



## Standard Practice for Testing for Leaks Using the Halogen Leak Detector (Alkali-Ion Diode)<sup>1</sup>

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 ( $\epsilon$ ) 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  $2.2 \times 10^{-14}$  mol/s ( $5 \times 10^{-10}$  Std cm<sup>3</sup>/s).<sup>2</sup> 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:*

E 1316 Terminology for Nondestructive Examinations<sup>3</sup>

2.2 *Other Documents:*

ASNT “Leak Testing Handbook” Volume One of “Nondestructive Testing Handbook”<sup>4</sup>

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>

### 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*<sup>5</sup> 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  $1.3 \times 10^{-13}$  mol/s ( $3 \times 10^{-10}$  Std cm<sup>3</sup>/s)<sup>2</sup> on the most sensitive range, a maximum 1 min drift of 0 and sensitivity drift of  $\pm 15$  percent of full scale on this range, and  $\pm 5$  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  $4.5 \times 10^{-10}$  mol/s ( $1 \times 10^{-5}$  Std cm<sup>3</sup>/s)<sup>2</sup> 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  $4.5 \times 10^{-12}$  mol/s ( $1 \times 10^{-7}$  Std cm<sup>3</sup>/s).<sup>2</sup> Testing down to  $4.5 \times 10^{-13}$  mol/s ( $1 \times 10^{-9}$  Std cm<sup>3</sup>/s)<sup>2</sup> 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 pure (that is, zero-halogen) air. This reduced sample intake has the disadvantage of reducing the vacuum-cleaner effect of the

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.08 on Leak Testing Method.

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<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 Arlington Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

<sup>5</sup> Marr, J. William, *Leakage Testing Handbook*, prepared for Liquid Propulsion Section, Jet Propulsion Laboratory, National Aeronautics and Space Administration, Pasadena, CA, Contract NAS 7-396, June 1967.

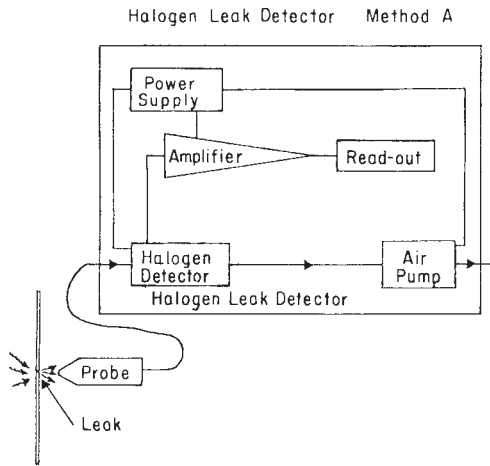


FIG. 1 Halogen Leak Detector, Method A

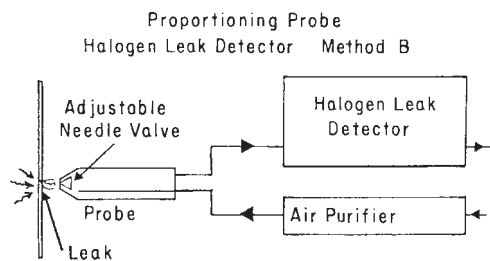


FIG. 2 Proportioning Probe, Halogen Leak Detector, Method B

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

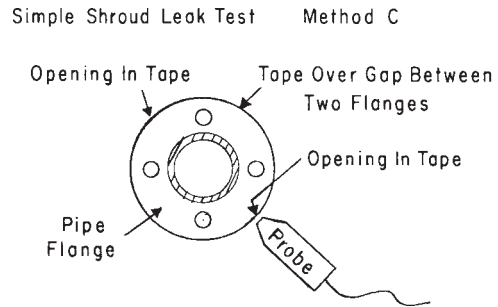


FIG. 4 Simple Shroud Leak Test, Method C

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  $4.5 \times 10^{-12}$  mol/s ( $1 \times 10^{-7}$  Std cm<sup>3</sup>/s).<sup>2</sup>

