Designation: E 427 – 95 (Reapproved 2006)

Standard Practice for
Testing for Leaks Using the Halogen Leak Detector
(Alkali-Ion Diode)[1]

This standard is issued under the fixed designation E 427; 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 practice covers procedures for testing and locating the sources of gas leaking at the rate of 2.2×10^{-14} mol/s (5×10^{-10} Std cm³/s).[2] The test may be conducted on any device or component across which a pressure differential of halogen tracer gas may be created, and on which the effluent side of the area to be leak tested is accessible for probing with the halogen leak detector.

1.2 Five methods are described:

1.2.1 *Method A*—Direct probing with no significant halogen contamination in the atmosphere.

1.2.2 *Method B*—Direct probing with significant halogen contamination in the atmosphere.

1.2.3 *Method C*—Shroud test.

1.2.4 *Method D*—Air-curtain shroud test.

1.2.5 *Method E*—Accumulation test.

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

1.4 *This standard does not purport to address all of 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:* [3]
E 1316 Terminology for Nondestructive Examinations

2.2 *Other Documents:*
ASNT "Leak Testing Handbook" Volume One of "Nondestructive Testing Handbook"[4]

SNT-TC-1A Recommended Practice for Personnel 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 Practice

4.1 Section 1.8 of NASA's *Leakage Testing Handbook*[5] will be of value to some users in determining which leak test method to use. Section 11 of the *ASNT Testing Handbook* may also be of value.

4.2 These methods require halogen leak detection equipment with a full-scale readout of at least 1.3×10^{-13} mol/s (3×10^{-10} Std cm³/s)[2] on the most sensitive range, a maximum 1 min drift of 0 and sensitivity drift of ± 15 percent of full scale on this range, and ± 5 percent or less on others (see 8.1.5).

4.3 Method A (Fig. 1) is the simplest test, requiring only that a halogen tracer-gas pressure be created across the area to be tested, and the searching of the atmospheric side of the area with the detector probe. This method detects leakage and locates its source or sources, when used in a test area free from significant halogen contamination in the atmosphere (see 7.1). Experience has shown that leak detection down to 4.5×10^{-10} mol/s (1×10^{-5} Std cm³/s)[2] in factory environments will usually be satisfactory if reasonable precautions are taken against releasing halogens in the building. If a test booth is constructed so as to be purged with clean outdoor air, this level may be reduced to 4.5×10^{-12} mol/s (1×10^{-7} Std cm³/s).[2] Testing down to 4.5×10^{-13} mol/s (1×10^{-9} Std cm³/s)[2] will require additional halogen removal. This can be accomplished by passing the test-booth purge air through a bed of activated charcoal.

4.4 Method B (Fig. 2) is essentially the same as Method A, except that the amount of air drawn by the probe from the test area is reduced, and the required sample flow is made up with

Halogen Leak Detector   Method A

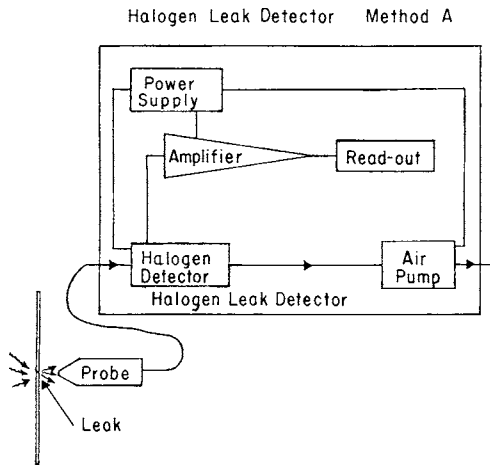**FIG. 1 Halogen Leak Detector, Method A**

Proportioning Probe
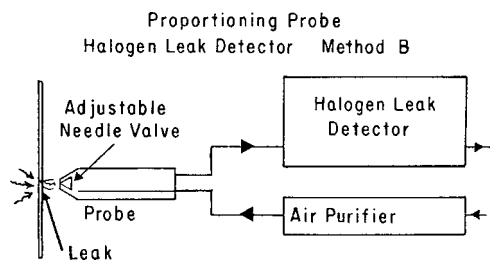Halogen Leak Detector   Method B

FIG. 2 Proportioning Probe, Halogen Leak Detector, Method B

pure (that is, zero-halogen) air. This reduced sample intake has the disadvantage of reducing the vacuum-cleaner effect of the larger flow and thus requires closer and more careful probing. However, the tolerance to atmospheric halogen can be increased up to 100 times. Also, large leaks beyond the range of Method A can be accurately located (but not measured) by Method B.

