; see 345.2.3(c).
	1. RETESTING
		1. If piping does not pass the test or leaks are found, locate leak, safely vent pressure, and then repair leaks.
		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 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. 11, dated June 30, 2022.