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

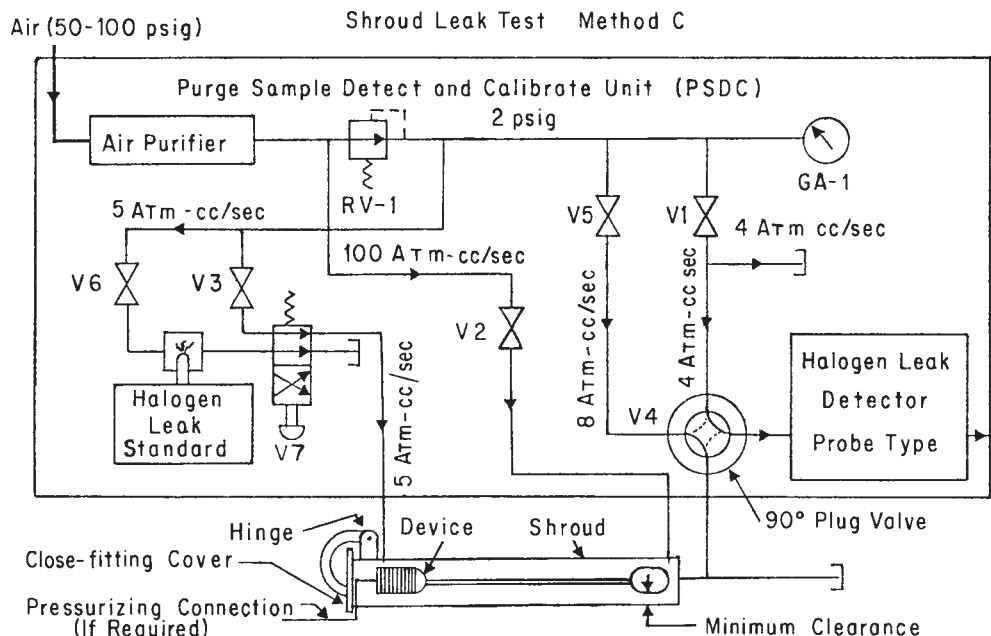


FIG. 3 Shroud Leak Test, Method C

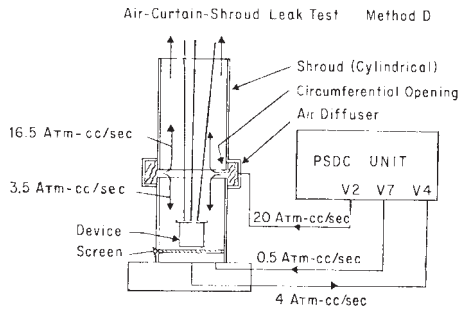


FIG. 5 Air-Curtain-Shroud Leak Test, Method D

picked up by the detector. This method is useful for detecting leaks down to  $4.5 \times 10^{-12}$  mol/s ( $1 \times 10^{-7}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup> 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 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:

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

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,  $\text{cm}^3$ .

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

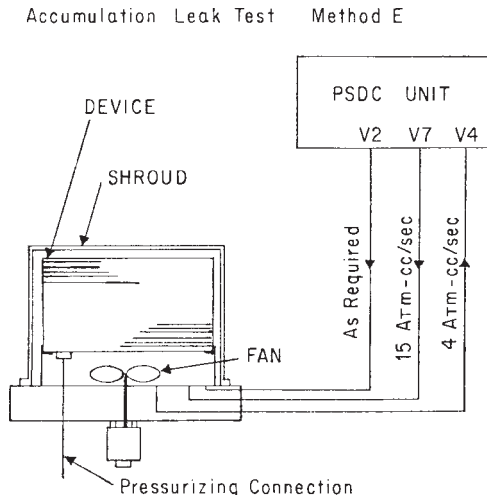


FIG. 6 Accumulation Leak Test, Method E

system of  $10^2 \text{ cm}^3$  net volume, or a  $2.2 \times 10^{-9}$  mol/s ( $5 \times 10^{-5}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup> leak in a  $10^7\text{-cm}^3$  system. Where variables, time, volume, and leak rate permit, values of readout should be set in the  $4.5 \times 10^{-12}$  or  $4.5 \times 10^{-13}$  mol/s ( $10^{-7}$  or  $10^{-8}$  Std  $\text{cm}^3/\text{s}$ )<sup>2</sup> 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.

## 8. Apparatus

8.1 *Halogen Leak Detector*—To perform leak tests as specified in this standard, the leak detector should meet the following minimum requirements:

8.1.1 *Sensor*—Alkali-ion diode or electron capture.

8.1.2 *Readout*—Panel instrument or digital readout.

