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**Roseville**

**Irvine**

**San Diego**

**Pressurized Piping  
Pre-Task Meeting Checklist**

Date / / Project Name \_\_\_\_\_ Project # \_\_\_\_\_

This Pre-Task meeting is being conducted by: \_\_\_\_\_

Print: \_\_\_\_\_ Sign: \_\_\_\_\_

Title: \_\_\_\_\_ Company: \_\_\_\_\_

Location of Activity: \_\_\_\_\_

Activity Start Time \_\_\_\_\_ Completion Time \_\_\_\_\_

**PURPOSE** –To identify hazards associated with the above referenced task and the methods that will be used to eliminate those hazards.

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**ATTENDEES:**

NAME	SIGNATURE	COMPANY



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## **PRE-TASK CHECKLIST FOR PRESSURIZED PIPE TESTING**

### **A. PIPING PRESSURE TEST (Preliminary Information)**

Pressure in a fluid system may be considered to be a measure of the ENERGY per unit VOLUME ( $P = E / V$ ) of that system. Pressure is commonly referred to as the applied FORCE distributed over the cross-sectional AREA ( $P = F / A$ ) of the system, but pressure can also be thought of as the amount of WORK being done on a system along the TRANSVERSE of its cross-sectional AREA. ( $P = W / Ad$ )

When dealing with a pressure in an incompressible liquid at rest, such as water, the medium is treated as a continuous distribution of matter. (Similar to a solid) When you deal with a compressible medium, such as a gas, the pressure must be observed as the average pressure from each molecular collision within the walls of the system.

An incompressible fluid, such as water, is characterized as a fluid in which the DENSITY remains constant through an isothermal (constant temperature) PRESSURE change. In other words, the velocity of the individual water molecules does not increase with an increase in PRESSURE. Also, in an incompressible fluid, the force is transmitted throughout the fluid. In a long, completely filled piping system, if a pump is turned on at one end, the water will immediately begin to flow to the other end of the pipe.

In a compressible fluid, such as air, the application of a force at one end does not transmit throughout the entire fluid. Instead, the fluid compresses near where the force is applied. Its DENSITY locally increases in this area, but not at the other end of the system. In other words, with water, the pressure being applied is the same at all points along the system. With air, the pressure can be different in different areas of the system, and it can take a considerable amount of time for the system pressure to equalize.

Based on this characteristic, compressible fluids are capable of absorbing and storing greater amounts of energy in their respective systems than are incompressible fluids. As a result, air has an energy density more than 200 times that of water for a given pressure. That means, that a piping system that is being pressure tested with air has over 200 times as much energy stored in it than the same system would have if it was being tested with water at the same pressure.

This is why hydrostatic testing is preferred over pneumatic testing. There is much less energy stored in the system.

Please read through the pre-task procedure and checklist on the following pages.



**B. TESTING PREPARATION & NOTIFICATION**

1. Written notification must be provided to the Rudolph & Sletten project Superintendent two days prior to the start of ANY testing. Written notification shall include:
  - a) Locations of piping being tested and boundaries of area under test
  - b) Piping service, material and type of joints
  - c) Whether test is preliminary or final
  - d) Test Pressure
  - e) Duration of test
  - f) Testing method (static, hydrostatic, flow, etc.)
  - g) Testing medium (air, water, nitrogen, etc.)
  - h) Relevant specification section
2. All crews for all trades shall be notified of areas that will be under test every morning prior to the start of daily activities and understand the importance / precautions of performing work within close proximity to piping.
3. All end of line blind flanges, caps and plugs must be fully bolted, welded, brazed, soldered or attached in a permanent fashion that is approved for the piping system being tested. Personnel will be protected from line ends.
4. All temporary end of line flanges, caps and blinds that are greater than 2" in diameter must be installed with bleed valves and a maximum 3/4" plug, regardless of testing medium used. Personnel protection will be in place.
5. Warning signs shall be placed along egress pathways in the area tested, as well as at all end of line flanges, caps and plugs, noting that piping system is under pressure in the area. Work in close proximity to systems under test will be prohibited.
6. For underground piping, thrust block locations must be laid out if installed.
7. Piping system must have high side vents and low point drains where required.
8. A walk-down of the piping system to be tested must be performed by an R&S representative prior to testing for visual confirmation of readiness for testing, including complete joints, correct valve positions, identification and awareness of check valves installed, plugs, caps and temporary blinds.

