

UG-99: HYDROSTATIC TEST



Hydrostatic test for pressure vessels constructed in compliance with the rules of ASME Section VIII, Division 1 (Code) is conducted after all fabrication has been completed, and after all examinations have been performed. This article describes the code requirements for the hydrostatic test; however, it does not highlight requirements for specific materials.

Internal Pressure

Vessels designed for internal pressure shall be subjected to a hydrostatic test pressure at least equal to 1.3 times the maximum allowable working pressure (MAWP) multiplied by the lowest stress ratio (LSR) for pressurized boundary materials of which the vessel is constructed. The stress ratio for each pressure boundary material is the ratio of the allowable stress at its test temperature to the allowable stress at its design temperature.

Calculated Hydrostatic Test Pressure

Hydrostatic test pressure based on a calculated pressure may be used by agreement between the user and the manufacturer. When this pressure is used, the authorized inspector (AI) may require the manufacturer to furnish the calculations used in determining the hydrostatic test pressure.

Upper Limit for Hydrostatic Test Pressure

The code does not specify an upper limit for hydrostatic test pressure. However, if the test pressure is allowed to increase to such a degree that the vessel is subjected to visible permanent distortion, the authorized inspector reserves the right to reject the vessel.

ASME Section VIII, Division 2 requires that the stress from the test pressure shall not exceed 95% of the yield stress of the pressure vessel material.

Combination Units

INDEPENDENT PRESSURE CHAMBERS: Pressure chambers of combination units that have been designed to operate independently shall be hydrostatically tested as separate vessels, i.e., each chamber shall be tested without pressure in the adjacent chamber.

If the common elements are designed for a differential pressure that is larger than the higher MAWP on the adjacent chamber, the hydrostatic test shall subject the common elements to at least their design differential pressure times LSR.

DEPENDENT PRESSURE CHAMBERS: When the pressure chambers of the combination units have their common elements designed for the maximum differential pressure that is less than the higher pressure in the adjacent chambers, the common elements shall be subjected to at least 1.3 times the differential pressure times the LSR.

Following the test of common elements, the adjacent chambers shall be hydrostatically tested simultaneously. The vessel stamping and the MDR must describe the common elements and their limiting differential pressure.

Pressure Vessels Designed for Vacuum Only

These are pressure vessels where the MAWP is less than or equal to zero. They shall be subjected to either of the following:

1. The applied test pressure not less than 1.3 times the specified external design pressure.
2. Vacuum test conducted at the lowest value of specified absolute internal design pressure. In conjunction with the vacuum, a leak test shall be performed following a written procedure.

Inspection of All Joints and Connections

The code does not specify how long should the hydrostatic test pressure be applied for. It may be as specified in the Manufacturer's hydrotest procedure (subject to Client approval) or specified by the Client. About 30 minutes is a common practice.

Following the application of the hydrostatic test pressure, the test pressure shall be reduced to the test pressure divided by 1.3. An inspection shall be made of all joints and connections. Except for leakage that might occur at temporary test closures for those openings intended for welded connections, leakage is not allowed.

Visual inspection of joints and connections may be waived provided:

1. A suitable gas leak test is applied.
2. Substitution of the gas leak test is by agreement between the Manufacturer and Inspector.
3. All welded seams that will be hidden by assembly are given a visual examination prior to assembly.
4. Vessel shall not contain "lethal" substance.

Hydrostatic Test Temperature

Vents shall be provided at all high points of the vessel to purge possible air pockets while the vessel is filling. Before applying pressure, the test equipment shall be examined to see that it is tight and that all low-pressure filling lines and other appurtenances that should not be subject to the test pressure have been disconnected. The test pressure shall not be applied until the vessel and its content are at about the same temperature.

Any liquid that is nonhazardous at any temperature may be used for the hydrostatic test if it is below its boiling point. Combustible liquids having a flash point less than 110°F may be used only near atmospheric temperature tests.

For materials not covered in Part UCS: To minimize the risk of brittle fracture, the coldest metal temperature during the hydrostatic test should be at least 30°F warmer than the vessel MDMT and shall never be colder than the vessel MDMT.