8.1.3 *Range (Linear)*— $4.5 \times 10^{-11}$  to  $1.3 \times 10^{-14}$  mol/s ( $1 \times 10^{-6}$  to  $1 \times 10^{-9}$  Std cm<sup>3</sup>/s)<sup>2</sup> full scale.

8.1.4 *Response Time*—3 s or less.

8.1.5 *Stability of Zero and Sensitivity*—A maximum variation of  $\pm 15$  percent of full scale on most sensitive range while probe is in pure air; a maximum variation of  $\pm 5$  percent of full scale on other ranges, for a period of 1 min.

8.1.6 *Controls*:

8.1.6.1 *Range*—Preferably in scale steps of about 3 times or 10 times.

8.1.6.2 *Zero*—Automatic zeroing option is desirable.

8.2 *Halogen Leak Standard*—To perform leak tests as specified in this standard, the leak standard should meet the following minimum requirements:

8.2.1 *Ranges*— $4.5 \times 10^{-10}$  to  $4.5 \times 10^{-14}$  mol/s ( $10^{-5}$  to  $10^{-9}$  Std cm<sup>3</sup>/s)<sup>2</sup> full scale.

8.2.2 *Adjustability*—Adjustable leak standards are a convenience, but are not mandatory.

8.2.3 *Accuracy*— $\pm 25$  percent of full-scale value or better.

8.2.4 *Temperature Coefficient*—Shall be stated by manufacturer.

8.3 *Other Apparatus*—Fixtures or other equipment specific to one test method are listed under that method.

## 9. Material

9.1 *Test Gas*:

9.1.1 *Test-Gas Requirements*—To be satisfactory, the test gas should be nontoxic, nonflammable, not detrimental to common materials, inexpensive, and have a response factor of one. R-12 (dichlorodifluoromethane, CCl<sub>2</sub>F<sub>2</sub>) and R-22 (monochlorodifluoromethane, CHClF<sub>2</sub>) have these characteristics. R-12 is commonly used unless the higher pressure of the more expensive R-22 is needed (130 psig versus 70 psig at 70 F). If the test specification allows leakage of  $4.5 \times 10^{-10}$  mol/s ( $1 \times 10^{-5}$  Std cm<sup>3</sup>/s)<sup>2</sup> or more, or if large vessels are to be tested, consideration should be given to diluting the tracer gas with nonhalogen gas such as dry air or nitrogen. This will avoid operating in the nonlinear portion of the sensor output, or in the case of large vessels, save tracer-gas expense. However, the halogen content of the specification leak should remain compatible with the expected level of atmospheric halogen and the test method as outlined in Section 4.

NOTE 1—When a vessel is not evacuated prior to adding test gas, the latter is automatically diluted by 1 atm of air.

9.1.2 *Producing Premixed Test Gas*—If the volume of the device or the quantity to be tested is small, premixed gases can be conveniently obtained in cylinders. The user can also mix gases by batch in the same way. Continuous mixing using calibrated orifices is another simple and convenient method when the test pressure does not exceed 50 percent of the tracer gas pressure available (Note 2). Another method is to pass the

nonhalogen gas through the liquid tracer. This produces test gas containing the maximum amount of tracer gas.

NOTE 2—**Caution:** The liquid tracer gas supply should not be heated above ambient temperature.

9.2 *Pure Air, Air from Which Halogens Have Been Removed to a Level of Less Than 1 ppb (or Other Suitable Nonhalogen Gas, Such as Nitrogen)*.

9.2.1 *Requirements*:

9.2.1.1 Less than 1 ppb of halogen.

9.2.1.2 Less than 10 ppm of gases reactive with oxygen, such as petroleum-base solvent vapors.

9.2.1.3 Dew point 18°F (10°C) or more below ambient temperature.

9.2.1.4 Shall be reasonably free from rust, dirt, oil, etc.

9.2.2 *Production of Pure Air, or Other Gas*—Air or gas of suitable purity, may be produced by first passing it through a conventional filter-drier (if necessary) and then through activated charcoal.

## 10. Calibration

10.1 The leak detectors used in making leak tests by these methods are not calibrated in the sense that they are taken to the standards laboratory, calibrated, and then returned to the job. Rather, the leak detector is used as a comparator between a leak standard (set to the specified leak size) which is part of the instrumentation, and the unknown leak. However, the sensitivity of the leak detector is checked and adjusted on the job so that a leak of specified size will give a readily observable, but not off-scale reading. More specific details are given in Section 11 under the test method being used. To verify detection, reference to the leak standard should be made before and after a prolonged test. When rapid repetitive testing of many items is required, refer to the leak standard often enough to assure that desired test sensitivity is maintained.