**C. TESTING PROCEDURES**



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1. If a preliminary test is to be performed using AIR/NITROGEN as the medium, the test pressure will be limited to 10 psig for systems categorized within ASME B31.9 standards and 25 psig for systems categorized within ASME B31.1 standards. An R&S representative will determine which standards are applicable. (See Appendix A for ASME B31.1 and B31.9 standards)
2. Medical Gas piping is pre-tested with Nitrogen, and per NFPA 99 (2002 Edition) 5.1.12.2.3.4 & 5, "The test pressure for gases shall be 1.5 times the system working pressure but not less than a gage pressure of 150 psig. The test pressure for vacuum shall not be less than a gage pressure of 60 psig."
3. If Med Gas contractor is working on a system to find leaks prior to pre-test, 30 psig may be used. For systems that have passed pre-test inspection, or are no longer being worked on, 10 psig may be left on the system as a means of ensuring piping integrity.\*\*\*\*
4. If finished product has been installed and Medical Gas Piping has been terminated to nipples at headwall, R&S will review allowable pressure left on system at the request of contractor
5. Per ASME, pneumatic testing is prohibited for piping systems that contain cast iron pipe or plastic pipe that is subject to brittle failure. Pneumatic testing is also prohibited for piping systems that contain soldered joints over 2 inches in size and for systems containing solvent cement joints over 2 inches in size.  
**Note:** Fire protection piping that is considered to be "wet" piping will NOT be pneumatically tested unless it falls under criteria listed in NFPA 13 8-2.3. Fire protection piping that is considered to be "dry" or part of a "double interlocked" system shall be tested according to NFPA 13 8-2.3.
6. For final tests requiring pneumatic pressurization, the initial test pressure will be no greater than 10psig and then slowly raised to 25% of the final test pressure and thereafter in increments of 10% of the final test pressure.
7. Subcontractor is responsible for their own testing, as well as any testing that is to be conducted for second tier subcontractor.
8. Pre-task checklist must be completed prior to testing. (See next page)
9. System is to be depressurized immediately following test. Pneumatic systems must be taken down to no more than 10 psig. Water filled systems must be drained to no more than 30 psig. Subcontractor to notify R&S once system has been depressurized. R&S Safety to confirm and log in time and date.
10. All signs must be removed from area following completion of test.
11. No pressurized vessel or piping will be handled on the jobsite using a crane or forklift, unless the Rudolph & Sletten Superintendent has been notified and the proper warnings and



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precautions have been implemented. Written confirmation from R&S must be received before proceeding.

12. No system shall be left under test pressure for greater than 24hrs. If system must be left pressurized overnight, Subcontractor must notify R&S Safety

**D. PRE-TEST CHECKLIST:** This checklist applies to all tests (Pre-Tests & Final Tests)

1. Subcontractor Name: \_\_\_\_\_
2. System to be Tested: \_\_\_\_\_
3. Type of Test: Pre-Test  Final
4. Location
  - a) Building/Floor/Level: \_\_\_\_\_
  - b) Area: \_\_\_\_\_
  - c) Date: \_\_\_\_\_
5. Written notification has been provided to the Rudolph & Sletten project superintendent at least two days prior to the start of testing Yes  No
6. Can a hydrostatic test be performed? Yes  No   
If "NO", provide a reason: \_\_\_\_\_  
\_\_\_\_\_
7. Has the following information been provided in the abovementioned notification:
  - a) Location of piping system to be tested and boundaries of area under test: Yes  No
  - b) Test pressure: Yes  No
  - c) Duration of the test: Yes  No
  - d) Test method (Water or Air): Yes  No
  - e) Specification section(s) relevant to this work. Yes  No
8. Has a complete system walk-down been performed with an R&S representative:  
Yes  No
9. Have end of line blind flanges, caps and plugs have been fully secured in place as approved for piping system being tested (i.e. welded, brazed, soldered, bolted, etc.)  
Yes  No



