



Designation: A418/A418M – 15 (Reapproved 2020)

Standard Practice for Ultrasonic Examination of Turbine and Generator Steel Rotor Forgings¹

This standard is issued under the fixed designation A418/A418M; 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 practice for ultrasonic examination covers turbine and generator steel rotor forgings covered by Specifications A469/A469M, A470/A470M, A768/A768M, and A940/A940M. This practice shall be used for contact testing only.

1.2 This practice describes a basic procedure of ultrasonically inspecting turbine and generator rotor forgings. It does not restrict the use of other ultrasonic methods such as reference block calibrations when required by the applicable procurement documents nor is it intended to restrict the use of new and improved ultrasonic test equipment and methods as they are developed.

1.3 This practice is intended to provide a means of inspecting cylindrical forgings so that the inspection sensitivity at the forging center line or bore surface is constant, independent of the forging or bore diameter. To this end, inspection sensitivity multiplication factors have been computed from theoretical analysis, with experimental verification. These are plotted in Fig. 1 (bored rotors) and Fig. 2 (solid rotors), for a true inspection frequency of 2.25 MHz, and an acoustic velocity of $2.30 \text{ in./s} \times 10^5 \text{ in./s}$ [$5.85 \text{ cm/s} \times 10^5 \text{ cm/s}$]. Means of converting to other sensitivity levels are provided in Fig. 3. (Sensitivity multiplication factors for other frequencies may be derived in accordance with X1.1 and X1.2 of Appendix X1.)

1.4 Considerable verification data for this method have been generated which indicate that even under controlled conditions very significant uncertainties may exist in estimating natural discontinuities in terms of minimum equivalent size flat-bottom holes. The possibility exists that the estimated minimum areas of natural discontinuities in terms of minimum areas of the comparison flat-bottom holes may differ by 20 dB (factor of 10) in terms of actual areas of natural discontinuities. This magnitude of inaccuracy does not apply to all results but

should be recognized as a possibility. Rigid control of the actual frequency used, the coil bandpass width if tuned instruments are used, and so forth, tend to reduce the overall inaccuracy which is apt to develop.

1.5 This practice for inspection applies to solid cylindrical forgings having outer diameters of not less than 2.5 in. [64 mm] nor greater than 100 in. [2540 mm]. It also applies to cylindrical forgings with concentric cylindrical bores having wall thicknesses of 2.5 [64 mm] in. or greater, within the same outer diameter limits as for solid cylinders. For solid sections less than 15 in. [380 mm] in diameter and for bored cylinders of less than 7.5 in. [190 mm] wall thickness the transducer used for the inspection will be different than the transducer used for larger sections.

1.6 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.

1.7 This practice is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the practice, the SI units are shown in brackets. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

