Designation: E 1003 – 95 (Reapproved 2000)

Standard Test Method for Hydrostatic Leak Testing[1]

This standard is issued under the fixed designation E 1003; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the testing of components for leaks by pressurizing them inside with a liquid.

1.2 This test method can be used on piping, valves, and containers with welded or fitted sections which can be sealed at their ends and which are designed for internal pressure.

1.3 Basic procedures are described based on the type of inspection used. These procedures should be limited to finding leakage indications of 4.5×10^{-9} mol/s (1×10^{-4} Std cm^3/s)[2] or larger.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 1316 Terminology for Nondestructive Examinations[3]

2.2 *Other Documents:*

SNT-TC-1A Recommended Practice for Personal Qualification and Certification in Nondestructive Testing[4]

ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, see Terminology E 1316 Section E.

4. Summary of Test Method

4.1 Hydrostatic testing requires that a component be completely filled with a liquid, such as water. Pressure is slowly applied to the liquid until the required pressure is reached. This pressure is held for the required time at which point the component is inspected visually to locate leaks or the pressure on the gage is recorded to determine the components total leakage.

4.2 The two basic procedures are described together with methods for improving their sensitivity.

4.2.1 *Pressure Drop Indication*—This procedure is used primarily to measure total system leakage.

4.2.2 *Visual Inspection for Leakage*— This procedure is intended primarily to locate leaks.

4.3 Ultrasonic pretesting for gross leaks is described.

5. Personnel Qualification

5.1 It is recommended that personnel performing leak testing attend a dedicated training course on the subject and pass a written examination. The training course should be appropriate for NDT level II qualification according to Recommended Practice No. SNT-TC-1A of the American Society for Nondestructive Testing or ANSI/ASNT Standard CP-189.

6. Significance and Use

6.1 This test method is useful for quality control testing and field inspection of piping systems, pipelines, valves, and containers that are expected to retain liquids. It is not sensitive enough for leak testing when toxic or explosive gas is expected to be retained under pressure.

7. Interferences

7.1 The interior and exterior welds and joints where leaks are often found must be free of oil, grease, flux, slag, or other contaminants that might temporarily block or mask leakage. New systems should be tested prior to painting, where practical.

7.2 Hydrostatic testing should not be performed before a leak test using air or a tracer gas. The liquid test media may clog small leaks causing later tests to be inaccurate.

7.3 Test liquid must be equal or above atmosphere temperature or droplets will form on the outside. The minimum temperature of the liquid should be 16°C (61°F).

---

[1] This test method is under the jurisdiction of ASTM Committee E-7 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.08 on Leak Testing.

Current edition approved Sept. 10, 1995. Published November 1995. Originally published as E 1003 – 84. Last previous edition E 1003 – 94.

[2] The gas temperature is referenced to 0°C. To convert to another gas reference temperature, T_{ref}, multiply the leak rate by $(T_{ref} + 273)/273$.

[3] *Annual Book of ASTM Standards*, Vol 03.03.

[4] Available from American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

7.4 If the container to be tested has parts made of stainless steel, nickel, or chromium alloys, the liquid or any additives used must have a sulfur and halogen content of less than 50 ppm of each. If water is used as a test fluid it should be deionized.

7.5 To avoid brittle fracture, the test pressure must not be applied until the metal and the test fluid are approximately the same temperature. The metal should be a minimum of 16°C (61°F) prior to the application of pressure.

7.6 If a test liquid other than water is used, the liquid's flash point should be 93°C (200°F) or above.

7.7 If plastic parts are used in the test container, the fluid should not promote stress cracking or softening on the plastic.

7.8 When the test container has carbon steel components, a rust inhibitor should be used.

8. Apparatus

8.1 *Pressure Gage*—The gage must be able to withstand normal test pressures and be accurate enough to record small pressure drops. Pressure gages should be calibrated before each test. The gage must be accurate to within 1 % of full scale. The gage must read at least $1.5\times$ but not more than $4\times$ the maximum test pressure to be used. (See Terminology E 1316 for a description of terms.)

8.2 *Pressure Relief Valve*.

8.3 *Pressure Alarm*.

8.4 *Emergency Pressure Shut-Off Valve*.

8.5 *Trapped Air Vent*.

8.6 *Pressure Pump*.

8.7 *Liquid Test Media*.

8.8 *Pressure Hoses and Fittings*.

8.9 *Protection Chamber for High-Pressure Tests*.

9. General Procedures

9.1 *Openings*:

9.1.1 Seal all openings using plugs or covers that can withstand the test pressure and can be completely removed after the test.

9.1.2 The test fluid inlet should be located on the bottom of the test object with the trapped air vent at the highest point.

9.1.3 Components rated at pressures below the test pressure must be isolated.

9.2 *Gages*—One or more test gages must be connected to the system. If more than one gage is used, one may be a recording gage. At least one gage which is used for acceptance of the test shall be calibrated within 30 days prior to use. One indicating gage must be easily visible to the operator controlling the pressure throughout the pressurizing and testing cycle.

9.3 *Pre-Test Inspection*:

9.3.1 Before pressurizing is begun, inspect the outside of the test object to verify that it is dry and all welds and connectors are exposed if a visual inspection is to be conducted.