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- 10. Temporary end of line flanges, blinds and caps greater than 2” in size have been installed with bleed valves and a maximum 3/4” plug: Yes  No
- 11. System valves are in the correct positions (Open if shown as Normally Open; Closed if shown as Normally Closed or to isolate system being tested) Yes  No
- 12. A certified and calibrated pressure gauge has been installed on each system being tested.  
Yes  No
- 13. Warning signs have been hung in the following places: (See back page for Warning Sign template)
  - a) End of line flanges, blinds, caps and plugs. Yes  No
  - b) Egress pathways in area being tested. Yes  No
  - c) System shutoff valves. Yes  No
- 14. Barriers have been provided in location of test drops and gauges. Yes  No
- 15. Piping system has been installed with low point drains and high side vents. Yes  No
- 16. If system being tested includes a riser:
  - a) Warning signs have been placed on all floors served by the riser under test. Yes  No
  - b) Systems on other floors that are tapped into the riser, but not part of the test have been isolated from the system by isolation valves. Yes  No
- 17. For preliminary pneumatic leak test, subcontractor will be using a test pressure of 10 psig per ASME B31.9 or 25 psig per ASME B31.1, whichever is deemed applicable by R&S representative. (See Appendix A for ASME B31.1 and ASME B31.9 standards)
- 18. Subcontractor has personnel and work plan in place for water cleanup if necessary

Comments

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Note: Marking, underlining, highlighting, and circling items or text on this document in addition to writing comments in the spaces provided and in the page margins is an acceptable method for documenting what was discussed during the pre-task meeting. Please make sure that these comments and other markings clearly indicate the intended message. (i.e. does a checkmark mean yes or no)

File with jobsite safety documents.

Attachments: Appendix A ASME B31.1 and ASME B31.9

## Chapter VI

# Inspection, Examination, and Testing

### 936 INSPECTION AND EXAMINATION

#### 936.1 General

Inspection applies to quality assurance functions performed by the owner, or for the owner by persons other than the manufacturer, fabricator, or erector. Examination applies to quality control functions performed by personnel employed by the manufacturer, fabricator, or erector of the piping.

**936.1.1 Quality System Program.** A quality system program is not required by this Code. If a system is required by the engineering design, the program in Non-mandatory Appendix A or a similar program acceptable to the owner may be used.

#### 936.2 Required Inspection

Prior to initial operation, it is the owner's responsibility to verify that all required examination and testing have been completed and to inspect the piping, or have it inspected, to the extent necessary to satisfy himself that it conforms to all applicable requirements of this Code and the engineering design.

**936.2.1 Access to the Work.** The owner and his representatives shall have access to any place where work concerned with the piping is being performed. This includes manufacture, fabrication, assembly, erection, examination, and testing of the piping.

**936.2.2 Rights of Owner.** The owner and his representatives shall have the right to audit any examinations, to inspect the piping using examination methods specified in the engineering design, and to review all certifications and records.

#### 936.3 Responsibility for Examination

Inspection does not relieve the manufacturer, fabricator, or erector of responsibility for performing all required examinations and preparing suitable records for the owner's use.

#### 936.4 Methods of Examination

The methods described herein shall be performed by competent personnel.

**936.4.1 Visual Examination.** Visual examination is observation of the portions of materials, components, joints, supports, and other piping elements that are or can be exposed to view before, during, or after manufacture, fabrication, assembly, or erection. This examination

includes verification of Code and engineering design requirements for materials and components, dimensions, joint preparation, alignment, joining practices, supports, assembly, and erection.

#### 936.5 Type and Extent of Required Examination

Unless otherwise specified in the engineering design, the type of examination shall be visual examination in accordance with the method in para. 936.4.1.

If the degree of examination and inspection or the basis for rejection is to be more rigorous than required by this Code, it shall be a matter of prior agreement between the fabricator or installer and the purchaser.

#### 936.6 Acceptance Criteria

Imperfections or indications revealed by examination shall be evaluated in accordance with the following criteria. They are acceptable unless they exceed the specified limitations. Those that exceed the stated limits are defects, and the work shall be repaired or replaced in accordance with the appropriate requirements in Chapter V. Acceptance criteria in para. 936.6 not detectable by visual examination are included to indicate a minimum quality level acceptable under this Code.

**936.6.1 Girth Welds and Groove Welds.** Limitations on imperfections are as follows.

(a) *Cracks.* None permitted.

(b) *Lack of Fusion.* The length of unfused areas shall not be more than 20% of the circumference of the pipe, or of the total length of the weld, and not more than 25% in any 6 in. (152 mm) of weld.