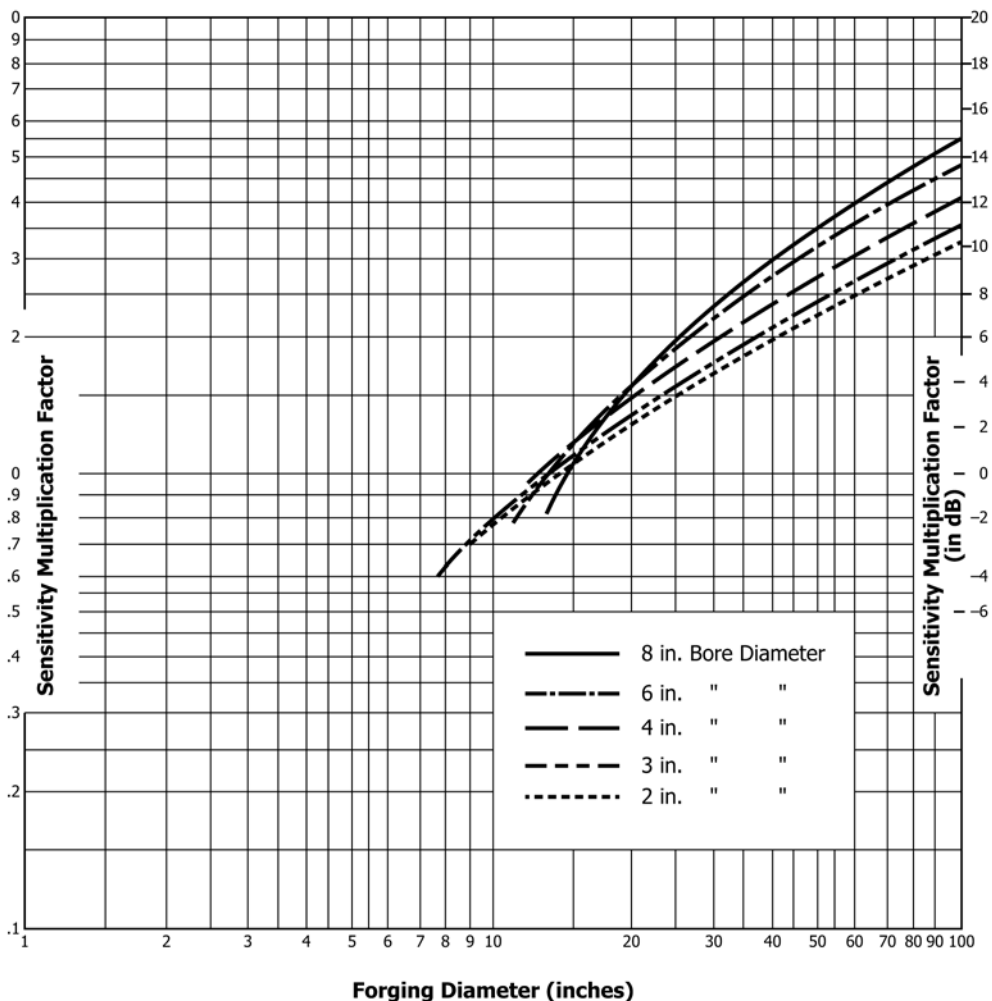
1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

¹ 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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*A Summary of Changes section appears at the end of this standard



SENSITIVITY MULTIPLICATION FACTORS FOR BORED FORGINGS

NOTE 1—Sensitivity multiplication factor such that a 10 % indication at the forging bore surface will be equivalent to a 1/8 in. [3 mm] diameter flat bottom hole. Inspection frequency: 2.0 MHz or 2.25 MHz. Material velocity: 2.30 in./s × 10⁵ in./s [5.85 cm/s × 10⁵ cm/s].

FIG. 1 Bored Forgings

2. Referenced Documents

2.1 The reference is to the latest issue of these designations that appear in the *Annual Book of ASTM Standards* or are available as separate reprints. It shall also apply to product specifications, which may be issued when specifically referenced therein.

