Designation: E 432 – 91 (Reapproved 1997)

Standard Guide for Selection of a Leak Testing Method[1]

This standard is issued under the fixed designation E 432; 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 guide[2] is intended to assist in the selection of a leak testing method.[3] Fig. 1 is supplied as a simplified guide.

1.2 The type of item to be tested or the test system and the method considered for either leak measurement or location are related in the order of increasing sensitivity.

1.3 *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 425 Terminology Relating to Leak Testing[4]

3. Terminology

3.1 *Definitions*—The definitions of terms relating to leak testing which appear in Terminology E 425 shall apply to the terms in this guide.

4. Selection of System

4.1 The correct choice of a leak testing method optimizes sensitivity, cost, and reliability of the test. One approach is to rank the various methods according to test system sensitivity.

4.2 The various testing methods must be individually examined to determine their suitability for the particular system being tested. Only then can the appropriate method be chosen. For example, radioactive gases are not generally employed as a tracer for leak location because of the hazards associated with their use. However, such gases are employed in leakage detection equipment when they can be safely added to, and removed from, a test chamber on a periodic basis.

4.3 It is important to distinguish between the sensitivity associated with the instrument employed to measure leakage and the sensitivity of the test system followed using the instrument. The sensitivity of the instrument influences the sensitivity that can be attained in a specific test. The range of temperatures or pressures, and the types of fluids involved, influence both the choice of instrument and the test system.

4.4 The sensitivity of various test systems differ. For example, a test utilizing a mass spectrometer leak detector normally has an ultimate sensitivity of 4.4×10^{-15} mol/s when the procedure involves the measurement of a steady-state gas leakage rate. The sensitivity of the test may be increased under special conditions to 4.4×10^{-19} mol/s by allowing an accumulation of the leakage to occur in a known volume before a measurement of leakage is made. In the first case, the sensitivity of the test equals the sensitivity of the instrument; whereas in the second case, the sensitivity of the test is 10^4 times greater than that of the instrument. If the test system utilizes a mass spectrometer operating in the detector-probe mode, the sensitivity of the test can be 10^2 to 10^4 smaller than that of the mass spectrometer itself.

5. Leakage Measurement

5.1 In general, leakage measurement procedures involve covering the whole of the suspected region with tracer gas, while establishing a pressure differential across the system by either pressurizing with a tracer gas or by evacuating the opposite side. The presence and concentration of tracer gas on the lower pressure side of the system are determined and then measured.

5.2 A dynamic test method can be performed in the shortest time. While static techniques increase the test sensitivity, the time for testing is also increased.

5.3 Equipment or devices that are the object of leakage measurement fall into two categories: (*1*) open units, which are accessible on both sides, and (*2*) units that are sealed. The second category is usually applied to mass-produced items including gas and vacuum tubes, transistors, integrated circuit modules, relays, ordnance units, and hermetically sealed instruments.

---

[1] This guide 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 April 15, 1991. Published June 1991. Originally published as E 432 – 71. Last previous edition E 432 – 71 (1984)$^{\epsilon 1}$.

[2] For ASME Boiler and Pressure Vessel Code applications see related Recommended Guide SE-432 in the Code.

[3] Additional information may be obtained from Marr, J. W., *Leakage Testing Handbook*, Report No. CR-952, NASA, Scientific and Technical Information Facility, P. O. Box 33, College Park, MD 20740 (Organizations registered with NASA) or Clearing House for Federal, Scientific and Technical Information, Code 410.14, Port Royal Road, Springfield, VA 22151.