9.3.2 Securely brace critical areas that may not be able to withstand the weight.

9.4 *Pressurizing*—Gradually increase the pressure in the system to 50 % of test pressure and make an initial check for leakage. Thereafter slowly increase the pressure to the final test pressure. The test pressure usually is between 75 % and 150 % of the operating design pressure.

9.5 *Leak Test*:

9.5.1 At the completion of test pressure holding time, examine the system for leakage. Examination for leakage shall be made of all accessible joints and connections, attachment welds where practical, and weep holes for paddings and attachments. Also inspect the area around inaccessible leakage sites.

9.5.2 The inspector shall circle all accessible leaks found on the equipment using a nondeleterious marker. The magnitude of leak shall be described in terms of: damp or moist area, drops per minute or steady stream.

9.6 *Depressurizing*—After inspection release the pressure slowly. The air vents need to be opened during draining to admit air and prevent collapsing of the test system.

10. Pressure Drop Method

10.1 Pressurize the system in accordance with Section 8.

10.2 After reaching full pressure check the system to make sure all trapped air has been removed.

10.3 Disconnect the pressure pump and allow the pressure in the system to stabilize for a period of 10 min or 5 % of the test time whichever is longer.

10.4 After stabilization, record the exact pressure and monitor during the test period.

10.5 *Sensitivity*:

10.5.1 Sensitivity for this type of test using water as the test fluid is normally 4.5×10^{-7} mol/s $(1\times10^{-2}$ Std $cm^3/s)^2$.

10.5.2 By lengthening the test period, results can often be improved to 4.5×10^{-8} mol/s $(1\times10^{-3}$ Std $cm^3/s)^2$.

10.5.3 Sensitivity increases to 4.5×10^{-8} mol/s $(1\times10^{-3}$ Std $cm^3/s)^2$ can be achieved when the test fluid's resistance to flow is decreased by use of a water additive and an alternative test fluid, such as a penetrant.

11. Visual Inspection Method

11.1 Pressurize the system in accordance with the procedures in Section 8.

11.2 After reaching test pressure, inspect the outside surfaces for leakage.

11.2.1 Test pressure should be held for a minimum of 6 min/cm (1.5 min/in.) of wall thickpness. As a minimum the test pressure should be held for 10 min and the maximum time should be limited to 2 h.

11.2.2 If the system is not intended to operate under steady pressure, pulse the pressure in the system one or more times after each complete inspection cycle by dropping the pressure to 50 % of final test pressure and bringing it back to test pressure.

11.2.3 If the outside of the system is covered by insulation which is not removed, increase the test time by a factor of 10, to a maximum of 4 h.

11.3 *Sensitivity*:

11.3.1 Normal sensitivity for visual inspection using deionized or distilled water as the test fluid is 4.5×10^{-7} mol/s $(1\times10^{-2}$ Std $cm^3/s)^2$.

11.3.2 Sensitivity can be improved to 4.5×10^{-8} mol/s $(1\times10^{-3}$ Std $cm^3/s)^2$ by using products to enhance leakage visibility as follows:

11.3.2.1 Water developer applied to outside which changes color in contact with moisture.

11.3.2.2 Visible dye tracer added to the test water.

11.3.2.3 Fluorescent dye tracer added to the test water.

11.3.3 Sensitivity can be improved to 4.5×10^{-8} mol/s $(1 \times 10^{-3}$ Std cm ^{3}/s$)^2$ by lowering the resistance to test liquid flow at the interface between the fluid and the leak by using a water additive and an alternate test fluid, such as a penetrant.

11.3.4 By combining a visibility enhancer and low resistance to flow, sensitivity of the test can be improved to 4.5×10^{-9} mol/s $(1 \times 10^{-4}$ Std cm ^{3}/s$)^2$.

12. Pretest to Locate Gross Leaks

12.1 This test can be applied to the system prior to hydrostatic testing to locate leaks larger than 4.5×10^{-7} mol/s $(1 \times 10^{-2}$ Std cm ^{3}/s$)^2$ and as a precautionary procedure to save time.

12.2 *Ultrasonic Test*:

12.2.1 Use air, nitrogen, or other nonflammable gas as a test medium.

12.2.2 Pressurize the system with the gas gradually to 50 % of design pressure. A minimum pressure is 170 kPa (25 psi) for this test.

12.2.3 Inspect all joints and connections and welds with an acoustic leak detector capable of hearing airborne audio frequencies in the range of 45 000 Hz.

13. Report

13.1 The following information should be recorded at the time of the measurements and included in the report:

13.1.1 Date tested.

13.1.2 Test conditions (temperature, pressure, test time).

13.1.3 Leak locations.

13.1.4 Leakage rate.

13.1.5 Test fluid.

13.1.6 Signature of tester.

14. Precision and Bias

14.1 This procedure is believed to represent the best available method. No round-robin tests have been made to determine the precision and reliability of this method. The bias of the test is dependent on the operational procedure used and the training and qualification of the operators. No statement is made about the precision or bias of the procedure since the result merely states whether there is conformance to the criteria for success specified in the test method.

15. Keywords

15.1 hydrostatic leak testing; leak testing; pressure leak testing