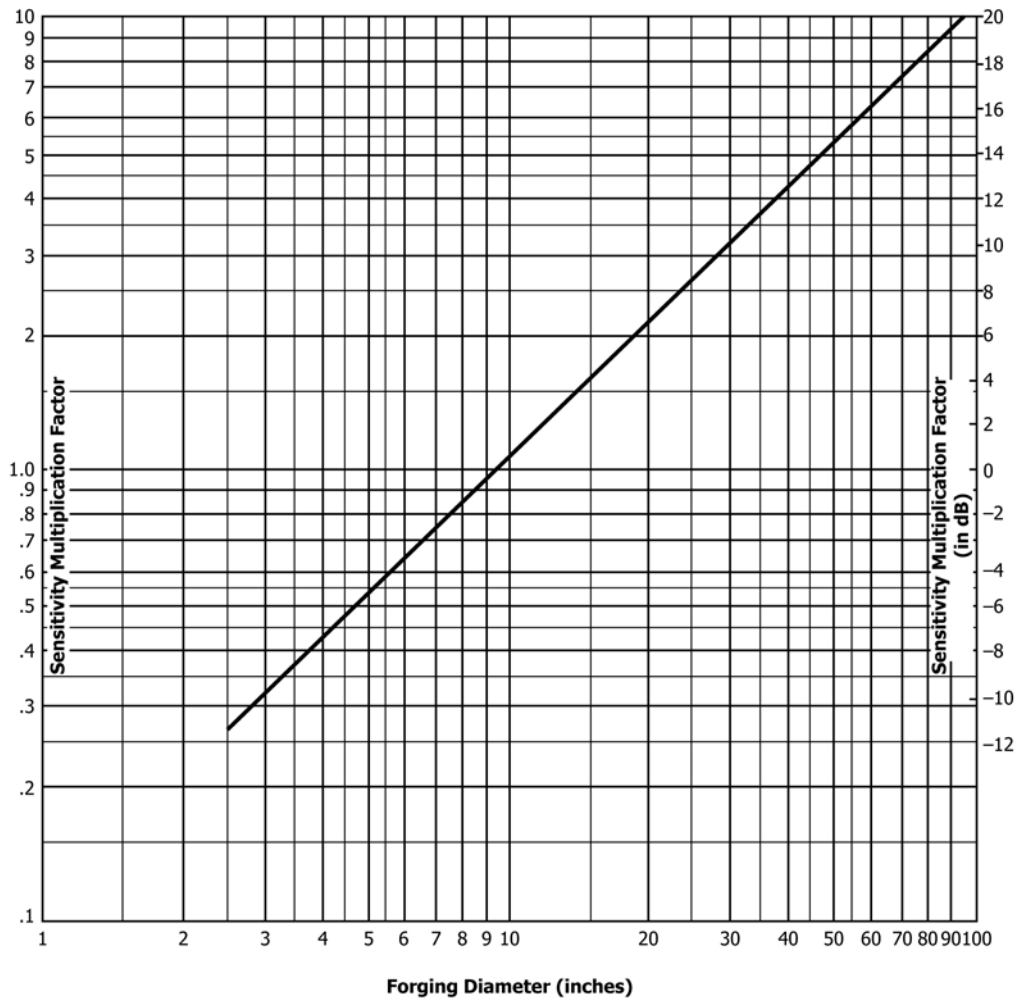
2.2 *ASTM Standards*:²

- A469/A469M Specification for Vacuum-Treated Steel Forgings for Generator Rotors
- A470/A470M Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts

- A768/A768M Specification for Vacuum-Treated 12 % Chromium Alloy Forgings for Turbine Rotors and Shafts (Withdrawn 2018)³
- A788/A788M Specification for Steel Forgings, General Requirements
- A940/A940M Specification for Vacuum Treated Steel Forgings, Alloy, Differentially Heat Treated, for Turbine Rotors (Withdrawn 2017)³
- E317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments
- E1065/E1065M Practice for Evaluating Characteristics of Ultrasonic Search Units

² 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.

³ The last approved version of this historical standard is referenced on www.astm.org.



SENSITIVITY MULTIPLICATION FACTORS FOR SOLID FORGINGS

NOTE 1—Sensitivity multiplication factor such that a 10 % indication at the forging centerline surface will be equivalent to a 1/8 in. [3 mm] diameter flat bottom hole. Inspection frequency: 2.0 MHz or 2.25 MHz. Material velocity: 2.30 in./s × 10⁵ in./s [5.85 cm/s × 10⁵ cm/s].

FIG. 2 Solid Forgings

2.3 Other Standard:

Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing⁴

3. Significance and Use

3.1 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.

3.2 The acceptance criteria shall be clearly stated as order requirements.

4. General Requirements

4.1 As far as possible, the entire volume of the forging shall be subjected to ultrasonic inspection. Because of fillets at steps

and other local configurations, access to inspect some portions of a forging may be limited.

4.2 The ultrasonic inspection shall be performed after final heat treatment of the forging. In those cases in which wheels, slots, or similar features are machined into the forging before heat treatment, the entire forging shall be inspected ultrasonically before such machining, and as completely as practicable after the final heat treatment.

4.3 For overall scanning, the ultrasonic beam shall be introduced radially. To conform with this requirement, external conical surfaces of the forging shall be replaced by stepped surfaces in order to maintain the ultrasonic beam perpendicular to the longitudinal axis. Such stepped surfaces shall be shown on the forging drawing.

4.4 Forgings may be tested either stationary or while rotated by means of a lathe or rollers. If not specified by the purchaser, either method may be used at the manufacturer’s option. Scanning speed shall not exceed 6 in./s [15 cm/s].

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