(c) *Incomplete Penetration.* The total joint penetration shall not be less than the thickness of the thinner of the components being joined, except that incomplete root penetration is acceptable if it does not exceed the lesser of  $\frac{1}{32}$  in. (1 mm) or 20% of the required thickness, and its extent is not more than 25% in any 6 in. (152 mm) of weld.

(d) *Undercut and Reinforcement.* Undercut shall not exceed the lesser of  $\frac{1}{32}$  in. (1 mm) or 12½% of wall thickness. Thickness of weld reinforcement shall not exceed  $\frac{3}{16}$  in. (4.8 mm).

(e) *Concave Root.* Concavity of the root surface shall not reduce the total thickness of the joint, including reinforcement, to less than the thickness of the thinner of the components being joined.

(f) *Excess Root Penetration.* The excess shall not exceed the lesser of  $\frac{1}{8}$  in. (3.2 mm) or 5% of the inside diameter of the pipe.

(g) *Weld Surfaces.* There shall be no overlaps or abrupt ridges and valleys.

**936.6.2 Fillet Welds.** Limitations on imperfections in fillet, socket, and seal welds are the same as in para. 936.6.1 for cracks, lack of fusion, undercut, and weld surfaces.

**936.6.3 Brazed and Soldered Joints.** Limitations on imperfections in brazed and soldered joints are as follows:

(a) Penetration of filler metal inside the pipe shall not exceed 100% of the wall thickness.

(b) There shall be no visible unfilled joint space.

(c) There shall be no visible evidence of excessive overheating.

**936.6.4 Threaded Joints.** Limitations on imperfections for ASME B1.20.1 threaded pipe joints are as follows:

(a) No more than six and no less than two threads shall be visible after makeup of the joint.

(b) There shall be no severe chipping or tearing of visible threads.

**936.6.5 Caulked and Leaded Joints.** Limitations on imperfections in caulked and leaded joints are as follows:

(a) The finished joint shall be within  $\frac{1}{4}$  in. (6.4 mm) of the rim of the bell.

(b) In the finished joint, the spigot shall be centered in the bell within  $\frac{1}{8}$  in. (3.2 mm).

(c) The joint shall be made in a continuous pour.

**936.6.6 Flanged Joints.** Limitations on imperfections in flanged joints are as follows:

(a) When observed during assembly, the flange faces shall be parallel within 1 deg, and the force required to align pipe axes shall not exceed 10 ft-lb (14 N·m) per in. (25 mm) of nominal pipe diameter.

(b) Bolts and nuts shall be fully engaged.

**936.6.7 Flared, Flareless, and Compression Joints.** Limitations on imperfections in flared, flareless, and compression joints are as follows:

(a) There shall be no cracks in flare or tube end.

(b) Tube ends shall be cut square (visual).

(c) Tube ends shall be free of distortion or grooves that would hinder assembly or sealing.

(d) Negligible force shall be required to align ends.

**936.6.8 Mechanical and Proprietary Joints.** Imperfections in mechanical and proprietary joints shall be within the limitations established by the manufacturer.

**936.6.9 Solvent-Cemented, Adhesive, and Heat-Fusion Joints.** Limitations on imperfections in solvent-cemented, adhesive and heat-fusion joints are as follows:

(a) Internal protrusion shall not exceed 50% of wall thickness for solvent-cemented and 25% for adhesive and heat-fusion joints.

(b) There shall be no visible unfilled or unbonded areas.

**936.6.10 Hand Lay-Up Joints.** Limitations on imperfections in hand lay-up joints are as follows:

(a) There shall be no visible evidence of lack of bonding.

(b) The length of the laid-up joint shall be at least the lesser of 4 in. (102 mm) or the nominal diameter of the pipe.

(c) The thickness of the laid-up joint shall be at least equal to the wall thickness of the thinner pipe.

## 937 LEAK TESTING

### 937.1 General

Prior to initial operation, each piping system shall be tested for leakage. Hydrostatic testing in accordance with para. 937.3 shall be employed if possible. Pneumatic testing may be used in lieu of hydrostatic testing only in accordance with the limitations in para. 937.4. Initial service testing may be used within the limitations of para. 937.5.

### 937.2 Preparation for Testing

**937.2.1 Exposure of Joints.** All joints including welds shall be left uninsulated and exposed for examination during the test.

**937.2.2 Temporary Supports.** Piping designed for vapor or gas may be provided with temporary supports if necessary to support the weight of test liquid.