For Part UCS materials: To minimize the risk of brittle fracture, the coldest metal temperature during the hydrostatic test should be at least 30°F warmer than one of the following:

1. The MDMT marked on the nameplate when the requirements of UG-20(f) have been met.
2. The MDMT marked on the nameplate when the UCS-66(b) or UCS-66(i) coincident ratio has not been applied to calculate the vessel MDMT. The allowable reduction in MDMT permitted by UCS-68(c) may be used when applicable.

UCS-66(b) is applicable when the coincident ratio is less than 1, and UCS-66(i) is applicable when Part UCS components are impact tested, and coincident ratio is less than 1.

3. The temperature determined either from Figure UCS-66 or from impact testing when the UCS-66(b) or UCS-66(i) coincident ratio has been applied to calculate the vessel MDMT. The allowable reduction in MDMT permitted by UCS-68(c) may be used when applicable.

The metal temperature during the hydrostatic test need not exceed 120°F. If the test temperature exceeds 120°F, inspection of the vessel should be delayed until the temperature is reduced to 120°F or less.

Painting and Coating

Unless permitted by the user, pressure-retaining welds of vessel shall not be painted or otherwise coated either internally or externally prior to the pressure test. When painting or coating prior to hydrostatic test is permitted, or when internal nonmetallic linings are to be applied, the pressure-retaining welds shall first be leak tested. Such a test may be waived with the approval of the user.

Vessels for lethal service shall not be painted or coated either internally or externally prior to hydrostatic test. They shall also not be internally lined by mechanical or welded attachments prior to hydrostatic pressure test unless the requirements of UCL-51 are followed. These requirements include a test for tightness of the applied lining and inspection of the interior of the vessel to determine if there is any seepage of test fluid through the lining. When seepage occurs, the lining shall be repaired. Repetition of radiography and heat treatment, or hydrostatic test of the vessel after lining repairs is not required unless there is a reason to suspect that the defect may have penetrated the base metal.

Test Gaskets and Bolting

Custom designed flange assemblies, including modified standard flange assemblies when additional calculations are required, shall be tested with gaskets and bolting that meet the following requirements:

1. Flange shall be assembled with identical gasket used for operation of pressure vessel, or a gasket with the same outside diameter, inside diameter, thickness, gasket factor (m), and minimum seating stress (y) as used in the flange design.
2. Flange shall be assembled with bolting having identical allowable stress at room temperature as used in the flange design.

The user may allow either or both requirements to be waived. The use of test gasket and bolting with properties differing from those used in design calculations does not necessarily verify the integrity of flange joints.

Test Gages

An indicating gage shall be connected directly to the vessel or with a pressure line that does not include intermediate valves. If the indicating gage is not readily visible to the operator controlling the pressure applied, an additional indicating gage shall be provided where it will be visible to the operator throughout the duration of the test. For large vessels, it is recommended that a recording gage be used in addition to indicating gages.

Dial indicating pressure gages used in testing shall be graduated over a range of about twice the intended test pressure, but in no case shall the range be less than 1-1/2 nor more than 4 times that pressure. Digital reading pressure gages having a wider range or pressure may be used, provided the readings give the same or greater degree of accuracy as obtained with dial pressure gages.

All gages shall be calibrated against a standard dead-weight tester or a calibrated master gage. Gages shall be recalibrated at any time there is a reason to believe that they are in error.

Application of Certification Mark

The certification Mark shall be applied after the hydrostatic test is complete. However, it may be preapplied to a nameplate. The nameplate may be attached to the vessel after the final fabrication and examination sequence but before the hydrostatic test, provided the sequence of stamping is described in the Manufacturer's accepted Quality Control System.

Postweld Heat Treatment

Postweld heat treatment, when required, shall be done before the hydrostatic test and after any welded repairs. When PWHT is not a service requirement or when it is not required to adjust the MDMT per UCS-68, then PWHT need not be done after welded repairs. A preliminary hydrostatic test to reveal leaks prior to PWHT is permissible.