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

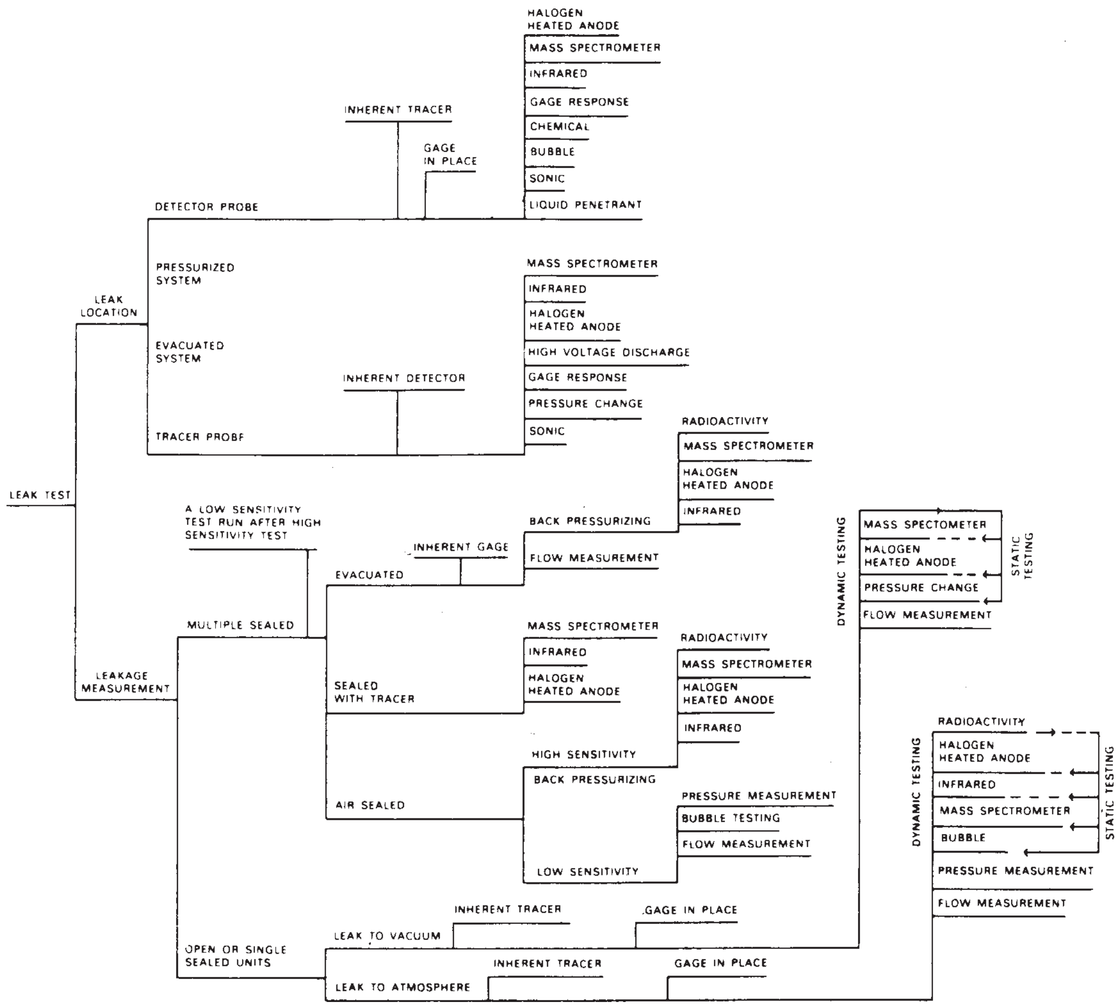

FIG. 1 Guide for Selection of Leakage Testing Method

5.3.1 *Open or Single-Sealed Units*—Either evacuation or pressurization of one side of a unit that is accessible on both sides, may be employed to test for leakage across a unit.

5.3.1.1 *Systems Leaking to Vacuum*—In the order of increasing sensitivity for testing an evacuated system, the methods include: flow measurement, absolute pressure measurement, the alkaline-ion diode halogen detector, and the helium mass spectrometer leak detector.

(a) (a) The first approach to the testing of units that may be evacuated is to determine if there is an inherent tracer in the system. This gas should be utilized if possible.

(b) (b) When one side is evacuated, leakage of the tracer into the vacuum will reach the detector quickly if there is essentially no stratification. However, evacuation does not always allow the most sensitive and reliable measurement. If the evacuated region is extremely large, high pumping speeds will be required and the leakage gas will tend to follow streamlines to the pump port. The amount of tracer gas that reaches the detector may then be substantially reduced depending on the location of the detector in the evacuated region.

(c) (c) When no inherent tracer is available, the next approach should be to determine if there is a gage in the system that might be used for leakage measurement. This gage might be an ionization gage or, in some fortunate circumstances, a mass spectrometer in the system as part of the analytical instrumentation. Consideration should be given not only to gages that are normally used for leak detection, but to any gas concentration detection equipment that may be used for leakage measurement if it happens to be available. Equipment not originally intended for pressure measurement may be used; for example, it is possible to detect the pressure rise in a leaking vacuum tube by operating the grid at a positive and an anode at a negative potential, and noting an increase in anode current with time.

(d) (d) When there is no inherent tracer or gage within the system, a standard testing method must be chosen based on the sensitivity desired.

