PRESSURE TESTS according to ASME 3.1.

APPENDIX H – LEAK/PRESSURE TESTING

PURPOSE

This Appendix provides guidance for hydrostatic and pneumatic tests. The specific code requirements are contained in paragraph 345 of ASME B31.3.

SCOPE

The information in this Appendix applies to the testing of metallic Category D and Normal fluid service process piping systems constructed to ASME B31.3 “Process Piping”. Nonmetallic piping and other fluid service categories have additional requirements.

GENERAL

TEST PREPARATION

1) All Code and design required examinations shall be complete prior to testing.

2) A preliminary walk-down of the piping to be tested shall be made. Test personnel shall correct and/or identify test boundaries, any problems, incomplete items, joint access, fill points, vent points and any scaffolding required.

3) All joints, including welds and mechanical joints, are to be left un-insulated and exposed for examination during the test, except that joints previously tested may be insulated or covered.

4) Hangers and supports shall be placed in the proper position prior to the filling of the system to be tested.

5) Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary to support the weight of the test liquid, as designated by the designer. Spring hangers should be placed in the locked position.

6) Expansion joints shall be provided with temporary restraint if required for additional pressure load under test, or shall be isolated from the test.

7) The test personnel shall assure that the components (e.g., instruments, valves, etc.) that are not to be subjected to the pressure test, are either disconnected from the piping or isolated by blind flanges or other means during the tests. Valves may be used for isolation, provided the valve (including the closure mechanism) is suitable for the proposed test pressure.

8) A flanged joint at which a blank is inserted to isolate other equipment during the test need not be examined for leaks. These joints should be leak tested during initial service.

9) If a pressure test is to be maintained for a period of time and the test liquid in the system is subject to changes in temperature, precautions shall be taken to avoid excessive pressure due to thermal expansion or freezing.

10) A preliminary air test at not more than 25 psi gage pressure may be made prior to hydrostatic test in order to locate major leaks.
PRESSURE TESTS according to ASME 3.1.

11) A test record shall be made for each leak test. The record shall include the following:
12) Date of test
13) Identification of piping to be tested (test boundaries)
14) Test fluid
15) Test pressure
16) Certification of the examiner
17) An example Pressure Test Record is provided at the end of this appendix.
18) Following hydrostatic or pneumatic leak testing, the piping system should be cleaned, and dried if necessary. Refer to Appendix K for cleaning techniques.
19) Prior to in-service leak test, the piping system should be cleaned, and dried if necessary. Refer to Appendix K for cleaning techniques.
20) During Hydrostatic testing or in-service leak testing, strainers should be used to protect equipment against the introduction of construction debris or dirt.

HYDROSTATIC LEAK TEST

TEST FLUID

1) The test fluid shall be water unless there is a possibility of damage due to freezing, or if the process or piping material would be adversely affected by water. In that case other suitable test fluids may be used. Special precautions are required if the test fluid is toxic or flammable.

2) The temperature of the test fluid should be no less than 40°F in piping systems subject to brittle fracture (i.e. carbon steel).

3) If the test fluid temperature produces condensation on the piping exterior surface, the water shall be heated to a temperature above the dew point or the test shall be postponed to a time when the dew point temperature has changed sufficiently such that condensation will not occur on the piping exterior surface.

4) Material and test water temperature shall be approximately equal prior to pressurizing the system.

5) High points in the system shall be vented so that air will be displaced while the system is being filled with the test fluid.

6) The operator shall take adequate measures to ensure that the piping system is not over-pressurized during hydrostatic testing. Adequate measures include a relief valve, or a dedicated operator to monitor pressure, or dual pressure regulators, etc.

TEST PRESSURE

1) The minimum hydrostatic test pressure for metallic piping shall be per the following equation.

\[ P_T = 1.5 \times P_D \times S_\text{f}/S_D \]

where: \( P_T \) = minimum test gage pressure
PRESSURE TESTS according to ASME 3.1.

\[ P_d = \text{internal design gage pressure} \]
\[ S_T = \text{allowable stress value at test temperature} \]
\[ S_D = \text{allowable stress value at design temperature} \]

Note: The maximum allowable value of \( S_T/S_D \) is 6.5

2) When a maximum test pressure is specified, the test pressure shall not exceed this amount.

3) When no maximum test pressure is specified, the test shall not be greater than 110% of the minimum.

4) When using water, static head due to differences in the elevation of the top of the piping system and the elevation of the test gage shall be accounted for in pressuring the piping system to be tested by the following equations:

\[ \text{SH (psi)} = \left( \text{HE} - \text{GE} \right) \times 0.433 \]

\[ P_{ST} = P_T + \text{SH} \]

where: \( \text{HE} = \text{high point elevation (ft)} \) \\
\( \text{GE} = \text{gage point elevation (ft)} \) \\
\( \text{SH} = \text{static head (psi)} \)

\[ P_{ST} = \text{minimum test gage pressure corrected for static head} \]

\[ 0.433 = \text{conversion factor (ft of water to psi)} \]

5) Pressure gages should be connected directly to the piping. Calibrated pressure gages shall be used in all Code testing. Pressure gage range should exceed the intended test pressure by approximately double but in no case should the range be less than one and one-half (1 1/2) times the test pressure.

