



AEROSPACE MATERIAL SPECIFICATION

AMS2634™**REV. D**

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Revised 2026-05

Superseding AMS2634C

(R) Ultrasonic Inspection,
Thin Wall Metal Tubing

RATIONALE

AMS2634D is the result of a Five-Year Review and update of the specification. The revision incorporates new technology adding LCD and EL readouts in addition to CRT and includes calibration and adds system performance verification requirements (see 3.2.1, 3.2.1.1, and 3.2.1.2), updates pulse repetition rate to align with system standardization (see 3.2.1.3), revises recording methods to cover alternate methods (see 3.2.1.5, 3.2.1.5.1.1, and 3.2.1.5.2), revises recorder system check frequency based on type of system used (see 3.2.1.5.1.3), aligns transducer characterization and target reflector with industry standard practice options (see 3.2.2 and subsections), establishes calibration as the measure of serviceability (see 3.2.2.4), updates terminology and adds alignment details to tube handling systems (see 3.2.3), adds recommendation for flow meter controls and flow rate (see 3.2.3.2), defers to part requirements to establish roughness requirements for reference standards (see 3.2.4.2), addresses procedure approval by Level III personnel at test facility (see 3.4.1), adds noise level to procedures (see 3.4.2), allows a range of transducers to be included in relevant procedures (see 3.4.2.3), updates terminology from calibration to standardization (throughout), adds scan index to address some systems (see 3.4.2.5 and 3.5.1.1), adds allowance for full-immersion testing (see 3.4.3.1), simplifies water path adjustments emphasizing detection of notches (see 3.5.1.5), clarifies use of Equations 4 and 5 with respect to optimizing setup (see 3.5.2.1 and 3.5.2.2), allows full screen saturation and guidance on gating (see 3.5.2.3), discusses alternatives when standard sensitivity protocols cannot be met (see 3.5.2.3.1 and 3.5.2.3.2), adds method of determining rejection threshold (see 3.5.2.5.1), adds notes on weld zone and tube plug inspection (see 3.6.1.1 and 3.6.3), adds detailed requirements for in-process standardization (see 3.6.5 and subsections), and revises records required for ultrasonic references (see 4.3.5).

1. SCOPE

1.1 Purpose

This specification covers procedures for ultrasonic inspection of thin wall metal tubing of titanium, titanium alloy, and corrosion- and heat-resistant steels and alloys having nominal OD over 0.1875 inch (4.762 mm) with OD to wall thickness ratio of 8 or greater and wall thickness variation not exceeding $\pm 10\%$ of nominal.

1.2 Application

This process has been used typically for locating internal defects, such as cracks, voids, seams, and other discontinuities, which may or may not be exposed to the surface, but usage is not limited to such applications.

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2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E213 Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing

ASTM E317 Standard Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments

ASTM E1065/E1065M Evaluating Characteristics of Ultrasonic Search Units

ASTM E1316 Terminology for Nondestructive Testing

ASTM E1324 Standard Guide for Measuring Some Electronic Characteristics of Ultrasonic Testing Instruments

2.3 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS410 NAS Certification and Qualification of Nondestructive Test Personnel

2.4 ASME Publications

Available from ASME, Two Park Avenue, New York, NY 10016-5990, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 646-616-3100 (outside North America), www.asme.org.

ASME B46.1 Surface Texture

2.5 ASNT Publications

Available from American Society for Nondestructive Testing, Inc., 1201 Dublin Road, Suite #G04, Columbus, OH 43215, www.asnt.org.

SNT-TC-1A Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing

2.6 A4A Publications

Available from Airlines for America, 1301 Pennsylvania Avenue NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

Spec 105 Guidelines for Training and Qualifying Personnel in Nondestructive Testing

2.7 Definitions

Terms used in AMS are defined in AS7766.

2.7.1 Refer to ASTM E1316 for definition of terms related to ultrasonic inspection.

3. TECHNICAL REQUIREMENTS

3.1 Qualification/Certification

3.1.1 Personnel

Personnel shall be qualified and certified in accordance with NAS410. Alternate procedures (i.e., SNT-TC-1A or Spec 105) may be used if specified by the drawing or purchase order. It is the supplier's responsibility to ensure that personnel are certified and function within the limits of the applicable specification or procedure.

3.1.2 Facilities

Facilities shall be subject to survey and approval by the purchaser of the inspected product. Ultrasonic test facility equipment shall include, but not be limited to, the basic ultrasonic test instrument, search units (transducers), appropriate ultrasonic reference standards, fixtures, tube handling equipment, recorders, reference specifications, and documentation necessary to verify the qualification of equipment and test personnel.