## 11. Procedure

11.1 *General Considerations*:

11.1.1 *Test Specifications*—Use a testing specification that includes the following:

11.1.1.1 The gas pressure on the high side of the device to be tested; also on the low side if it need differ from atmospheric.

11.1.1.2 The test gas composition, if there is need to specify it.

11.1.1.3 The maximum allowable leak rate in standard cubic centimeters per second.

11.1.1.4 Whether the leak rate is for each leak or for total leakage of the device, and

11.1.1.5 If an “each leak” specification, whether or not areas other than seams, joints, and fittings need to be tested.

11.1.2 *Safety Factor*—Where feasible, ascertain that a reasonable safety factor has been allowed between the actual operational requirements of the device, and the maximum specified for testing. Experience indicates that a factor of at least 10 should be used when possible. For example, if a maximum total leak rate for satisfactory operation of a device



is  $2.2 \times 10^{-11}$  mol/s ( $5 \times 10^{-6}$  Std cm<sup>3</sup>/s),<sup>2</sup> the test requirement should be  $2.2 \times 10^{-12}$  mol/s ( $5 \times 10^{-7}$  Std cm<sup>3</sup>/s)<sup>2</sup> or less.

11.1.3 *Test Pressure*—Test the device at or above its operating pressure and with the pressure drop in the normal direction, where practical. Take precautions so that the device will not fail during pressurization, or that the operator is protected from the consequences of a failure.

11.1.4 *Disposition or Recovery of Test Gas*—Do not dump test gas into the test area if further testing is planned. Either vent it outdoors or recover for reuse if the volume to be used makes this worthwhile.

11.1.5 *Detrimental Effects of R-12 and R-22 Tracer Gases*—These gases are quite inert, and seldom cause any problem with most materials, particularly when used in gaseous form for leak testing and then removed. Test gas should not be left in the device unless it is dry and sealed, as most halogens in the presence of moisture accelerate corrosion over a period of time. When there is a question as to the compatibility of the tracer with a particular material, an authority on the latter should be consulted. This is particularly true when the material may be subject to chloride stress corrosion under conditions of use.

11.1.6 *Correlation of Test-Gas Leakage with Other Gases or Liquids at Different Operating Pressures*—Given the normal variation in leak geometry, accurate correlation is an impossibility. However, if a safety factor of ten or more is allowed (see 11.1.2) adequate correlation for gas leakage within these limits can usually be obtained by assuming viscous flow and using the following relation:

$$Q_2 = Q_1(N_1/N_2)[P_2^2 - P_1^2]/(P_1^2 - P_3^2) \quad (2)$$

where:

- $Q_2$  = test leakage,
- $Q_1$  = operational leakage,
- $N_2$  = viscosity of test gas (Note 4),
- $N_1$  = viscosity of operational gas (Note 4),
- $P_2, P_1$  = absolute pressures on high and low sides at test, and
- $P_4, P_3$  = absolute pressures on high and low sides in operation.

Experience has shown that, at the same pressures, gas leaks smaller than  $4.5 \times 10^{-10}$  mol/s ( $1 \times 10^{-5}$  Std cm<sup>3</sup>/s)<sup>2</sup> will not show visible leakage of a liquid, such as water, that evaporates fairly rapidly. For slowly evaporating liquids such as lubricating oil, the gas leak should be another order of magnitude smaller,  $4.5 \times 10^{-11}$  mol/s ( $1 \times 10^{-6}$  Std cm<sup>3</sup>/s).<sup>2,6</sup>

NOTE 3—Viscosity differences between gases is a relatively minor effect and can be ignored if desired.

## 11.2 Method A (See 4.3 and Fig. 1):

### 11.2.1 Apparatus:

#### 11.2.1.1 Test specification.

#### 11.2.1.2 Halogen leak detector; standard probe type.

11.2.1.3 Halogen leak standard, upper 9/10 of scale to include halogen content of maximum leak in accordance with the specification, with response factor correction.