HYDROSTATIC TESTING OF PIPING WITH VESSELS AS A SYSTEM

1) Where the test pressure of piping attached to a vessel is the same as or less than the test pressure for the vessel, the piping may be tested with the vessel at the test pressure of the piping.

2) Where the test pressure of the piping exceeds the vessel test pressure and isolation is not considered practicable, the piping and the vessel may be tested together at the test pressure of the vessel, if approved by the design authority. The vessel test pressure must not be less than 77% of the piping test pressure.

EXAMINATION FOR LEAKS

1) Test personnel shall ensure the hydrostatic pressure is maintained for sufficient time to determine if there are any leaks. A minimum time of 10 minutes is required by Code. After the hydrostatic pressure time has been satisfied, all joints shall examined visually for leaks.

2) Examination shall be made of all welds and mechanical joints. There shall be no visible evidence of leakage. Welds and joints previously tested need not be examined for leaks.

3) Leakage detected in welded joints shall be repaired by draining, repair welding, non-destructively examining in accordance with original requirements, and re-tested to the original test pressure.
PRESSURE TESTS according to ASME 3.1.

4) Mechanical joint leakage at permanent joints shall be repaired, examined in accordance with original requirements, and re-tested to the original test pressure.

PNEUMATIC TESTING

PRECAUTIONS

Pneumatic testing involves a hazard due to possible release of energy stored in compressed gas. Care must be taken to minimize the chance of brittle failure during testing by initially assuring the system is suitable for pneumatic testing. Pneumatic testing may be used in lieu of hydrostatic testing, recognizing the hazard of energy stored in compressed gas, when a hydrostatic test is considered impracticable. Guidance for when to use a pneumatic test is provided below.

1) When components, appurtenances, or systems are so designed or supported that they cannot be safely filled with water.

2) When components, appurtenances, or systems, that are not readily dried, are to be used in services where traces of the testing medium cannot be tolerated.

TEST FLUID

Air or Nitrogen shall be used as a test medium unless otherwise specified by engineering. Special precautions are required if the test fluid is toxic or flammable.

TEST PRESSURE

1) The pneumatic test pressure shall be per the following equation.
   \[ P_T = 1.1 \times P_D \]
   where:
   \[ P_T = \text{test gage pressure} \]
   \[ P_D = \text{internal design gage pressure} \]

2) Temporary test pressure relief device shall be provided during pneumatic testing. The set pressure shall not be higher than the test pressure plus the lesser of 50 psi or 10% of the test pressure.

EXAMINATION FOR LEAKS

1) The pressure in the piping system shall be increased gradually in steps providing sufficient time to allow the piping to equalize strains during the test. When the system pressure reaches the lesser of ½ the test pressure or 25 psi a preliminary leak check of the system shall be made. Following the preliminary leak check the pressure shall be increased gradually until the test pressure is reached. The pressure shall then be reduced to the design pressure before examining for leaks.

2) Examination shall be made of all welds and mechanical joints. There shall be no visible evidence of leakage. Welds and joints previously tested need not be examined for leaks.

3) During pneumatic tests, all joints shall be examined with a bubble-producing solution specifically compounded for leak detection.
PRESSURE TESTS according to ASME 3.1.

4) Leakage detected in welded joints shall be repaired by de-pressurizing, repair welding, non-destructively examined as the original, and re-tested to the original test pressure.

5) Mechanical joint leakage at permanent joints shall be repaired, examined as original, and re-tested to the original test pressure.

PIPING SUBJECT TO EXTERNAL PRESSURE

TEST METHOD

Either the hydrostatic or pneumatic test method described above may be used to test externally pressured piping. The piping shall be tested at an internal gage pressure 1.5 times the external pressure, but not less than 15 psi.
PRESSURE TESTS according to ASME 3.1.

PRESSURE TEST RECORD

(SAMPLE – Edit to suit but capture all data required for ASME B31 compliance)

<table>
<thead>
<tr>
<th>TEST NUMBER:</th>
<th>PROJECT NO.:</th>
<th>PAGE 1 OF</th>
</tr>
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**TEST INFORMATION**

SYSTEM DESCRIPTION:

DESCRIPTION OF TEST BOUNDARIES: (Attach Sketch Showing Boundaries as Required. P&ID Recommended)

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<th>DESIGN PRESSURE:</th>
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<table>
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<th>PNEUMATIC</th>
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<table>
<thead>
<tr>
<th>TEST FLUID:</th>
<th>APPLICABLE CODE:</th>
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**TEST REQUIREMENTS**

REQUIRED TEST PRESSURE:  
TEST FLUID TEMPERATURE:  
REQUIRED TEST DURATION:  
AMBIENT TEMPERATURE:  

**GAUGE PRESSURE CALCULATION (See Section 4.2.4)**

ELEVATION DIFFERENCE BETWEEN GAUGE AND HIGH POINT:

\[ X \text{ CONVERSION FACTOR:} \]

PLUS REQUIRED TEST PRESSURE:

EQUALS REQUIRED GAUGE PRESSURE:

**TEST RESULTS**

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<table>
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<tr>
<th>FINISH TIME:</th>
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ACTUAL GAUGE PRESSURE:

**TEST EQUIPMENT**

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**REMARKS:**

**TEST ACCEPTANCE**

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