



Standard Practice for Leaks Using Ultrasonics¹

This standard is issued under the fixed designation E1002; 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 *Practice A, Pressurization*—This practice covers procedures for calibration of ultrasonic instruments, location, and estimated measurements of gas leakage to atmosphere by the airborne ultrasonic technique.²

1.2 In general practice this should be limited to leaks detected by two classifications of instruments, Class I and Class II. Class I instruments should have a minimum detectable leak rate of 6.7×10^{-7} mol/s (1.5×10^{-2} std. cm^3/s at 0°C) or more for the pressure method of gas leakage to atmosphere. Class II instruments should have a minimal detectable leak rate of 6.7×10^{-6} mol/s (1.5×10^{-1} std. cm^3/s at 0°C) or more for the pressure method of gas leakage to atmosphere. Refer to Guide E432 for additional information.

1.3 *Practice B, Ultrasonic Transmitter*—For object under test not capable of being pressurized but capable of having ultrasonic tone placed/injected into the test area to act as an ultrasonic leak trace source.

1.3.1 This practice is limited to leaks producing leakage of 6.7×10^{-6} mol/s (1.5×10^{-1} std. cm^3/s at 0°C) or greater.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*³

E432 Guide for Selection of a Leak Testing Method

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.

Current edition approved July 1, 2011. Published July 2011. Originally approved in 1986. Last previous edition approved in 2005 as E1002 - 05. DOI: 10.1520/E1002-11.

² This technique is sometimes called “ultrasonic translation.”

³ 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.

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

2.2 *Other Documents:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing⁴

ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel⁴

NAS-410 Certification and Qualification of Nondestructive Personnel⁵

3. Terminology

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

4. Summary of Practice

4.1 *Practice A*—This practice sets minimum requirements for an ultrasonic detector (Classifications I and II). It provides for sensitivity validation of the detector and gives procedures for pressurizing the test object, locating leaks, and estimating the leakage rates.

4.2 *Practice B*—This practice sets minimum requirements for an ultrasonic detector used in conjunction with an ultrasonic transmitter. It gives procedures for locating leaks using an electronically generated ultrasonic leak tracer source.

5. Basis of Application

5.1 The following items are subject to contractual agreement between parties using or referencing this practice.

5.2 *Personnel Qualification*

5.2.1 If specified in the contractual agreement, personnel performing examinations to this practice shall be qualified in accordance with a national or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

⁴ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlington Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

⁵ Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

5.3 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E543. The applicable revision of Practice E543 shall be in the contractual agreement.

6. Significance and Use

6.1 *Practice A*—This practice is useful for locating and estimating the size of pressurized gas leaks, either as a quality control test or as a field inspection procedure. It is also valuable as a pretest before other more time consuming and more sensitive leak tests are employed. It should not be used exclusively to locate highly toxic or explosive gas leaks.

6.2 *Practice B*—This practice is useful for locating leaks in systems that are not under pressure or vacuum as either a quality control or a field inspection procedure. It is not useful for estimating the size of a leak. It is also valuable as a pretest before leak tests using pressurized gas methods and more sensitive leak tests are employed.

7. Interferences

7.1 The areas to be tested must be free of oil, grease, paint, and other contaminants that might mask a leak.

7.2 Under certain conditions background noise detected by the instrument can prevent the detection of relevant leakage. This background noise can result from equipment vibration and air movement due, for example, to wind, or air-cooled motors, aircraft engines, pneumatic systems, etc.

7.3 Use of earphones is required in areas where the background noise might interfere with hearing the audible output of a speaker.

8. Apparatus

8.1 *Ultrasonic Leak Detection System:*

8.1.1 The system shall consist of an instrument, probes, focusing probe accessory and earphones. (A speaker may or may not be utilized.)

8.1.2 The system shall provide for detection of acoustic energy in the ultrasonic range from 20 000 to 100 000 Hz and shall translate this energy into an audible signal that can be heard by use of earphones or speaker, or both.

8.1.3 The detected energy shall be indicated on a signal level indicator.

8.2 *Minimum Instrument Requirements*—The instrument shall meet the following requirements:

8.2.1 The detected ultrasonic energy shall be indicated on a signal level indicator with a change above normal background fluctuations.

8.2.2 The audible response shall consist of the down-converted heterodyned ultrasonic signal. This audio signal will be representative of the amplitude or frequency characteristics, or both, of the original ultrasonic signal. Heterodyned signals could allow the operator to discriminate audible background interference as in 7.2.

8.2.3 The instrument shall be equipped with a sensitivity control or gain adjustment, or both, to achieve the conditions of 9.3.3.

8.2.4 The internal power supply shall be regulated to provide repeatability of the sensitivity set point to within $\pm 5\%$ of full scale over the full range of battery condition.

8.2.5 The instrument may include additional features which could enhance leak detection such as frequency controls or meter/display response selection, or both.

8.3 *Other Apparatus*—Pressure gages, valves, and piping as required.