4.5 Method C (Fig. 3 and Fig. 4) is suited for leak testing items which have an approximate cross-section dimension of 2 in. (50 mm), but may be as long as 30 ft (10 m). In this method, air, either atmospheric or purified, is passed over the halogen-pressurized part, which is inside a close-fitting container. The discharge air from the container is sampled by the halogen detector, and any additional halogen content indicated. The shroud principle may be applied in a manner as simple as Fig. 4, wherein a piece of tape is applied around a flanged joint to be tested, or as complete as in Fig. 3. The latter provides isolation of the detector from atmospheric halogens, a pure-air reference supply, and a convenient calibration means. This enables detection of leaks as small as 4.5×10^{-12} mol/s (1×10^{-7} Std cm^3/s).[2]

4.6 Method D (Fig. 5) is useful for high-production testing of small items such as transistors which have been previously subjected to a halogen gas pressure above atmospheric (bombed), or testing the sealed-off end of a fill tube, and the like. In this method, the end of the shroud is always open, and the detector always draws a sample from the lower end. Atmospheric halogens are prevented from entering by a laminar-flow pure-air curtain. When any leaking object is inserted below the flow division level, the leakage is then picked up by the detector. This method is useful for detecting leaks down to 4.5×10^{-12} mol/s (1×10^{-7} Std cm^3/s)[2] in size.

4.7 Method E (Fig. 6) is similar to Method C (Fig. 3), except it provides for testing parts up to several cubic meters in volume. This is accomplished by allowing the leakage to accumulate in the chamber for a fixed period, while keeping it well mixed with a fan, and then testing the internal atmosphere for an increase in halogen content. The practical sensitivity attainable with this method depends primarily on two things. First, on the volume between the shroud and the object; and second, on the amount of halogen outgassing produced by the object. Thus, a part containing rubber, plastics, blind cavities or
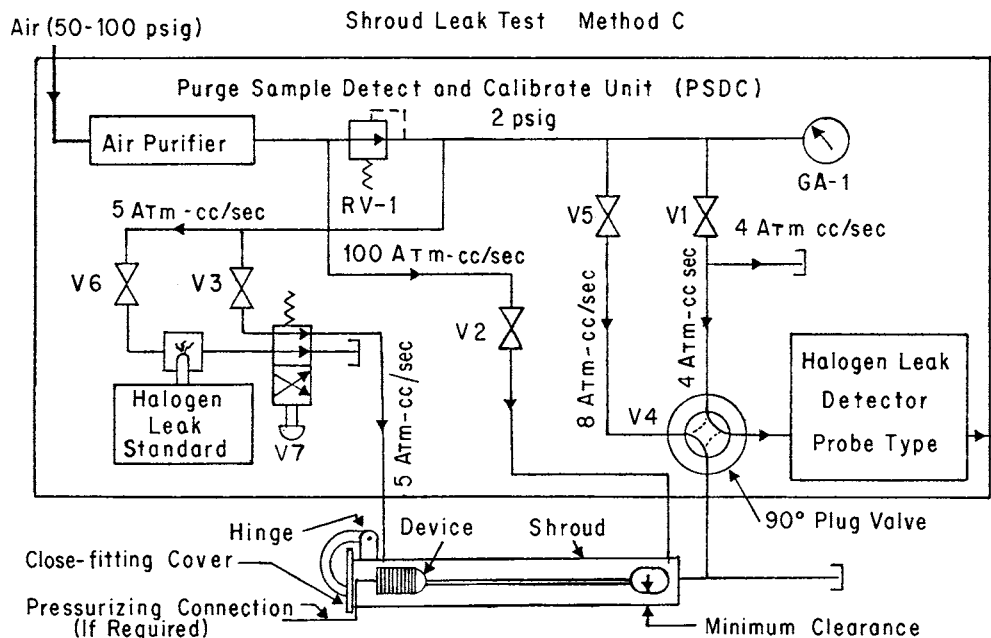

FIG. 3 Shroud Leak Test, Method C
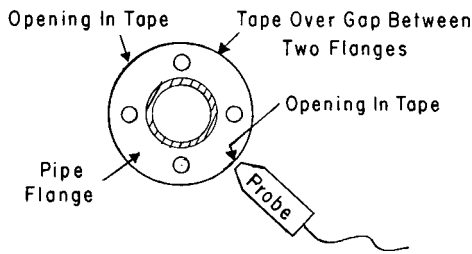
FIG. 4 Simple Shroud Leak Test, Method C