3.2 Ultrasonic Test System

3.2.1 Basic Ultrasonic Test Instrument

The instrument shall be capable of producing, receiving, amplifying, and displaying on an electronic display (e.g., cathode ray tube [CRT], liquid crystal display [LCD], or electroluminescent display [EL], etc.) high-frequency signals at specific frequencies as required. The ultrasonic instrument shall be of a pulse-reflection (echo), pulse-transmission type capable of operation at frequencies of 2.0 MHz or higher. The instrument shall be capable of being adapted to electronic circuitry, such as flaw gates, distance amplitude corrections, and alarms, that can aid in testing and interpretation of flaw signals.

3.2.1.1 Calibration

Ultrasonic instruments shall be subject to annual calibration when required by contract. When calibration is not required by contract, either annual calibration in accordance with 3.2.1.1 or process controls in accordance with 3.2.1.2 is required. Unless otherwise specified by contract, calibration shall be performed in accordance with the test equipment manufacturer's requirements. If the test equipment requirements are insufficient or unavailable, supplemental requirements shall be established by the user and approved by the Cognizant Level III. Use of ASTM E317 and ASTM E1324 (as appropriate) is recommended when supplemental calibration requirements are necessary.

3.2.1.2 System Performance Verification

The following instrument capabilities may be validated internally in lieu of annual calibration (when calibration is not required by contract). When these process controls are performed, they shall be validated at intervals not to exceed 12 months. Alternatively, these evaluations may be added as supplemental calibration requirements in accordance with 3.2.1.1. When performed, the results of these validations must be documented.

3.2.1.2.1 The ultrasonic instrument shall be capable of demonstrating a minimum dynamic range of 30 dB and shall have a transmitter/receiver crosstalk separation of at least 40 dB.

3.2.1.2.2 The vertical linearity of the ultrasonic instrument shall be determined in accordance with ASTM E317, using method A or B as appropriate, and shall meet the standard limits set forth therein.

3.2.1.2.3 The horizontal linearity of the ultrasonic instrument shall be determined in accordance with ASTM E317 and shall meet the standard limits set forth therein.

- 3.2.1.2.4 Instrument sensitivity or gain controls shall function so that a given amount or degree of sensitivity can be repeated, or returned to, with a pip height accuracy of $\pm 10\%$. If signal attenuators are used, they shall be accurate over the attenuation range and test frequency used so that attenuation measurement will represent an amplitude ratio within $\pm 10\%$ of the correct value. The dB attenuation value may be converted to an amplitude ratio by use of tables with dB versus voltage ratios. Alternatively, it may be calculated from the relationship shown in Equation 1.

$$\text{Amplitude Ratio} = \log_{10}^{-1} \frac{\text{dB}}{20} \quad (\text{Eq. 1})$$

3.2.1.3 Pulse Repetition Rate

The repetition rate of the pulser/receiver shall be a value necessary to reliably and repeatably detect the reference standard notches as required in 3.5, ensuring the limit defined in the equation in 3.5.1.3 is not exceeded. Should there exist a disparity between repetition rate displayed and the detectability of the notches at a given rotational speed (in accordance with 3.5.1.3), the equipment shall be evaluated and serviced as appropriate.

3.2.1.4 Voltage Regulation

If fluctuations in line voltage cause variations in the displayed signal amplitude or sweep length of $\pm 2.5\%$ or greater of full screen height (FSH) in a signal with an amplitude equal to one-half of the vertical limit of the instrument, a power source voltage regulator shall be used. If fluctuations persist, proper adjustments to instrument or power source shall be made so that the system will operate within the $\pm 2.5\%$ limits. Battery-powered systems are exempt from this requirement, but such systems shall not be operated when the power source is below the level to achieve full vertical and horizontal display as viewed on the CRT graticule.

3.2.1.5 Automatic Monitoring System

The test system shall be monitored automatically by using a recorder, by automatic marking of the tubes, by line shutdown, or by an automatic tube sorting system such that an operator's continuous attention is not required during operation.

3.2.1.5.1 Recorders

- 3.2.1.5.1.1 Recordings are required and may be produced by an analog strip chart recorder with a drive speed ratio and tolerance such that the actual linear location of a tube defect may be determined from the chart with an accuracy of ± 0.5 inch (± 13 mm). The recorder shall be interpreted as an event marker to indicate that one or more ultrasonic pulse returns have exceeded the rejection alarm level at a known (± 0.5 inch [± 13 mm]) linear location on the tube. The recorder shall have a response equivalent to, or faster than, the pulse repetition rate of the pulser/receiver of the ultrasonic system, or the automatic gating system shall be equipped with a pulse stretcher, a one shot multi-vibrator capable of being turned off and on, a pulse counter and a recorder combination, or other means that will make it impossible for more than one pulse to remain unrecorded; alternatively, the throughput may be adjusted to be compatible with the frequency response of the recorder, in which case the frequency response of the recorder shall be used in determining the maximum rpm as required by 3.5.1.3. The pulses may be recorded as one response or as individual pulses.

