



Standard Practice for Ultrasonic Testing of Wrought Products^{1,2}

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1. Scope

1.1 *Purpose*—This practice establishes the minimum requirements for ultrasonic examination of wrought products.

NOTE 1—This standard was adopted to replace MIL-STD-2154, 30 Sept. 1982. This standard is intended to be used for the same applications as the document which it replaced. Users should carefully review its requirements when considering its use for new, or different applications, or both.

1.2 *Application*—This practice is applicable for examination of materials such as, wrought metals and wrought metal products.

1.2.1 *Wrought Aluminum Alloy Products*—Examination shall be in accordance with Practice B594.

1.3 *Acceptance Class*—When examination is performed in accordance with this practice, engineering drawings, specifications, or other applicable documents shall indicate the acceptance criteria. Five ultrasonic acceptance classes are defined in Table 1. One or more of these classes may be used to establish the acceptance criteria or additional or alternate criteria may be specified.

1.4 *Order of Precedence*—Contractual requirements and authorized direction from the cognizant engineering organization may add to or modify the requirements of this practice. Otherwise, in the event of conflict between the text of this practice and the references cited herein, the text of this practice takes precedence. Nothing in this practice, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

1.5 *Measurement Values*—The values stated in inch-pounds are to be regarded as standard. The metric equivalents are in parentheses.

1.6 *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.*

¹ This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Method.

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² When accepted by DoD this standard is expected to replace MIL-STD-2154.

2. Referenced Documents

2.1 The following documents form a part of this practice to the extent specified herein:

2.2 *ASTM Standards*:³

B107/B107M Specification for Magnesium-Alloy Extruded Bars, Rods, Profiles, Tubes, and Wire

B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

B241/B241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

B594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products

E127 Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Standard Reference Blocks

E164 Practice for Contact Ultrasonic Testing of Weldments

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

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

E428 Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing

E543 Specification for Agencies Performing Nondestructive Testing

E1065 Guide for Evaluating Characteristics of Ultrasonic Search Units

E1158 Guide for Material Selection and Fabrication of Reference Blocks for the Pulsed Longitudinal Wave Ultrasonic Testing of Metal and Metal Alloy Production Material

E1316 Terminology for Nondestructive Examinations

2.3 *American Society for Nondestructive Testing (ASNT) Standards*:

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

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.

⁴ Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518.

TABLE 1 Ultrasonic Classes

Class	Single Discontinuity Response ^{A,B}	Multiple ^C Discontinuities	Linear ^D Discontinuity Length and Response	Loss of Back Reflection Percent ^{E,F}	Noise ^{G,H}
AAA ^H	1/64 in. (0.397 mm) or 25 % of 3/64 in. FB	10 % of 3/64 in. (0.119 mm) FB	1/8 in. (3.176 mm) long and 10 % of 3/64 in. (0.119 mm) FB	50	alarm level
AA ^H	3/64 in. (1.19 mm) FB	3/64 in. ^I (0.794 mm) FB	1/2 in. (12.7 mm) long 3/64 in. response (0.794 mm) FB	50	alarm level
A	5/64 in. (1.98 mm) FB	3/64 in. (1.191 mm) FB	1 in. (25.4 mm) long 3/64 in. response (1.19 mm) FB	50	alarm level
B	3/64 in. (3.18 mm) FB	5/64 (1.98 mm) FB	1 in. (25.4 mm) long 5/64 in. response (1.98 mm) FB	50	alarm level
C	3/64 in. (3.18 mm)	Not Applicable	Not Applicable	50	alarm level

^A Any discontinuity with a response greater than the response from a flat-bottom hole or equivalent notch (see footnote^B) at the estimated discontinuity depth and the discontinuity size given is not acceptable.

^B See Fig. 3, Fig. 4, or Fig. 5 for dimensions of notches and holes when these are required for angle beam examination of tube walls and near-surface regions of cylindrical parts and other products.

^C Multiple discontinuities with indications greater than the response from a reference flat-bottom hole or equivalent notch at the estimated discontinuity depth of the size given (diameter) are not acceptable if the centers of any two of these discontinuities are less than one inch apart (not applicable to Class C).