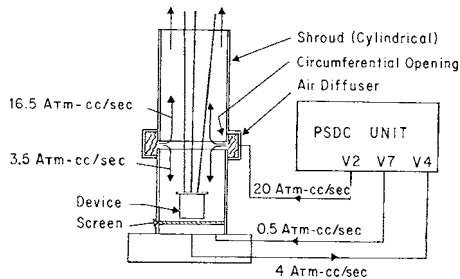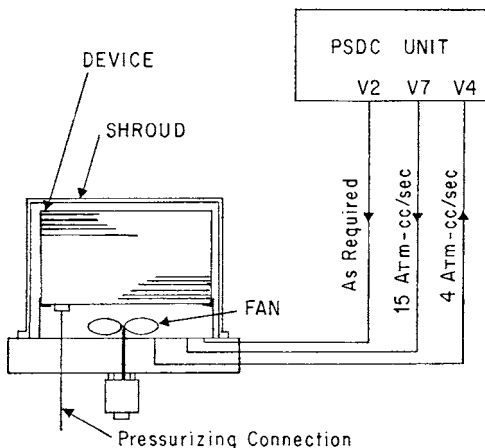**FIG. 5 Air-Curtain-Shroud Leak Test, Method D**

FIG. 6 Accumulation Leak Test, Method E

threads cannot be tested with the sensitivity obtainable with a smooth metallic part. The sensitivity of the test and net volume of the system are related as follows:

$$A_s = LF/V \qquad (1)$$

where:
A_s = rate of halogen increase in the volume, mol/s,
L = leak rate into the volume, mol/s,
F = flow rate in the detector probe, mol/s, and
V = net volume of the system, cm^3.

For practical operating considerations, the minimum value of A_s that should be used is about 8.9×10^{-16} mol/s (2×10^{-11} Std cm^3/s).[2] (This will give a detector readout of 100×10^{-11} or 4.5×10^{-13} mol/s (1×10^{-9} Std cm^3/s)[2] after a 50-s accumulation period.) Thus, (based on F = mol/s) a 2.2×10^{-14} mol/s (5×10^{-10} Std cm^3/s)[2] may be detected in a

system of 10^2 cm^3 net volume, or a 2.2×10^{-9} mol/s (5×10^{-5} Std cm ^{3}/s)[2] leak in a 10^7-cm^3 system. Where variables, time, volume, and leak rate permit, values of readout should be set in the 4.5×10^{-12} or 4.5×10^{-13} mol/s (10^{-7} or 10^{-8} Std cm ^{3}/s)[2] range for less critical operation. Methods C, D, and E are well adapted for automation of valving and material handling.

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 Halogen leak testing can be used to indicate the presence, location and magnitude of leaks in a closed vessel. This test method is normally used for production examination. Its use with halogenated refrigerant gases has been declining because of concerns about the effect of these gases on the ozone layer.

7. Interferences

7.1 *Atmospheric Halogens*—When direct probing (Methods A and B) is used to locate leaks, the leak detector probe is drawing in air from the atmosphere. If the atmosphere is contaminated with halogen to a degree that produces a noticeable indication on the detector, the detection of halogen from leaks becomes much more difficult. Significant atmospheric contamination with halogen is defined as the level where the detector response, when the probe is moved from zero-halogen air to test-area atmosphere, exceeds that expected from the smallest leak to be detected. For reliable testing, atmospheric halogen must be kept well below this level.

7.2 *Halogens Outgassed from Absorbent Materials*—When leak testing is done in enclosures which prevent atmospheric contamination from interfering with the test (Methods A, B, and C), halogen absorbed in various nonmetallic materials (such as rubber or plastics) may be released in the enclosure. If the amount released starts to approach the amount from the leak in the same period of time, then a reliable leak test becomes more difficult. The amount of such materials in the enclosure, or their exposure to halogen must then be reduced to obtain a meaningful test.

7.3 *Pressurizing with Test Gas*—In order to evaluate leakage accurately, the test gas in all parts of the device must contain substantially the same amount of tracer gas. When the device contains air prior to the introduction of test gas, or when an inert gas and a tracer gas are added separately, this may not be true. Devices in which the effective diameter and length are not greatly different (such as tanks) may be tested satisfactorily by simply adding tracer gas. However, when long or restricted systems are to be tested, more uniform tracer distribution will be obtained by first evacuating to a few torr, and then filling with the test gas. The latter must be premixed if not 100 percent tracer.