



## Standard Practice for Ultrasonic Examination of Steel Forgings<sup>1</sup>

This standard is issued under the fixed designation A388/A388M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This practice<sup>2</sup> covers the examination procedures for the contact, pulse-echo ultrasonic examination of steel forgings by the straight- and angle-beam techniques. The straight-beam techniques include utilization of the DGS (distance gain-size) method. See [Appendix X3](#).

1.2 This practice is to be used whenever the inquiry, contract, order, or specification states that forgings are to be subject to ultrasonic examination in accordance with Practice A388/A388M.

1.3 Supplementary requirements of an optional nature are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified individually by the purchaser in the purchase order or contract.

1.4 The values stated in either SI units or inch-pound 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.

1.5 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.

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

1.7 *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 Recom-*

*mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>3</sup>

[A469/A469M](#) Specification for Vacuum-Treated Steel Forgings for Generator Rotors

[A745/A745M](#) Practice for Ultrasonic Examination of Austenitic Steel Forgings

[A788/A788M](#) Specification for Steel Forgings, General Requirements

[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 (Withdrawn 2019)<sup>4</sup>

[E1065/E1065M](#) Practice for Evaluating Characteristics of Ultrasonic Search Units

[E1316](#) Terminology for Nondestructive Examinations

#### 2.2 Other Documents:

[ASME Boiler and Pressure Vessel Code](#)<sup>5</sup>

[SNT-TC-1A](#) Personnel Qualification and Certification in Nondestructive Testing (1988 or later)<sup>6</sup>

### 3. Terminology

3.1 *Definitions of Terms*—For definitions of terms used in this standard that are not included in [3.2](#), refer to Terminology [E1316](#).

#### 3.2 Definitions:

3.2.1 *indication levels (clusters), n*—five or more indications in a volume representing a 2 in. [50 mm] or smaller cube in the forging.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [www.astm.org/contact](http://www.astm.org/contact). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>6</sup> Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee A01 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-388/SA-388M in Section II of that Code.



3.2.2 *individual indications, n*—single indications showing a decrease in amplitude as the search unit is moved in any direction from the position of maximum amplitude and which are too small to be considered traveling or planar.

3.2.3 *planar indications, n*—indications shall be considered continuous over a plane if they have a major axis greater than 1 in. [25 mm] or twice the major dimension of the transducer, whichever is greater, and do not travel.

3.2.4 *traveling indications, n*—indications whose leading edge moves a distance equivalent to 1 in. [25 mm] or more of metal depth with movement of the transducer over the surface of the forging.

#### **4. Significance and Use**

4.1 This practice shall be used when ultrasonic inspection is required by the order or specification for inspection purposes where the acceptance of the forging is based on limitations of the number, amplitude, or location of discontinuities, or a combination thereof, which give rise to ultrasonic indications.

4.2 The ultrasonic quality level shall be clearly stated as order requirements.

#### **5. Ordering Information**

5.1 When this practice is to be applied to an inquiry, contract, or order, the purchaser shall so state and shall also furnish the following information:

5.1.1 Designation number (including year date),

5.1.2 Method of establishing the sensitivity in accordance with 9.2.2 and 9.3.3 (DGS (distance gain size), Vee- or rectangular-notch),

5.1.2.1 The diameter and test metal distance of the flat-bottom hole and the material of the reference block in accordance with 9.2.2.2,

5.1.3 Quality level for the entire forging or portions thereof in accordance with 12.3, and

5.1.4 Any options in accordance with 1.5, 6.4, 6.5, 7.1, 8.1, 8.2, 9.1.11, 10.1, 10.2, and 12.2.

#### **6. Apparatus**

6.1 *Electronic Apparatus*—An ultrasonic, pulsed, reflection type of instrument shall be used for this examination. The system shall have a minimum capability for examining at frequencies from 1 MHz to 5 MHz. On examining austenitic stainless forgings the system shall have the capabilities for examining at frequencies down to 0.4 MHz.

6.1.1 *Apparatus Qualification and Calibration*—Basic qualification of the ultrasonic test instrument shall be performed at intervals not to exceed 12 months or whenever maintenance is performed that affects the equipment function. The date of the last calibration and the date of the next required calibration shall be displayed on the test equipment.

6.1.2 The ultrasonic instrument shall provide linear presentation (within 5 %) for at least 75 % of the screen height (sweep line to top of screen). The 5 % linearity referred to is descriptive of the screen presentation of amplitude. Instrument linearity shall be verified in accordance with the intent of Practice E317. Any set of blocks processed in accordance with

Practice E317 or E428 may be used to establish the specified  $\pm 5$  % instrument linearity.

6.1.3 The electronic apparatus shall contain an attenuator (accurate over its useful range to  $\pm 10$  % (+1 dB) of the amplitude ratio) which will allow measurement of indications beyond the linear range of the instrument.

6.2 *Search Units*, having a transducer with a maximum active area of 1 in.<sup>2</sup> [650 mm<sup>2</sup>] with ½ in. [13 mm] minimum to 1 ⅛ in. [30 mm] maximum dimensions shall be used for straight-beam scanning (see 9.2); and search units having a transducer with ½ in. [13 mm] minimum to 1 in. [25 mm] maximum dimensions shall be used for angle-beam scanning (see 9.3).

6.2.1 *Transducers* shall be utilized at their rated frequencies.

6.2.2 Other transducers may be used for evaluating and pinpointing indications.

6.3 *Couplants*, having good wetting characteristics such as SAE No. 20 or No. 30 motor oil, glycerin, pine oil, or water shall be used. Couplants may not be comparable to one another and the same couplant shall be used for calibration and examination.

6.4 *Reference Blocks*, containing flat-bottom holes may be used for calibration of equipment in accordance with 6.1.2 and may be used to establish recording levels for straight-beam examination when so specified by the order or contract.

6.5 *DGS Scales*, matched to the ultrasonic test unit and transducer to be utilized, may be used to establish recording levels for straight- or angle-beam examination, when so specified by the order or contract. The DGS scale range must be selected to include the full thickness cross-section of the forging to be examined. An example of a DGS overlay is found in Appendix X3.

6.5.1 As an alternative to using DGS overlays, an ultrasonic instrument having DGS software, integral decibel gain, or attenuator controls in combination with a specifically paired transducer and DGS diagram may be used to evaluate ultrasonic indications.

#### **7. Personnel Requirements**

7.1 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 (1988 or later) or another national standard that is acceptable to both the purchaser and the supplier.

#### **8. Preparation of Forging for Ultrasonic Examination**

8.1 Unless otherwise specified in the order or contract, the forging shall be machined to provide cylindrical surfaces for radial examination in the case of round forgings; the ends of the forgings shall be machined perpendicular to the axis of the forging for the axial examination. Faces of disk and rectangular forgings shall be machined flat and parallel to one another.

8.2 The surface roughness of exterior finishes shall not exceed 250  $\mu$ in. [6  $\mu$ m] where the definition for surface finish is in accordance with Specification A788/A788M unless otherwise shown on the forging drawing or stated in the order or the contract.