^D Any discontinuity longer than the length given with indications equal to or greater than the response given (flat-bottom hole or notch response) is not acceptable. Not applicable to Class C).

^E Loss of back reflection by more than 50 %, when compared to non-defective material in the same or a similar part, is not acceptable.

^F For longitudinal examination of material over 6-in. (152.4-mm) thick in the short transverse direction, any loss of back reflection equal to or greater than 12 dB over an area 2 by 2 in. (50.8 by 50.8 mm) is rejectable. (Noise level is not relevant to this back reflection evaluation.

^G Noise which exceeds the alarm level setting (see 7.4.10.7), is not acceptable, except for titanium. For titanium alloys, the alarm level may be set just above the noise level, but shall not exceed 70 % of the reference standard response.

^H When examining titanium, Class AA and Class AAA, no rejection shall be made on the basis of "noise" level, if within the limits specified in footnote^G.

^I Evaluation may be done by setting up on a 3/64 in. (1.19 mm) hole and adding 7 dB of gain. (Also see Note 5 under Table 5.)

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

2.4 Society for Automotive Engineers (SAE) Standards:

AMS 4928 Titanium Alloy, Bars, Wire, Forgings, and Rings 6Al-4V Annealed⁵

AMS 6409 Steel, Bars, Forgings, and Tubing, 0.80 Cr, 1.8 Ni, 0.25 Mo, (0.38 - 0.45 C), (SAE 4340) Special Aircraft Steel Cleanliness, Normalized and Tempered⁵

AMS 6415 Steel, Bars, Forgings, and Tubing, 0.80 Cr, 1.8 Ni, 0.25 Mo (0.38 - 0.43 C) (SAE 4340)⁵

AMS 6484 Steel, Bars, Forgings, and Tubing, 080 Cr, 1.8 Ni, 0.25 Mo (0.38 - 0.43 C) (SAE 4340) Normalized and Tempered⁵

2.5 Aerospace Industries Association Standard:

NAS 410 Certification and Qualification of Nondestructive Test Personnel⁶

2.6 Federal Specifications:

QQ-A-225/6 Aluminum Alloy Bar, Rod, and Wire, Rolled, Drawn, or Cold Finished, 2024⁶

QQ-A-225/9 Aluminum Alloy Bar, Rod, Wire, and Special Shapes, Rolled, Drawn, or Cold Finished, 7075⁶

2.7 Military Standards:⁷

NOTE 2—For DoD contracts, unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the

DoDISS (Department of Defense Index of Specifications Standards) cited in the solicitation.

3. Terminology

3.1 *Definitions*—Definitions relating to ultrasonic examination, which appear in Terminology E1316, shall apply to the terms used in this standard.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *back surface resolution*—the minimum distance between the back surface and a discontinuity of known size that will result in a clear differentiation of the two signals as indicated by the trace recovering to 20 % or less of discontinuity or back surface amplitude (whichever is lower) between the indications at the sensitivity required for the specified examination.

3.2.2 *cognizant engineering organization*—the company, government agency, or other authority responsible for the design, or end use, of the system or component for which ultrasonic examination is required. This, in addition to design personnel, may include personnel from engineering, material and process engineering, stress analysis, NDT or quality groups and others, as appropriate.

3.2.3 *contract document*—any document specified in the contract, including the purchase order, specification, drawing, or other written material.

3.2.4 *display*—the display on which ultrasonic data are presented, including, but is not limited to, cathode ray tubes, liquid crystals, electro-luminescent phosphors, or plasmas.

⁵ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

⁶ Aerospace Industries Association of America, Inc., 1250 Eye Street NW, Washington, DC 20005.

⁷ Copies of specifications, standards, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.

3.2.5 *entry surface resolution*—the minimum distance between the entry surface and a discontinuity of known size that will result in a clear differentiation of the two signals as indicated by the trace recovering to 20 % or less of the discontinuity amplitude between the indications at the sensitivity required for the specified examination.

3.2.6 *full scale deflection (FSD)*—the maximum displayable signal amplitude on the display device, or any signal reaching or exceeding the 100 % amplitude scale graduation.

