Designation: E498/E498M – 11 (Reapproved 2022)

Standard Practice for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode[1,2]

This standard is issued under the fixed designation E498/E498M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers procedures for testing and locating the sources of gas leaking at the rate of 1×10^{-8} Pa m^3/s (1×10^{-9} Std cm^3/s)[3] or greater. The test may be conducted on any object to be tested that can be evacuated and to the other side of which helium or other tracer gas may be applied.

1.2 Three test methods are described:

1.2.1 *Test Method A*—For the object under test capable of being evacuated, but having no inherent pumping capability.

1.2.2 *Test Method B*—For the object under test with integral pumping capability.

1.2.3 *Test Method C*—For the object under test as in Test Method B, in which the vacuum pumps of the object under test replace those normally used in the leak detector.

1.3 *Units*—The values stated in either SI or std-cc/sec units are to be regarded separately as standard. The values stated in each system may not be exact equivalents: therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

E1316 Terminology for Nondestructive Examinations

2.2 *Other Documents:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing[5]

ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel[5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology E1316, Section E.

4. Summary of Practice

4.1 The tests in this practice require a helium leak detector that is capable of detecting a leak of 1×10^{-9} Pa m^3/s (1×10^{-10} Std cm^3/s).[3]

4.2 *Test Method A*—This test method is used to helium leak test objects that are capable of being evacuated to a reasonable test pressure by the leak detector pumps in an acceptable length of time. This requires that the object be clean and dry. Also to cope with larger volumes or relatively "dirty" devices, auxiliary vacuum pumps having greater capacity than those in the mass spectrometer leak detector (MSLD) may be used in conjunction with the MSLD. The leak test sensitivity will be reduced under these conditions.

4.3 *Test Method B*—This test method is used to leak test equipment that can provide its own vacuum (that is, equipment that has a built-in pumping system) at least to a level of a few hundred pascals (a few torr) or lower.

4.4 *Test Method C*—When a vacuum system is capable of producing internal pressures of less than 2×10^{-2} Pa (2×10^{-4} torr) in the presence of leaks, these leaks may be located and

[1] 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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[2] (Atmospheric pressure external, vacuum internal). This document covers the Tracer Probe Mode described in Terminology E1316.

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

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[5] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

*A Summary of Changes section appears at the end of this standard

evaluated by the use of either a residual gas analyzer (RGA) or by using the spectrometer tube and controls from a conventional MSLD, provided, of course, that the leakage is within the sensitivity range of the RGA or MSLD under the conditions existing in the vacuum system.

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 Test Method A is the most frequently used in leak testing components which are structurally capable of being evacuated to pressures of 0.1 Pa (approximately 10^{-3} torr). Testing of small components can be correlated to calibrated leaks, and the actual leak rate can be measured or acceptance can be based on a maximum allowable leak. For most production needs acceptance is based on acceptance of parts leaking less than an established standard which will ensure safe performance over the projected life of the component. Care must be exercised to ensure that large systems are calibrated with reference leak at a representative place on the test volume. Leak rates are determined by calculating the net gain or loss through a leak in the test part that would cause failure during the expected life of the device.

6.2 Test Method B is used for testing vacuum systems either as a step in the final test of a new system or as a maintenance practice on equipment used for manufacturing, environmental test or for conditioning parts. As the volume tends to be large, a check of the response time as well as system sensitivity should be made. Volume of the system in liters divided by the speed of the vacuum pump in L/s will give the response time to reach 63 % of the total signal. Response times in excess of a few seconds makes leak detection difficult.

6.3 Test Method C is to be used only when there is no convenient method of connecting the leak detector to the outlet of the high vacuum pump. If a helium leak detector is used and the high vacuum pump is an ion pump or cryopump, leak testing is best accomplished during the roughing cycle as these pumps leave a relatively high percentage of helium in the high vacuum chamber. This will obscure all but large leaks, and the trace gas will quickly saturate the pumps.

7. Interferences

7.1 Series leaks with an unpumped volume between them present a difficult if not impossible problem in helium leak testing. Although the trace gas enters the first leak readily enough since the pressure difference of helium across the first leak is approximately one atmosphere, it may take many hours to build up the partial pressure of helium in the volume between the two leaks so that enough helium enters the vacuum system to be detected by the MSLD. This type of leak occurs frequently under the following conditions:

7.1.1 Double-welded joints and lap welds.

7.1.2 Double O-rings.

7.1.3 Threaded joints.

7.1.4 Ferrule and flange-type tubing fittings.

7.1.5 Casings with internal voids.

7.1.6 Flat polymer gaskets.

7.1.7 Unvented O-ring grooves.

7.2 In general, the solution is in proper design to eliminate these conditions; however, when double seals must be used, an access port between them should be provided for attachment to the MSLD. Leaks may then be located from each side of the seal and after repair, the access port can be sealed or pumped continuously by a "holding" pump (large vacuum systems).

7.3 Temporarily plugged leaks often occur because of poor manufacturing techniques. Water, cleaning solvent, plating, flux, grease, paint, etc., are common problems. To a large extent, these problems can be eliminated by proper preparation of the parts before leak testing. Proper degreasing, vacuum baking, and testing before plating or painting are desirable.

7.4 In a device being tested, capillary tubing located between the leak and the leak detector can make leak testing extremely difficult as test sensitivity is drastically reduced and response time increased. If there is a volume at each end of the capillary, each such volume should be attached to the leak detector during testing. If this is impossible, the device should be surrounded with a helium atmosphere while attached to the leak detector for a long time to assure leak tightness. When unusually long pumping times are necessary, the connections to the leak detector (and all other auxiliary connections) that are exposed to the helium should be double-sealed and the space between the seals evacuated constantly by a small auxiliary roughing pump to avoid allowing helium to enter the system through seals that are not a part of the device to be tested.

TEST METHOD A—HELIUM LEAK TESTING OF SMALL DEVICES USING THE MSLD

8. Apparatus

8.1 *Helium Mass Spectrometer Leak Detector,* having a minimum detectable leak rate as required by the test sensitivity.

8.2 *Auxiliary Pumps,* capable of evacuating the object to be tested to a low enough pressure so that the MSLD may be connected.

NOTE 1—If the object under test is small and clean and the MSLD has a built-in roughing pump, the auxiliary pumps are not required.

8.3 *Suitable Connectors and Valves,* to connect to the MSLD test port. Compression fittings and metal tubing should be used in preference to vacuum hose.

8.4 *Standard Leaks of Both Capsule Type (Containing its own Helium Supply) and Capillary Type (an Actual Leak which is Used to Simulate the Reaction of the Test System to Helium Spray)*—The leak rate from the capsule-type leak should be adequate to demonstrate the minimum allowable sensitivity of the MSLD. The capillary type should be slightly smaller than the test requirement.