11.2.1.4 Test gas, at or above specification pressure.

11.2.1.5 Pressure gages, valves and piping for introducing test gas, and if required, vacuum pump for evacuating device.

11.2.1.6 Pure-air supply, if not part of halogen leak detector.

11.2.1.7 Test booth or other atmospheric contamination control, if shown to be necessary by 11.2.2.

### 11.2.2 Procedure:

11.2.2.1 Set the halogen leak standard at the maximum halogen content of the specification leak. *Example:* if the maximum leak rate is  $4.5 \times 10^{-9}$  mol/s ( $1 \times 10^{-4}$  Std cm<sup>3</sup>/s)<sup>2</sup> and the test gas is 1 percent R-12 in air, set the standard at  $4.5 \times 10^{-9} \times .01 = 4 \times 10^{-11}$  mol/s ( $1 \times 10^{-6}$  Std cm<sup>3</sup>/s).<sup>2</sup>

11.2.2.2 Start the pure-air supply and adjust to flow in excess of that of the leak-detector probe, couple the probe loosely to the supply, so that air is not forced into the detector.

11.2.2.3 Start the detector, warm up and adjust in accordance with the manufacturer's instructions for detection of leaks of size of 11.2.2.1, using the "Manual Zero" mode.

11.2.2.4 Remove the probe from the pure-air supply to the test area, and note the reading, and also minimum and maximum readings for a period of 1 min.

11.2.2.5 Rezero the instrument, place the probe on the leak standard, and note the reading.

NOTE 4—If necessary to obtain a reasonable instrument deflection in 11.2.2.4 and 11.2.2.5, return the probe to the pure-air supply, adjust the "range" control and rezero if necessary.

11.2.2.6 If 11.2.2.4 is larger than 11.2.2.5, or if the 1-min variation is more than 30 percent of 11.2.2.5, take steps to reduce the atmospheric halogen content of the test area before proceeding with the leak test.

11.2.2.7 If the "automatic zero" mode is to be used, increase the sensitivity by a factor of three.

11.2.2.8 Evacuate (if required) and apply test gas to the device at the specified pressure.

11.2.2.9 Probe areas suspected of leaking. Hold the probe on or not more than 0.2 in. (5 mm) from the surface of the device, and move not faster than 1.0 in./s (30 mm/s). If leaks are located which cause a "reject" indication when the probe is held 0.2 in. (5 mm) from the apparent leak source, repair all such leaks before making final acceptance test. If a marginal indication is observed while detecting in "automatic zero" mode, reduce the sensitivity by a factor of three, switch to the "manual zero" mode and compare the leak reading on the leak standard and on the device.

11.2.2.10 Maintain an orderly procedure in probing the required areas, preferably identifying them as tested, and plainly indicating points of leakage.

11.2.2.11 At the completion of the test, evacuate or purge, or both, the test gas from the device.

11.2.2.12 Write the test report, or otherwise indicate test results as required.

### 11.3 Method B (See 4.4 and Fig. 2):

11.3.1 *Apparatus*—Same as for Method A (see 11.2) except 11.2.1.2, halogen leak detector to be proportioning probe type.

<sup>6</sup> Santeler, D. J., and Moller, T. W., "Fluid Flow Conversion in Leaks and Capillaries," *Vacuum Symposium Transactions*, 1956, p. 29. Also General Electric Co. Report R56GL261.

11.3.2 *Procedure*—Same as for Method A except as follows:

11.3.2.1 Use a self-contained pure-air supply. Activate by closing the probe tip valve tightly, which sends 100 percent pure air to the sensor.

11.3.2.2 In 11.2.2.4, open the probe valve wide (about two turns), which sends 100 percent atmospheric sample to the sensor.

11.3.2.3 If the conditions of 11.2.2.6 are met, proceed with the test. If not, partially close the probe valve until they are. However, do not reduce the valve opening below the point at which the response to the leak standard is reduced 30 percent.

11.4 *Method C* (See 4.5 and Fig. 3):

11.4.1 *Apparatus*:

11.4.1.1 Test specification.

11.4.1.2 Purge the sample detect and calibrate unit (PSDC), Fig. 3, plus the shroud to fit the device under test (the upper 9/10 of halogen leak standard scale shall include halogen content of maximum leak in accordance with the specification, with response factor correction).

11.4.1.3 Test gas, at or above specification pressure if the device is not already pressurized.

11.4.2 *Procedure*:

11.4.2.1 Set the halogen leak standard at the maximum halogen content of the specification leak (see 11.2.2.1).

11.4.2.2 Adjust the air pressure, air flows (except purge valve V<sub>2</sub>) and valves V4 and V7 as indicated in the diagram for this method. (The addition of flowmeters and pressure gages at appropriate places in the circuit to facilitate these adjustments is recommended.)