8.4 *Ultrasonic Transmission*

8.4.1 The system shall consist of an apparatus described in 8.1 – 8.3 with the addition of an ultrasonic transmitter.

8.4.2 The transmitter shall produce an ultrasound peaked between the frequencies of 38 to 42 kHz.

8.4.3 The output of the transmitter transducer shall be in excess of 100 dB at 1 ft.

8.4.4 The intensity of the output may be adjustable.

8.4.5 The heterodyned signal received by the ultrasonic leak detection system from the ultrasonic transmitter must be easily identified and recognized as the ultrasonic tracer source.

8.4.6 The internal power supply shall be regulated and be sufficient to produce the required output (see 8.4.3).

8.4.7 The transmitter may include additional features that could enhance the leak detection process such as a warble tone transmission and amplitude adjustments.

9. Calibration

9.1 *Calibration/Sensitivity Validation*—The ultrasonic instrument should be calibrated or have the sensitivity validated before each initial use.

9.2 *Calibration/Sensitivity Validation Equipment*—Use the following equipment for calibration of the test system:

NOTE 1—This equipment serves a dual function; either to calibrate the ultrasonic instrument for leakage rate approximation as in 11.3, or to verify the sensitivity for detection and location as in 11.1.

9.2.1 *Leak Standard*, with a preset flow rate of 6.7×10^{-5} mol/s (1.5 std. cm^3/s at 0°C) $\pm 5\%$ for both Class I and Class II instruments. The orifice size shall be approximately 0.2 mm [0.008 in.].

9.2.2 *Regulator*, for the nitrogen supply with output pressure and flow gages. The tank pressure gage is optional.

9.3 *Air Probe Sensitivity Validation:*

9.3.1 For Class I instruments, locate the detection probe a distance of 10.0 m (± 0.1 m) from the calibrated leak standard specified in 9.2.1. For Class II instruments, place the detection probe a distance of 5.0 m (± 0.1 m) from the calibrated leak specified in 9.2.1.

9.3.2 Check to see that the detector probe and leak source are aligned to obtain the peak response (see Fig. 1).

9.3.3 A signal level indication above normal background fluctuations should be observed.

9.3.4 Place a sound absorbing barrier in front of the microphone, blocking out the calibrated leak source; the meter reading should zero with a corresponding absence of an audible signal.