**937.2.3 Expansion Joints.** Expansion joints that cannot sustain the reactions due to test pressure shall be provided with temporary restraint, or they may be isolated from testing.

**937.2.4 Equipment Not Subject to Testing.** Equipment that is not to be subjected to the test pressure shall be isolated from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

**937.2.5 Precautions Against Overpressure.** If the test pressure is to be maintained for a period of time during which the test fluid is subject to thermal expansion or any other source of overpressurizing during the test, precautions such as the installation of a relief device shall be taken to avoid excessive pressure.

### 937.3 Hydrostatic Testing

**937.3.1 Test Medium.** Water at ambient temperature shall be used as the test medium except where there



is risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping.

**937.3.2 Vents and Drains.** Vents shall be provided at high points in the system to release trapped air while filling the system. Drains shall be provided at low points for complete removal of the test liquid.

**937.3.3 Preliminary Check.** The system shall be examined to see that all equipment and parts that cannot withstand the test pressure are properly isolated. Test equipment shall be examined to ensure that it is tight and that low pressure filling lines are disconnected.

#### 937.3.4 Hydrostatic Test Pressure

(a) *Minimum Pressure.* Except as limited in para. 937.3.4(b), a piping system shall be subjected to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure.

(b) *Maximum Pressure.* The test pressure shall not exceed the maximum test pressure for any vessel, pump, valve, or other component in the system under test. A check shall be made to verify that the stress due to pressure at the bottom of vertical runs does not exceed either of the following:

- (1) 90% of specified minimum yield strength
- (2) 1.7 times the *SE* value in Mandatory Appendix I (for brittle materials)

**937.3.5 Examination for Leakage.** Following the application of hydrostatic test pressure for at least 10 min, examination shall be made for leakage of the piping, and at all joints and connections. If leaks are found, they shall be eliminated by tightening, repair, or replacement, as appropriate, and the hydrostatic test repeated until no leakage is found.

### 937.4 Pneumatic Testing

**937.4.1 General.** Compressed gas poses the risk of sudden release of stored energy. For that reason, pneumatic testing shall be used only within the following limitations:

- (a) The piping system does not contain cast iron pipe or plastic pipe subject to brittle failure.
- (b) The system does not contain soldered or solvent cement joints over NPS 2 (DN 50).
- (c) The test pressure does not exceed 150 psig (1 034 kPa).
- (d) The system will be used in gas service, or for other reasons cannot be filled with water.

(e) Traces of a test liquid would be detrimental to the intended use of the piping.

**937.4.2 Test Medium.** The gas shall be nonflammable and nontoxic.

**937.4.3 Preliminary Test.** Prior to application of full pneumatic test pressure, a preliminary test of not more than 10 psig (69 kPa) shall be applied to reveal possible major leaks. (This preliminary test is not subject to the limitations in para. 937.4.1, and may be used in conjunction with hydrostatic testing or initial service testing.)

#### 937.4.4 Pneumatic Test Pressure

(a) Except as limited in para. 937.4.4(b), the test pressure shall not exceed 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium at each stage.

(b) The test pressure shall not exceed the maximum allowable pneumatic test pressure for any vessel, pump, valve, or other component in the system under test.

**937.4.5 Examination for Leakage.** After the preliminary test, pressure shall be raised in stages of not more than 25% up to full pneumatic test pressure, allowing time for equalization of strains and detection of major leaks at each stage. Following the application of test pressure for at least 10 min, the pressure may be reduced to design pressure and examination shall be made for leakage of the piping. Leaks may be detected by soap bubble, halogen gas, scented gas, test gage monitoring, ultrasonic, or other suitable means. If leaks are found, pressure shall be vented, appropriate repair or replacement shall be made, and the pneumatic test repeated until no leakage is found.

### 937.5 Initial Service Leak Test

**937.5.1 General.** For gases and steam and condensate service not over 15 psig (103 kPa gage), and for nontoxic, noncombustible, nonflammable liquids at pressures not over 100 psig (689 kPa) and temperatures not over 200°F (93°C), it is permissible to conduct the system testing with the service fluid as outlined in para. 937.5.2.

**937.5.2 Service Testing.** A preliminary test with air at low pressure (para. 937.4.3) may be used. In any event, the piping system shall be brought up to operating pressure gradually with visual examination at a pressure between one-half and two-thirds of operating pressure. A final examination shall be made at operating pressure. If the piping system is free of leaks, it will have met the requirements of this paragraph.