3.2.7 *horizontal limit*—the maximum readable length of horizontal position that is determined either by electrical or a physical limit in the A-scan presentation of an ultrasonic examination instrument.

3.2.8 *immersion ultrasonic examination*—the use of a water medium to couple the search unit to the part surface. This technique includes immersion in a tank of water, the use of water columns, bubblers, or similar device.

3.2.9 *primary reference response*—the maximized signal amplitude obtained from the applicable reference reflector that produces the lowest amplitude signal.

3.2.10 *vertical linearity limit (upper and lower)*— values of the vertical amplitude at which a proportional relationship with the input signal deviates from or exceeds a prescribed amount.

4. Significance and Use

4.1 This practice is intended primarily for the examination of wrought metals, forged, rolled, machined parts or components to an ultrasonic class most typically specified in the purchase order or other contract document.

5. Basis of Application

5.1 *Basis of Application*—There are areas in this practice that may require agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

6. General Requirements

6.1 *Specifying*—When ultrasonic examination is specified in accordance with this practice, the ultrasonic technique (immersion, contact, angle beam, straight beam, and so forth) and acceptance criteria should be specified. Suggested classes in **Table 1** may be specified to establish acceptance criteria. A contract document shall specify zones, when applicable, to indicate different quality level acceptance criteria based on the criticality of each zone. When directions of maximum stressing are indicated on a contract document and configuration allows, ultrasonic examination shall be performed to locate discontinuities oriented perpendicular to the directions of maximum stressing.

6.2 *Personnel Qualification/Certification*—Personnel performing examinations to this practice shall be qualified in accordance with ANSI/ASNT-CP-189, NAS-410, or SNT-TC-1A and certified by the employer or certifying agency as applicable. Other equivalent qualification documents may be used when specified in the contract or purchase order.

6.3 *Agency Evaluation*—If required by contract, evaluation of the agency performing examination shall be in accordance with Practice **E543**.

6.4 *Written Procedure*—A detailed procedure (general procedure, or part specific technique, or both) shall be prepared for each part and type of examination to be performed. The procedure shall meet the requirements of this practice and shall provide consistency for producing the results and quality level required by this practice and other contractual documents. The procedure shall be approved by an individual qualified and certified as a Level III in the practice of ultrasonic examination. The procedure shall be submitted upon request to the contracting agency for approval, or review, or both (see **8.1**). The procedure shall cover all of the specific information required to set-up and perform the examination, such as the following:

6.4.1 Name and address of examination facility,

6.4.2 Number of the procedure including latest revision designation, if applicable, and date.

6.4.3 Number of this standard including latest revision designation letter, if applicable, and date.

6.4.4 Examination method and acceptance criteria to be applied.

6.4.5 Examination zones, if applicable.

6.4.6 Specific part number and configuration or product form for which the procedure is being prepared.

6.4.7 Manufacturer and model numbers of any instrumentation to be used in the examination. Any external recording equipment, alarm equipment and electronic distance-amplitude correction equipment shall be included.

6.4.8 Type and size of search unit. Include frequency, focal length, as applicable, manufacturer, sound beam angle and description of any wedges, shoes, saddles, stand-off attachments, bubblers, or squirters.

6.4.9 Description of manipulating and scanning equipment.

6.4.10 Couplant: type and manufacturer.

6.4.11 Scanning plan which describes, for each portion of the examination, the surfaces from which the examination will be performed, the ultrasonic modes, and directions of the sound beam.

6.4.12 Method of applying transfer (see **7.4.10.4**), if applied.

6.4.13 Reference blocks, water path (if applicable) and methods of standardization and scan index determination, maximum scanning speed, and minimum pulse repetition rate.

6.4.14 Method of establishing scan sensitivity for concave and convex surfaces, if applicable.

6.4.15 Discontinuity evaluation procedure.

6.4.16 Any other pertinent data which would be needed to duplicate the original examination.

6.5 *General Procedures*—General procedures are acceptable for common product forms such as plate, bar stock, extrusions, forgings, tubing and cylindrical stock, and designated thickness ranges. The general procedure shall include the applicable items of **6.4**.

7. Detail Requirements

7.1 *Couplants*: