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Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof¹

This standard is issued under the fixed designation A609/A609M; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice² covers the standards and procedures for the pulse-echo ultrasonic examination of heat-treated carbon, low-alloy, and martensitic stainless steel castings by the longitudinal-beam technique.

1.2 This practice is to be used whenever the inquiry, contract, order, or specification states that castings are to be subjected to ultrasonic examination in accordance with Practice A609/A 609M.

1.3 This practice contains two procedures for ultrasonic inspection of carbon, low-alloy, and martensitic stainless steel castings; that is, Procedure A and Procedure B. Procedure A is the original A609/A609M practice and requires calibration using a series of test blocks containing flat bottomed holes. It also provides supplementary requirements for angle beam testing. Procedure B requires calibration using a back wall reflection from a series of solid calibration blocks.

NOTE 1—Ultrasonic examination and radiography are not directly comparable. This examination technique is intended to complement Guide E 94E94 in the detection of discontinuities.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately 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 this practice.

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:³

A217/A217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service

E94 Guide for Radiographic Examination

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

2.2 Other Document:

SNT-TC-1A Recommended Practice for Non-Destructive Testing Personnel Qualification and Certification⁴

3. Ordering Information

3.1 The inquiry and order should specify which procedure is to be used. If a procedure is not specified, Procedure A shall be used.

3.2 *Procedure A—Flat-Bottomed Hole Calibration Procedure:*

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 A01.18 on Castings.

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² For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-609 of Section II of that Code.

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, Vol 01-02, volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Annual Book of ASTM Standards, Vol 03.03.

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

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

3.2.1.1 Quality levels for the entire casting or portions thereof,

3.2.1.2 Sections of castings requiring longitudinal-beam examination,

3.2.1.3 Sections of castings requiring dual element examination,

3.2.1.4 Sections of castings requiring supplementary examination, using the angle-beam procedure described in Supplementary Requirement S1 in order to achieve more complete examination, and

3.2.1.5 Any requirements additional to the provisions of this practice.

3.3 *Procedure B: Back-Wall Reflection Calibration Procedure*—When this procedure is to be applied to an inquiry, contract, or order, the purchaser shall designate the quality levels for the entire casting or applicable portions.

PROCEDURE A—FLAT-BOTTOMED HOLE CALIBRATION PROCEDURE

4. Apparatus

4.1 *Electronic Apparatus:*

4.1.1 An ultrasonic, pulsed, reflection type of instrument that is capable of generating, receiving, and amplifying frequencies of at least 1 to 5 MHz.

4.1.2 The ultrasonic instrument shall provide linear presentation (within $\pm 5\%$) for at least 75 % of the screen height (sweep line to top of screen). Linearity shall be determined in accordance with Practice E-317E317 or equivalent electronic means.

4.1.3 The electronic apparatus shall contain a signal attenuator or calibrated gain control that shall be accurate over its useful range to $\pm 10\%$ of the nominal attenuation or gain ratio to allow measurement of signals beyond the linear range of the instrument.

4.2 *Search Units:*

4.2.1 *Longitudinal Wave*, internally grounded, having a $\frac{1}{2}$ to $1\frac{1}{8}$ in. [13 to 28 mm] diameter or 1-in. [25-mm] square piezo-electric elements. Based on the signals-to-noise ratio of the response pattern of the casting, a frequency in the range from 1 to 5 MHz shall be used. The background noise shall not exceed 25 % of the distance amplitude correction curve (DAC). Transducers shall be utilized at their rated frequencies.

4.2.2 *Dual-Element*, 5-MHz, $\frac{1}{2}$ by 1-in. [13 by 25-mm], 12° included angle search units are recommended for sections 1 in. [25 mm] and under.

4.2.3 Other frequencies and sizes of search units may be used for evaluating and pinpointing indications.

4.3 *Reference Blocks:*

4.3.1 Reference blocks containing flat-bottom holes shall be used to establish test sensitivity in accordance with 8.2.

4.3.2 Reference blocks shall be made from cast steels that give an acoustic response similar to the castings being examined.

4.3.3 The design of reference blocks shall be in accordance with Fig. 1, and the basic set shall consist of those blocks listed in Table 1. When section thicknesses over 15 in. [380-mm] are to be inspected, an additional block of the maximum test thickness shall be made to supplement the basic set.

4.3.4 Machined blocks with $\frac{3}{32}$ -in. [2.4-mm] diameter flat-bottom holes at depths from the entry surface of $\frac{1}{8}$ in. [3 mm], $\frac{1}{2}$ in. [13 mm], or $\frac{1}{2} t$ and $\frac{3}{4}$ in. [19 mm], or $\frac{3}{4} t$ (where t = thickness of the block) shall be used to establish the DAC for the dual-element search units (see Fig. 2).

4.3.5 Each reference block shall be permanently identified along the side of the block indicating the material and the block identification.

4.4 *Couplant*—A suitable couplant having good wetting characteristics shall be used between the search unit and examination surface. The same couplant shall be used for calibrations and examinations.

5. Personnel Requirements

5.1 The manufacturer shall be responsible for assigning qualified personnel to perform ultrasonic examination in conformance with the requirements of this practice.

5.2 Personnel performing ultrasonic examinations in accordance with this practice shall be familiar with the following:

5.2.1 Ultrasonic terminology,

5.2.2 Instrument calibration,

5.2.3 Effect of transducer material, size, frequency, and mode on test results,

5.2.4 Effect of material structure (grain size, cleanliness, etc.) on test results,

5.2.5 Effect of test distance on test results,

5.2.6 Effect of nonlinearity on test results,

5.2.7 Effect of thickness and orientation of discontinuities on test results, and

5.2.8 Effect of surface roughness on test results.

5.3 A qualification record (see Note 2) of personnel considered suitable by the manufacturer to perform examinations in accordance with this practice shall be available upon request.

NOTE 2—SNT-TC-1A, Ultrasonic Testing Method, provides a recommended procedure for qualifying personnel. Other personnel qualification requirement documents may be used when agreed upon between the purchaser and the supplier.