(A.2.2)  $\frac{1}{3}t$  for  $t$  from  $\frac{3}{4}$  in. (19.0 mm) to  $2\frac{1}{4}$  in. (57.0 mm), incl.

(A.2.3)  $\frac{3}{4}$  in. (19.0 mm) for  $t$  over  $2\frac{1}{4}$  in. (57.0 mm) where  $t$  is the thickness of the thinner portion of the weld

NOTE:  $t$  referred to in (A.2.1), (A.2.2), and (A.2.3) above pertains to the thickness of the weld being examined; if a weld joins two members having different thickness at the weld,  $t$  is the thinner of these two thicknesses.

(A.3) any group of indications in line that have an aggregate length greater than  $t$  in a length of  $12t$ , except where the distance between the successive indications exceeds  $6L$  where  $L$  is the longest indication in the group

(A.4) porosity in excess of that shown as acceptable in Appendix A-250 of Section I of the ASME Boiler and Pressure Vessel Code

(A.5) root concavity when there is an abrupt change in density, as indicated on the radiograph

(07) **136.4.6 Ultrasonic Examination.** When required by this Chapter (see Table 136.4), ultrasonic examination (UT) shall be performed in accordance with Article 4 of Section V of the ASME Boiler and Pressure Vessel Code and the following additional requirements.

(A) The following criteria shall also be met when performing ultrasonic examinations:

(A.1) The equipment used to perform the examination shall be capable of recording the UT data to facilitate the analysis by a third party and for the repeatability of subsequent examinations, should they be required. Where physical obstructions prevent the use of systems capable of recording the UT data, manual UT may be used with the approval of the Owner.

(A.2) NDE personnel performing and evaluating UT examinations shall be qualified and certified in accordance with their employer's written practice and the requirements of para. 136.3.2 of this Code. Personnel, procedures, and equipment used to collect and analyze UT data shall have demonstrated their ability to perform an acceptable examination using test blocks approved by the Owner.

(B) *Acceptance Standards.* Welds that are shown by ultrasonic examination to have discontinuities which produce an indication greater than 20% of the reference level shall be investigated to the extent that ultrasonic examination personnel can determine their shape, identity, and location so that they may evaluate each discontinuity for acceptance in accordance with (B.1) and (B.2) below.

(B.1) Discontinuities evaluated as being cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

(B.2) Other discontinuities are unacceptable if the indication exceeds the reference level and their length exceeds the following:

(B.2.1)  $\frac{1}{4}$  in. (6.0 mm) for  $t$  up to  $\frac{3}{4}$  in. (19.0 mm).

(B.2.2)  $\frac{1}{3}t$  for  $t$  from  $\frac{3}{4}$  in. (19.0 mm) to  $2\frac{1}{4}$  in. (57.0 mm).

(B.2.3)  $\frac{3}{4}$  in. (19.0 mm) for  $t$  over  $2\frac{1}{4}$  in. (57.0 mm) where  $t$  is the thickness of the weld being examined. If the weld joins two members having different thicknesses at the weld,  $t$  is the thinner of these two thicknesses.

## 137 PRESSURE TESTS

### 137.1 General Requirements

**137.1.1 Subassemblies.** When conducted in accordance with the requirements of this Code, the pressure testing of piping systems to ensure leak tightness shall be acceptable for the determination of any leaks in piping subassemblies.

**137.1.2 Temperature of Test Medium.** The temperature of the test medium shall be that of the available source unless otherwise specified by the Owner. The test pressure shall not be applied until the system and the pressurizing medium are approximately at the same temperature. When conducting pressure tests at low metal temperatures, the possibility of brittle fracture shall be considered.

**137.1.3 Personnel Protection.** Suitable precautions in the event of piping system rupture shall be taken to eliminate hazards to personnel in the proximity of lines being tested.

**137.1.4 Maximum Stress During Test.** At no time during the pressure test shall any part of the piping system be subjected to a stress greater than that permitted by para. 102.3.3(B).

**137.1.5 Testing Schedule.** Pressure testing shall be performed following the completion of postweld heat treatment, required by para. 132, nondestructive examinations required by Table 136.4, and all other fabrication, assembly and erection activities required to provide the system or portions thereof subjected to the pressure test with pressure retaining capability.

