



## Standard Test Method for Leaks Using Bubble Emission Techniques<sup>1</sup>

This standard is issued under the fixed designation E 515; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers procedures for detecting or locating leaks, or both, by bubble emission techniques. A quantitative measure is not practical. The normal limit of sensitivity for this test method is  $4.5 \times 10^{-10}$  mol/s ( $1 \times 10^{-5}$  Std cm<sup>3</sup>/s).<sup>2</sup>

- 1.2 Two techniques are described:
- 1.2.1 Immersion technique, and
  - 1.2.2 Liquid application technique.

NOTE 1—Additional information is available in ASME Boiler and Pressure Vessel Code, Section V, Article 10-Leak Testing, and Guide E 479.

1.3 *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 479 Guide for Preparation of a Leak Testing Specification<sup>3</sup>
  - E 1316 Terminology for Nondestructive Examinations<sup>3</sup>
- 2.2 *Other Documents:*
- SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing<sup>4</sup>
  - ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel<sup>4</sup>
  - ASME Boiler and Pressure Vessel Code, Section V, Article 10-Leak Testing<sup>5</sup>
- 2.3 *Military Standard:*

MIL-L-25567D Leak Detection Compound Oxygen Systems<sup>6</sup>

### 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 The basic principle of this method consists of creating a pressure differential across a leak and observing for bubbles in a liquid medium located on the low pressure side. The sensitivity of the method is dependent on the pressure differential, the gas used to create the differential, and the liquid used for testing. As long as the pressure differential can be maintained across the area to be tested, this method can be used.

### 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 The immersion technique is frequently used to locate leaks in sealed containers. Leaks in a container can be seen independently. Leak size can be approximated by the size of the bubble. It is not suitable for measurement of total system leakage.

6.2 The liquid film technique is widely applied to components and systems that can not easily be immersed and is used to rapidly locate leaks. An approximation of leak size can be made based on the type of bubbles formed, but the technique is not suitable for measuring leakage rate. It can be used with a vacuum box to test vessels which cannot be pressurized or where only one side is accessible.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee E-7 on Non-destructive 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 515 – 74. Last previous edition E 515 – 94.

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

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>4</sup> Available from American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228 – 0518.

<sup>5</sup> Available from American Society of Mechanical Engineers, 345 E. 47th Street, New York, NY 10017.

<sup>6</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

**7. Interferences**

7.1 Surface contamination of the test specimen, if small immersed parts, in the form of grease, rust, weld slag, etc., may be a source of bubbles giving false indication of leakage. Test specimens should be thoroughly cleaned to avoid rejection of acceptable items.

7.2 Contaminated detection fluid or one that foams on application can cause spurious surface bubbles on the test specimen.

7.3 An excessive vacuum on the low-pressure side when using the vacuum differential technique may cause the detection fluid to boil.

7.4 If the component to be tested has parts made of stainless steel, nickel, or chromium alloys, the test fluid must have a sulfur and halogen content of less than 10 ppm of each.

7.5 Immediate application of high pressure may cause large leaks to be missed in the liquid application technique.

7.6 If the component to be tested has parts made of polyethylene or structural plastic, the test fluid must not promote environmental stress cracking (E.S.C).

7.7 If the test fluid is to be used on oxygen systems it must meet the requirements of MIL-L-25567D.

**8. Immersion Technique**

8.1 *Application*—This technique is applicable to test specimens whose physical size allows immersion in a container of fluid when the test specimen can be sealed prior to the test.

**8.2 Techniques for Creating Pressure Differential:**

8.2.1 *Pressurization of Test Specimen*— Seal components and apply an elevated pressure, or if accessible, increase the internal pressure for test purposes.

8.2.2 *Elevated-Temperature Test Fluid*— Heat the test fluid to a temperature not exceeding the maximum rated temperature of the test specimen. This will cause expansion of the gas inside the test specimen, creating a pressure differential. This technique is usually limited to use on very small parts.

8.2.3 *Vacuum Technique*—Immerse the test specimen in the test fluid and then place the test fluid container in the vacuum chamber. Reduce the pressure in the chamber to a point that does not allow the test fluid to boil, thus creating a pressure differential. This technique is normally used on very small parts.

8.3 *Test Fluids Used in Immersion Technique*—The following test fluids may be used, provided they are not detrimental to the component being tested:

8.3.1 *Water*—Should be treated with a wetting agent up to 1/3 by volume to reduce surface tension and promote bubble growth.

8.3.2 *Methyl Alcohol (Technical Grade), Undiluted*—Not suitable for the heated-bath technique or the vacuum technique.

8.3.3 *Ethylene Glycol (Technical Grade), Undiluted.*

8.3.4 *Mineral Oil*—Degreasing of the test specimens may be necessary. This is the most suitable fluid for the vacuum technique.

8.3.5 *Fluorocarbons or Glycerin*—Fluorocarbons are not recommended for stainless steel nuclear applications.

**8.4 Procedures:**

**8.4.1 Pressurized Test Specimen:**

8.4.1.1 *Specimens Sealed at Elevated Pressures*—Place the test specimen or area being tested in the selected test fluid and observe for a minimum period of 2 min. Interpret as leakage a stream of bubbles originating from a single point or two or more bubbles that grow and then release from a single point.