9.4 *Recalibration:*

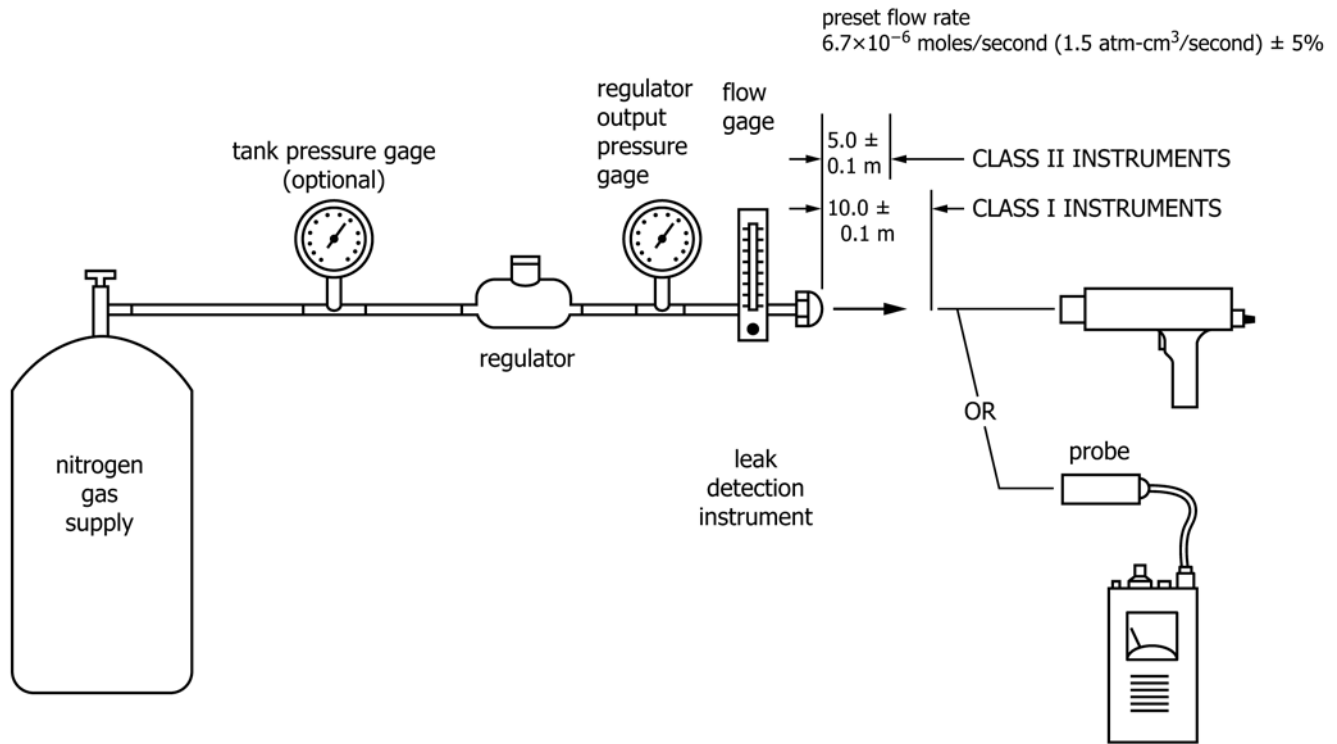


FIG. 1 Calibrated Leak Standard/Sensitivity Validation Equipment

9.4.1 Recheck or validate the sensitivity of the equipment at the beginning of each shift or designated work period interval. This test must be performed at the same sensing frequency as the initial test.

9.4.2 Recheck the equipment when abnormalities are observed in its operation.

9.5 *Ultrasonic Transmitter Sensitivity Validation*, should have the generated amplitude validated before each initial use. This could be done by placing the ultrasonic transmitter a fixed distance from the detection instrument to obtain a reading or by taking a NIST-traceable reading with a sound pressure level detector. Another method would be to place the ultrasonic transmitter in a container with a known leak that is equivalent to the leaks that are to be detected. To eliminate vessel or container vibrations from influencing the readings, the interior should be lined with closed cell foam, or rubber, or both. The orifice size shall be equivalent to the leaks that are to be detected.

10. General Considerations

10.1 Openings:

10.1.1 Seal all openings using plugs, covers or other suitable materials that can be readily and completely removed after the completion of the test.

10.1.2 Provide a gas inlet by attaching a valve to one of the test covers on all items to be pressurized.

10.2 Check of Test Parts:

10.2.1 Examine the part and test equipment before pressure is applied to ensure that it is tight and all appurtenances that should not be subjected to the test pressure have been disconnected or isolated by valves or other suitable means.

10.2.2 Check safe pressure rating to be sure it will not be exceeded during test.

10.3 Temperature of Vessel and Testing Medium:

10.3.1 The temperature of the pressurizing gas must not be at a level that would be injurious to the part or its components.

10.3.2 The test gas is dry nitrogen. (Compressed air can contain oil or water droplets which can seal leaks.)

10.4 Pressure:

10.4.1 Unless otherwise specified the gage pressure shall be at least 70 kPa [10 psig]. Normal safety precautions should be observed when pressurizing the part under test with the gas to avoid test part ruptures.

10.4.2 Gradually increase the pressure in the part to final test pressure.

10.5 *Ultrasonic Transmitter Method*—Inspect test object to be sure it is free of debris and liquids at the test sites.

11. Detection and Location of Pressurized Gas Leaks

11.1 Detection:

11.1.1 Set the sensitivity at maximum.

11.1.2 Begin to scan by pointing the probe towards the test area. The procedure is to go from “high sensitivity” to “low sensitivity,” reducing the sensitivity as the leak is approached.

11.1.3 Note the fluctuations in meter readings and the volume from the earphones or speaker.

11.1.4 If there is too much ultrasound in the area, reduce the sensitivity and continue to scan.

11.1.5 If it is difficult to isolate the leak due to competing ultrasound, place the focusing probe accessory over the scanning probe. This increases the directional response characteristics of the probe.

11.1.6 Listen for a “rushing” sound while observing the meter.

11.1.7 Follow the ultrasound to the loudest point. The meter will show a higher reading as the leak is approached.

11.2 *Ultrasonic Transmitter Method*—Provide for access of transmitter placement in the test object or provide an inlet pipe conduit fitting to couple with the transmitter allowing it to adequately saturate the test object with ultrasound in such a way as to shield stray ultrasonic leakage into the ultrasonic leak detection side.

11.2.1 All potential interferences shall be cleared away from the test areas either by cleaning or by blowing the areas dry with compressed gas.

11.2.2 *Transmitter Placement*—The transmitters shall be placed to adequately cover the test object with a uniform ultrasound.

11.2.3 Listen for the distinct heterodyned ultrasound produced by the ultrasonic transmitter. This may be a whistle or warbling tone.

11.3 *Location:*

11.3.1 In order to focus on the leak, keep reducing the sensitivity until a leak is located.

11.3.2 *To Confirm a Leak*—Position the scanning probe with or without the rubber focusing extension close to the suspect leak site and move it, slightly back and forth, up and down. If the leak is at this location, the sound and meter readings will both increase and decrease in intensity. This source discrimination technique will eliminate false leak identification due to reflected leak signals from other sites near the suspect leak site.

12. Report

12.1 The following information should be recorded at the time of the measurements and included in the report:

12.1.1 Date tested.

12.1.2 Test conditions such as temperature and pressure.

12.1.3 Location of leak.

12.1.4 Name and model of apparatus used.

12.1.5 Calibration.

12.1.6 Signature of tester.

13. Keywords

13.1 leak detection—ultrasonic; leak testing; leakage rate; ultrasonic detector

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>