### 137.2 Preparation for Testing

**137.2.1 Exposure of Joints.** All joints including welds not previously pressure tested shall be left uninsulated and exposed for examination during the test. By prior agreement the complete system or portions thereof subject to test may be insulated prior to the test period provided an extended holding time pressurization of the system is performed to check for possible leakage through the insulation barrier.

**137.2.2 Addition of Temporary Supports.** Piping systems designed for vapor or gas shall be provided with additional temporary supports if necessary to support the weight of the test liquid. Such supports shall meet the requirements for testing and system cleanup procedures described in para. 122.10.

**137.2.3 Restraint or Isolation of Expansion Joints.**

Expansion joints shall be provided with temporary restraint if required for the additional pressure load under test, or they shall be isolated during the system test.

**137.2.4 Isolation of Equipment and Piping Not Subjected to Pressure Test.** Equipment that is not to be subjected to the pressure test shall be either disconnected from the system or isolated by a blank or similar means. Valves may be used for this purpose provided that valve closure is suitable for the proposed test pressure. Owner shall be aware of the limitations of pressure and temperature for each valve subject to test conditions and as further described in para. 107.1(C). Isolated equipment and piping must be vented.

**137.2.5 Treatment of Flanged Joints Containing Blanks.** Flanged joints at which blanks are inserted to blank off other equipment during the test need not be tested after removal of the blank provided the requirements of para. 137.7.1 are subsequently performed.

**137.2.6 Precautions Against Test Medium Expansion.** If a pressure test is to be maintained for a period of time during which the test medium in the system is subject to thermal expansion, precautions shall be taken to avoid excessive pressure. A pressure relief device set at  $1\frac{1}{3}$  times the test pressure is recommended during the pressure test, provided the requirements of paras. 137.1.4, 137.4.5, and 137.5.5 are not exceeded.

**137.3 Requirements for Specific Piping Systems**

**137.3.1 Boiler External Piping.** Boiler external piping [see para. 100.1.2(A)] shall be hydrostatically tested in accordance with PG-99 of Section I of the ASME Boiler and Pressure Vessel Code. The test shall be conducted in the presence of the Authorized Inspector.

**137.3.2 Nonboiler External Piping.** All nonboiler external piping shall be hydrostatically tested in accordance with para. 137.4. As an alternative, when specified by the owner, the piping may be leak tested in accordance with para. 137.5, 137.6, or 137.7. Lines open to the atmosphere, such as vents or drains downstream of the last shutoff valve, need not be tested.

**137.4 Hydrostatic Testing**

**137.4.1 Material.** When permitted by the Material Specification, a system hydrostatic test may be performed in lieu of the hydrostatic test required by the material specifications for material used in the piping subassembly or system provided the minimum test pressure required for the piping system is met.

**137.4.2 Provision of Air Vents at High Points.** Vents shall be provided at all high points of the piping system in the position in which the test is to be conducted to purge air pockets while the component or system is

filling. Venting during the filling of the system may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents.

**137.4.3 Test Medium.** Water shall normally be used as the test medium unless otherwise specified by the Owner. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Further recommended precautions on the quality of test water used for hydrotesting of austenitic (300 series) and ferritic (400 series) stainless steels are contained in Appendix IV, para. IV-3.4.

**137.4.4 Check of Test Equipment Before Applying Pressure.** The test equipment shall be examined before pressure is applied to ensure that it is tightly connected. All low-pressure filling lines and all other items not subject to the test pressure shall be disconnected or isolated by valves or other suitable means.

**137.4.5 Required Hydrostatic Test Pressure.** The hydrostatic test pressure at any point in the piping system shall not be less than 1.5 times the design pressure, but shall not exceed the maximum allowable test pressure of any nonisolated components, such as vessels, pumps, or valves, nor shall it exceed the limits imposed by para. 102.3.3(B). The pressure shall be continuously maintained for a minimum time of 10 minutes and may then be reduced to the design pressure and held for such time as may be necessary to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.

