



Designation: A 745/A 745M – 94 (Reapproved 1999)

Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings¹

This standard is issued under the fixed designation A 745/A 745M; 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 practice² covers the standards and procedures for the contact, pulse-echo ultrasonic examination of austenitic steel forgings by the straight or angle beam techniques, or both.

1.2 This practice shall be used whenever the inquiry, proposal, contract, order, or specification states that austenitic steel forgings are to be subject to ultrasonic examination in accordance with Practice A 745/A 745M. Ultrasonic examination of nonmagnetic retaining ring forgings should be made to Practice A 531, not to this practice.

1.3 The values stated in either inch-pound or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the practice.

1.4 This practice and the applicable material specifications are expressed in both inch-pound units and SI units. However, unless the order specifies the applicable "M" specification designation [SI units], the material shall be furnished to inch-pound units.

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

2. Referenced Documents

2.1 ASTM Standards:

A 531/A531M Practice for Ultrasonic Inspection of Turbine-Generator Steel Retaining Rings³

E 317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Systems Without the Use of Electronic Measurement Instruments⁴

¹ This practice is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-745/SA-745M in Section II of that Code.

³ *Annual Book of ASTM Standards*, Vol 01.05.

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

E 428 Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection⁴

2.2 *American Society for Nondestructive Testing Document:*

SNT-TC-1A Recommended Practice for Nondestructive Personnel Qualification and Certification⁵

3. Ordering Information

3.1 When this practice is to be applied to an inquiry or purchase order, the purchaser shall furnish the following information:

3.1.1 Quality level of examination (see Section 12).

3.1.2 Additional requirements to this practice.

3.1.3 Applicability of supplementary requirements (see Supplementary Requirements section).

3.2 When specified, the manufacturer shall submit an examination procedure for purchaser approval that shall include, but not be limited to, a sketch of the configuration as presented for ultrasonic examination showing the surfaces to be scanned, scanning directions, notch locations and sizes (if applicable), extent of coverage (if applicable), and an instruction listing calibration and inspection details and stage of manufacture.

4. Apparatus

4.1 An electronic, pulsed, reflection type of instrument shall be used for this examination. The system shall have a minimum capability for operating at frequencies from 0.5 to 5.0 MHz. Either video or r-f presentation is acceptable.

4.2 The ultrasonic instrument shall provide linear presentation (within $\pm 5\%$ of the signal height) for at least 75% of the screen height (sweep line to top of screen). This 5% linearity is descriptive of the screen presentation of amplitude. Instrument linearity shall be verified in accordance with the intent of Practice E 317.

4.3 Instruments with incremental gain control (accurate over its useful range to $\pm 10\%$ of the nominal attenuation ratio) shall be used when possible to allow measurement of signals beyond the linear display range of the instrument.

4.4 *Search Units:*

⁵ Available from the American Society for Nondestructive Testing, 1711 Arlington Lane, P.O. Box 28518, Columbus, OH 43228-0518.

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4.4.1 Search units having transducers of either quartz or other piezoelectric materials may be employed.

4.4.2 The maximum nominal active area of 1½ in.² [970 mm²] with ½ -in. [13 mm] minimum to 1⅛ -in. [30 mm] maximum dimensions or ¾ -in. [20 mm] diameter minimum dimension shall be used for straight-beam scanning.

4.4.3 Angle-beam scanning transducers shall have a nominal active area of ½ to 1 in.² [325 to 650 mm²]. The search unit used for angle-beam examination shall produce a beam angle of 30 to 70° in the material.

4.4.4 Other search units, including frequencies other than those listed in Section 8, may be used for evaluating and pinpointing indications of discontinuities.

4.5 *Couplant*—A suitable couplant having good wetting characteristics shall be used between the transducer and the examination surface. The same couplant shall be used for calibration and examination.

4.6 *Reference Blocks*:

4.6.1 All ultrasonic standard reference blocks shall be in accordance with the general guidelines of Practice E 428. However, absolute conformance to Practice E 428 is not mandatory due to the nature of the material covered by this practice.