5.3.1.2 *Systems Leaking to Atmosphere*—The choice of a testing method for systems leaking to atmospheric pressure should be made in the same manner as suggested for evacuated systems. In the absence of an inherent tracer or a gage, one of the standard methods of making leakage measurements against atmospheric pressure must be chosen. These are, in the order of increasing sensitivity: flow measurement, pressure measurement, bubble testing (immersion), helium mass spectrometer, infrared analyzer, alkaline-ion diode halogen detector, and radioactive tracer. (Note that the helium mass spectrometer method may not be the most sensitive in this situation where the measurement is to be made at atmospheric pressure.)

5.3.2 *Multiple-Sealed Units*—In the testing of sealed units, applicable testing methods are, in the order of increasing sensitivity: bubble testing, flow measurement, pressure measurement, infrared analyzer, alkaline-ion diode halogen detector, helium mass spectrometer, and radioactive tracer. The last four methods are applicable to a back pressurizing testing procedure.

(a) (a) Back pressuring, or bombing, is the usual procedure used for applying a tracer gas. If the leak in the unit is exceptionally large, any tracer gas in the unit will escape rapidly when it is subjected to reduced pressure. Consequently, high-sensitivity tests for this tracer will be ineffective if the tracer gas has already escaped from the system. It is therefore recommended that all parts be tested for large leaks *after* the high sensitivity tests have been conducted. Tests for large leaks involved relatively insensitive procedures. If liquids are employed, the smaller leaks can easily become clogged and may not be detected during a subsequent high sensitivity test.

5.3.2.1 *Evacuated Unit Testing*—With evacuated units, the choice of a testing procedure is relatively simple. If the system includes a gage, this gage may be used to show the presence of gas contamination. The back pressurizing procedure should be used in the absence of an internal gage. The units should be passed through a bubble test after the back pressurizing test to locate the exceptionally large leaks. If the unit can be opened to the atmosphere, a flow measurement procedure may be used.

5.3.2.2 *Units Sealed with Air*—Testing procedures for units sealed with air may be divided into two categories: low sensitivity testing by either bubble testing, flow measurement, or pressure measurement, and high sensitivity testing using the back pressurizing technique.

5.3.2.3 *Units Sealed With Tracer Gas*—Units sealed with tracer gas may be tested for leakage of the gas out of the unit by dynamic or static procedures. Generally, the partial pressure of tracer gas inside a unit will be higher than it would be if the tracer gas was forced into an evacuated unit through a small leak as is done in the back pressurizing procedure. Thus, pre-sealing with tracer gas leads to a more sensitive procedure involving fewer steps. As in the case with the other methods, a final inspection must be conducted by means of a bubble test procedure to locate exceptionally large leaks.

6. Leak Location

6.1 Leak location can be subdivided into a tracer probe mode and a detector probe mode. The tracer probe procedure is used when the system is evacuated, and the tracer gas comes from a probe located outside the system. The detector probe mode is used when the system is pressurized with tracer gas and testing is done at atmospheric pressure. Usually the tracer probe technique is more rapid because the gas reaches the detector at a higher concentration, despite any streaming effects, than it does with a detector probe which detects tracer gas which is highly diluted by atmospheric gases. In the detector probe mode, a higher pressure differential across the system may be used, and therefore leaks of a smaller conductance can be found. In using either mode it is important that leak location be attempted only after the presence of a leak has been verified.

6.1.1 *Testing of Evacuated Systems (Tracer Probe Mode)*—In the location of leaks in evacuated systems, first determine if there is an inherent detector within the system. This may be a pressure gage; preferably a gage that is specific for some tracer gas which may be used. If such a gage does not exist, the methods to use in the order of increasing sensitivity are: sonic, pressure change, gage response, high-voltage discharge, alkali-ion diode leak halogen detector, infrared detector, and mass spectrometer.

6.1.2 *Testing at Atmospheric Pressure (Detector Probe Mode)*—In testing a system that is leaking into atmosphere, the first consideration is whether or not the leaking fluid may be used as a tracer. This will always be the case when using either the sonic method or the bubble-testing method. However, the tracer might be of a composition that will also prove satisfactory for use with the other testing methods. In order of increasing sensitivity these methods for leak location are: chemical testing, gage response, infrared gas analyzer, mass spectrometer, and alkali-ion diode halogen detector.

6.1.2.1 When using liquid penetrants, the pressure may be atmospheric both inside and outside. Both surfaces must be accessible. Leaks are detected visually by fluorescence or coloration.