**137.5 Pneumatic Testing**

**137.5.1 General.** Except for preliminary testing in accordance with para. 137.5.4, pneumatic testing shall not be used unless the Owner specifies pneumatic testing or permits its use as an alternative. It is recommended that pneumatic testing be used only when one of the following conditions exists:

(A) when piping systems are so designed that they cannot be filled with water

(B) when piping systems are to be used in services where traces of the testing medium cannot be tolerated

**137.5.2 Test Medium.** The gas used as the test medium shall be nonflammable and nontoxic. Since compressed gas may be hazardous when used as a testing medium, it is recommended that special precautions for protection of personnel be observed when a gas under pressure is used as the test medium.

**137.5.3 Check of Test Equipment Before Applying Pressure.** The test equipment shall be examined before pressure is applied to ensure that it is tightly connected. All items not subjected to the test pressure shall be

disconnected or isolated by valves or other suitable means.

**137.5.4 Preliminary Test.** A preliminary pneumatic test not to exceed 25 psig [175 kPa (gage)] may be applied, prior to other methods of leak testing, as a means of locating major leaks. If used, the preliminary pneumatic test shall be performed in accordance with the requirements of paras. 137.5.2 and 137.5.3.

**137.5.5 Required Pneumatic Test Pressure.** The pneumatic test pressure shall be not less than 1.2 nor more than 1.5 times the design pressure of the piping system. The test pressure shall not exceed the maximum allowable test pressure of any nonisolated component, such as vessels, pumps, or valves, in the system. The pressure in the system shall gradually be increased to not more than one-half of the test pressure, after which the pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. The pressure shall be continuously maintained for a minimum time of 10 minutes. It shall then be reduced to the lesser of design pressure or 100 psig [700 kPa (gage)] and held for such time as may be necessary to conduct the examination for leakage. Examination for leakage detected by soap bubble or equivalent method shall be made of all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leaking.

### 137.6 Mass-Spectrometer and Halide Testing

**137.6.1** When specified by the Owner, systems with conditions of operation and design that require testing methods having a greater degree of sensitivity than can be obtained by a hydrostatic or pneumatic test shall be tested by a method, such as helium mass-spectrometer test or halide test, which has the required sensitivity.

**137.6.2** When a mass-spectrometer or halide test is performed, it shall be conducted in accordance with the instructions of the manufacturer of the test equipment. In all cases a calibrated reference leak, with a leak rate not greater than the maximum permissible leakage from the system, shall be used. The equipment shall be calibrated against the reference leak in such a way that the system leakage measured by the equipment can be determined to be not greater than the leak rate of the reference leak.

### 137.7 Initial Service Testing

**137.7.1** When specified by the owner, an initial service test and examination is acceptable when other

types of tests are not practical or when leak tightness is demonstrable due to the nature of the service. One example is piping where shut-off valves are not available for isolating a line and where temporary closures are impractical. Others may be systems where during the course of checking out of pumps, compressors, or other equipment, ample opportunity is afforded for examination for leakage prior to full scale operation. An initial service test is not applicable to boiler external piping.

**137.7.2** When performing an initial service test, the piping system shall be gradually brought up to normal operating pressure and continuously held for a minimum time of 10 minutes. Examination for leakage shall be made of all joints and connections. The piping system exclusive of possible localized instances at pump or valve packing shall show no visual evidence of weeping or leaking.

### 137.8 Retesting After Repair or Additions

**137.8.1** Repairs may be made to the pressure parts of boiler external piping after the hydrostatic test required by para. 137.3.1, provided the requirements of PW-54.2 of Section I of the ASME Boiler and Pressure Vessel Code are met.

**137.8.2** Nonpressure parts may be welded to the pressure parts of boiler external piping after the hydrostatic test required by para. 137.3.1, provided the requirements of PW-54.3 of Section I of the ASME Boiler and Pressure Vessel Code are met.

**137.8.3** In the event repairs or additions to non-boiler external piping are made following a test, the affected piping shall be retested in accordance with the provisions of para. 137.3.2. However, a system need not be retested after seal welding or after attachments of lugs, brackets, insulation supports, nameplates, or other nonpressure retaining attachments provided

(A) the attachment fillet weld does not exceed  $\frac{3}{8}$  in. (10.0 mm) thickness or, if a full penetration weld is used, the material attached does not exceed the nominal thickness of the pressure retaining member or  $\frac{1}{2}$  in. (12.0 mm), whichever is less

(B) welds shall be preheated as required by para. 131

(C) welds shall be examined as required by Table 136.4

(D) seal welds shall be examined for leakage after system startup

**137.8.4** All weld defect repairs shall be made in accordance with para. 127.4.11.