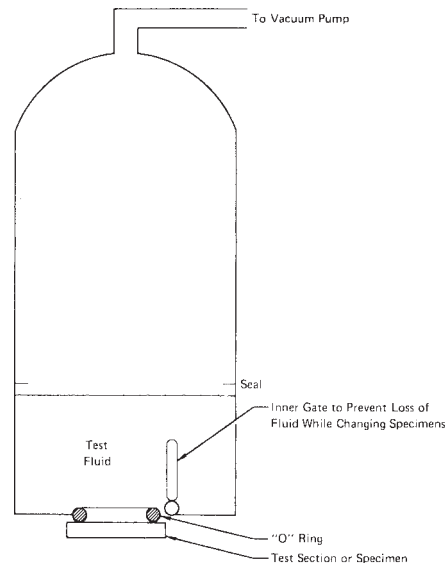
8.4.1.2 *Very Small Specimens Sealed at Ambient or Reduced Pressures*—Place the test specimen in a pressure chamber and expose to an elevated pressure. The actual pressure is dependent on the specimens. Place the specimen in the selected test fluid within 2 min after removal from the pressure chamber and observe for a minimum period of 2 min. Interpret as leakage a stream of bubbles originating from a single point.

8.4.2 *Elevated Temperature Test Fluid*— Place the test specimen in the test fluid which is stabilized and maintained at an elevated temperature at a temperature dependent on the specimen. Observe for a stream of bubbles originating from a single point or two or more bubbles that grow and then release from a single point. Interpret either as indicating leakage. The time of observation shall be dependent on the internal volume of the specimen and the case materials of the enclosure. Dwell time must be sufficient to allow a pressure increase to a pressure dependent on the specimen.

8.4.3 *Vacuum Technique*—Place the test specimen in a container of the selected test fluid and place the container in a vacuum chamber with viewing ports. Reduce the pressure in the vacuum chamber and observe for a stream of bubbles originating from a single point or two or more bubbles that grow and then release from a single point. The amount of vacuum used will be dependent on the test fluid and should be the maximum obtainable without the test fluid boiling. This technique is also applicable to unsealed components or specimen sections by use of the apparatus shown in Fig. 1.

**9. Liquid Application Technique**

9.1 *Application*—This technique is applicable to any test specimen on which a pressure differential can be created across the area to be examined. An example of this technique is the application of leak-test solutions to pressurized gas-line joints.



**FIG. 1 Vacuum Chamber Technique**

It is most useful on piping systems, pressure vessels, tanks, spheres, pumps, or other large apparatus on which the immersion techniques are impractical.

9.2 *Location of Bubble Test Fluid*—Apply the test liquid to the low-pressure side of the area to be examined and then examine the area for bubbles in the fluid. Take care in applying the fluid to prevent formation of bubbles. Flow the solution on the test area. Joints must be completely coated. The pressure differential should be created before the fluid is applied, to prevent clogging of small leaks.

9.3 *Type of Bubble Test Fluid*—A solution of commercial leak-testing fluids may be used. The use of soap buds or household detergents and water is not considered a satisfactory leak-test fluid for a bubble test, because of lack of sensitivity due to masking by foam. The fluid should be capable of being applied free of bubbles so that a bubble appears only at a leak. The fluid selected should not bubble except in response to leakage.

9.4 *Vacuum Technique*—Place a vacuum box (see Fig. 2) over the bubble test fluid. In testing equipment, such as storage tank floors and roofs, place the vacuum box over a section of the weld seam and evacuate to 3 psi (20.68 kPa) (or what the applicable standard requires) and hold for a minimum time of 15 s.

## 10. Precision and Bias

10.1 *Accuracy*—The methods are not intended to measure leakage rates but to locate leaks on a go, no-go basis. Their accuracy for locating leaks of  $4.5 \times 10^{-10}$  mol/s ( $1 \times 10^{-4}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup> and larger is  $\pm 5\%$ . Accuracy for locating smaller leaks depends upon the skill of the operator.

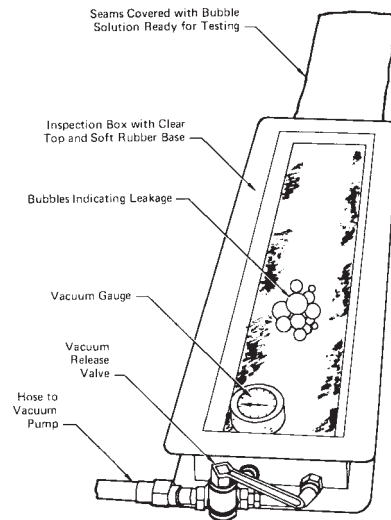


FIG. 2 Vacuum Box

10.2 *Repeatability*—On a go, no-go basis, duplicate tests by the same operator should not vary by more than  $\pm 5\%$  for leaks of  $4.5 \times 10^{-9}$  mol/s ( $1 \times 10^{-4}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup>.

10.3 *Reproducibility*—On a go, no-go basis, duplicate tests by other trained operators should not vary by more than 10% for leaks of  $4.5 \times 10^{-9}$  mol/s ( $1 \times 10^{-4}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup> and larger.

## 11. Keywords

11.1 bubble leak testing; film solution leak test; immersion leak test; leak testing; vacuum box leak testing

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