- 3.2.1.5.1.2 Alternatively, recordings may be made on a digital recorder - either strip chart or an amplitude-based C-Scan display - provided that the accuracy and response requirements detailed in 3.2.1.5.1.1 are met.

- 3.2.1.5.1.3 All recorder systems, whether analog or digital, shall be initially validated to ensure compliance with the requirements of 3.2.1.5.1.1. Additionally, analog recorders shall be revalidated annually.

3.2.1.5.2 Electronic Gating

The gating system of the ultrasonic response shall trigger on the initial pulse of the pulser/receiver.

3.2.2 Ultrasonic Search Units

Unless use of other types of transducers is approved by the purchaser of the product to be inspected, all search units shall be serialized and tested in accordance with ASTM E1065/E1065M before being placed in service. The actual results as determined in accordance with ASTM E1065/E1065M shall be provided with the search unit certification.

- 3.2.2.1 It is recommended that the nominal center frequency be not less than 5 MHz for search units used for titanium tubing and not less than 2 MHz for corrosion-resistant steel tubing.
- 3.2.2.2 The focal distance and the focal zone shall be determined using the appropriate target reflector. The distance from the reflector to the transducer at the peak reflected amplitude shall be the focal distance. The focal zone shall be determined as the range of distances from the reflector to the transducer within which the reflected amplitude does not drop below 50% of the peak amplitude (at the focal distance) (see Figure 1).

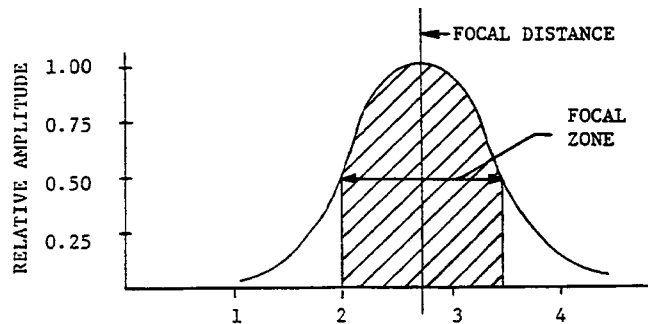


Figure 1 - Focal zone description

- 3.2.2.3 Using the appropriate target reflectors, the search unit X and Y beam profile shall be measured in accordance with ASTM E1065/E1065M.
- 3.2.2.4 After a search unit is initially tested as described above, it may remain in service provided that it is shown to be capable of meeting the requirements of 3.6.5.
- 3.2.2.5 The use of lithium sulfate (nondominant) transducers is not recommended in conjunction with broad-banded ultrasonic receivers. Quartz or ceramic (dominant) transducers cut accurately to meet the frequency requirement of 3.2.2.1 are recommended for use with broad-banded receivers. Either dominant or nondominant transducers cut to the specified frequency may be used with narrow-banded receivers.
- 3.2.2.6 Serialized records for each search unit used in inspections shall be retained as required by 3.4.2.

3.2.3 Tube Handling System

The test system shall utilize the immersion (full or "stuffing box") or a continuously irrigated (bubbler or squirter) method. The system shall be capable of fully automatic, as well as manual, operation and shall include a powered feed system capable of maintaining a tube helix pitch and rotational speed within a tolerance of $\pm 10\%$ of the rate established during standardization. The mechanical tube rotating and traversing system shall be checked initially and after any design changes to the drive mechanism to ensure that the limiting off-axis excursion of the tube, due to the system mechanics, is less than 0.005 inch (0.13 mm) in any direction at a sound entrance/exit point, measured at normal inspection speed. The system shall employ a tachometer, revolution counter, or appropriate encoder for measuring the rotational speed (rpm) of the tube, but this device shall not interfere with the part motion.

- 3.2.3.1 A suitable water filtering and/or deaerating system may be used on-line to reduce the amount of entrained air and debris, which would degrade the ultrasonic response. The water may be heated and the water temperature controlled to reduce the amount of entrained air.
- 3.2.3.2 In systems where water flow rate is critical to test repeatability and reliability, flow meters should be utilized and flow rates established in an appropriate document (procedure, technique, etc.). If employed, flow meters shall be calibrated annually.