4.6.2 The reference block grain size, as measured by the relative acoustic penetrability of the reference blocks, should be reasonably similar to the forging under examination. However, it must be recognized that large austenitic forgings vary considerably in acoustic penetrability throughout their volume due to variations in grain size and structure. Reference blocks should be chosen that reasonably approximate the average penetrability of the forging under examination. Supplementary blocks of coarser or finer grain may be used for evaluation of indications as covered in Section 11.

4.6.3 As an alternative method, where practicable, the appropriate size of reference hole (or holes) or notches may be placed in representative areas of the forging for calibration and examination purposes when removed by subsequent machining. When holes or notches are not removed by subsequent machining, the purchaser must approve the location of holes or notches.

5. Personnel Requirements

5.1 Personnel performing the ultrasonic examinations to this practice shall be qualified and certified in accordance with a written procedure conforming to Recommended Practice No. SNT-TC-1A or another national standard that is acceptable to both the purchaser and the supplier.

6. Forging Conditions

6.1 Forgings shall be ultrasonically examined after heat treating.

6.2 The surfaces of the forging to be examined shall be free of extraneous material such as loose scale, paint, dirt, etc.

6.3 The surface roughness of scanning surfaces shall not exceed 250 µin. [6 µm] unless otherwise stated in the order or contract.

6.4 The forgings shall be machined to a simple configuration, that is, rectangular or parallel or concentric surfaces where complete volumetric coverage can be obtained.

6.5 In certain cases, such as with contour forged parts, it may be impractical to assure 100 % volumetric coverage. Such forgings shall be examined to the maximum extent possible. A procedure indicating the extent of examination coverage shall be submitted for the purchaser's approval (see 3.2).

7. Procedure

7.1 Perform the ultrasonic examination after heat treatment when the forging is machined to the ultrasonic configuration but prior to drilling holes, cutting keyways, tapers, grooves, or machining sections to final contour.

7.2 To ensure complete coverage of the forging volume when scanning, index the search unit with at least 15 % overlap with each pass.

7.3 The scanning rate shall not exceed 6 in. [150 mm]/s.

7.4 Scan all regions of the forging in at least two perpendicular directions to the maximum extent possible.

7.5 Scan disk and disk-type forgings using a straight beam from at least one flat face and radially from the circumference when practicable. For the purposes of this practice, a disk is a cylindrical shape where the diameter dimension exceeds the height dimension. Disk-type forgings made as upset-forged "pancakes" shall be classified as disks for inspection purposes although at the time of inspection, the part may have a center hole, counterturned steps, or other detail configuration.

7.6 Scan cylindrical sections, ring and hollow forgings from the entire external surface (sides or circumference), using the straight-beam technique, and scan the forging in the axial direction to the extent possible. When the length divided by the diameter ratio (slenderness ratio) exceeds 6 to 1 (or axial length exceeds 24 in. [600 mm]), scan axially from both end surfaces to the extent possible. If axial penetration is not possible due to attenuation, angle-beam examination directed axially may be substituted in place of axial straight beam. Examine ring and hollow forgings having an outside-diameter to inside-diameter ratio of less than 2 to 1 and a wall thickness less than 8 in. [200 mm] by angle-beam techniques from the outside diameter or inside diameter, or both, using full node or half-node technique (see 10.1.2 and 10.1.3) as necessary to achieve either 100 % volumetric coverage or the extent of coverage defined by an approved procedure (see 3.2).

8. Examination Frequency

8.1 Perform all ultrasonic examination at the highest frequency practicable (as specified in 8.1.1, 8.1.2, or 8.1.3) that will adequately penetrate the forging thickness and resolve the applicable reference standard. Include in the ultrasonic examination report the examination frequency used. Determine the test frequency at the time of actual examination by the following guidelines:

8.1.1 The nominal test frequency shall be 2.25 MHz. Use of this frequency will generally be restricted due to attenuation.

8.1.2 One megahertz is acceptable and will be the frequency generally applicable.

8.1.3 When necessary, due to attenuation, 0.5-MHz examination frequency may be used. The purchaser may request notification before this lower frequency is employed.