11.4.2.3 Start the detector, warm up and adjust in accordance with the manufacturer's instruction for detection of leaks of size 11.4.1.1, using the "manual zero" mode.

11.4.2.4 Place a device not containing halogen (dummy) in the shroud and open valve V2 for as long as is required to purge the shroud of atmospheric halogens.

11.4.2.5 Turn valve V7 to "calibrate" and valve V4 to the "sample" position, note detector indication, adjust the sensitivity if required, and return the valves to the original ("standby") positions. Remove the dummy device of 11.4.2.4.

11.4.2.6 Insert the device to be tested inside the shroud and connect the evacuate or pressurize line, or both, if device is not already pressurized with tracer gas.

11.4.2.7 Open valve V2 for as long as is required to purge the shroud of atmospheric halogens.

11.4.2.8 Turn valve V4 to the "sample" position.

11.4.2.9 If the device is already pressurized, read the leakage, if any, on the detector.

11.4.2.10 If the device is not pressurized, check the leak detector for indication of incomplete purging, then pressurize and read the leakage, if any. An indication of the leak detector greater than that obtained during calibration 11.4.2.4 shows leakage greater than allowed by the specification.

11.4.2.11 If the device has been pressurized with halogen tracer for the leak test only, exhaust the test gas outside the test area, or recover for reuse.

11.4.2.12 Remove the device from the shroud and write the test report, or otherwise indicate the results of test as required.

11.5 *Method D* (See 4.6 and Fig. 5):

11.5.1 *Apparatus*:

11.5.1.1 Test specification.

11.5.1.2 PSDC unit (Fig. 3) plus shroud as in Fig. 5 to fit device (the upper 9/10 of the halogen leak standard scale shall include halogen content of maximum leak in accordance with the specification, with response factor correction).

11.5.2 *Procedure*:

11.5.2.1 Set the halogen leak standard at the maximum halogen content of the specification leak (see 11.2.2.1).

11.5.2.2 Adjust the air pressure and flows as indicated in the diagram for this method. Valve V2 is open, and valve V4 is set at the "sample" position continuously.

11.5.2.3 Start the detector, warm up, and adjust in accordance with the manufacturer's instruction for detection of leaks of size 11.5.1.1, using the "manual zero" mode.

11.5.2.4 Place a device not containing halogen (dummy) in the shroud. Turn valve V7 to the "calibrate" position, note detector indication, adjust the sensitivity if required and return the valve to the original (standby) position. Remove the dummy device.

11.5.2.5 Insert the device to be leak-tested (and which has previously been "bombed" or which is pressurized with halogen tracer) in the shroud.

NOTE 5—Any part of the device that is to be leak-tested must be below the purge air opening.

11.5.2.6 Read the leakage, if any. An indication on the leak detector greater than that obtained during calibration (see 11.5.2.4) shows leakage greater than that allowed by the specification.

11.5.2.7 Remove the device and record the test results as desired.

11.5.2.8 If a large leak is detected, the clean-up of the shroud and sensor can be expedited by turning valve V7 to "standby" for a few seconds. This will purge shroud, lines and sensor with pure air.

11.6 *Method E* (See 4.7 and Fig. 6):

11.6.1 *Apparatus*:

11.6.1.1 Test specification.

11.6.1.2 PSDC unit (Fig. 3) plus shroud as in Fig. 6 (the upper 9/10 of halogen leak standard scale shall include halogen content of maximum leak per specification, with response factor correction).

11.6.1.3 Test gas, at or above specification pressure, if the device is not already pressurized.

11.6.2 *Procedure*:

11.6.2.1 Set the halogen leak standard at maximum halogen content of the specification leak (see 11.2.2.1).

11.6.2.2 Adjust the air pressure, air flows (except purge valve V<sub>2</sub>) as indicated on the diagram for this method.

11.6.2.3 Start the detector, warm up, and adjust in accordance with the manufacturer's instructions for detecting leaks of size of 11.6.1.1, using the "manual zero" mode.

11.6.2.4 Place a device not containing halogen (dummy) under the shroud.

11.6.2.5 Open valve V2 for as long as is required to purge the shroud of atmospheric halogen.

