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Designation: A939/A939M – 12

StandardPractice for Ultrasonic Examination from Bored Surfaces of Cylindrical Forgings[1]

This standard is issued under the fixed designation A939/A939M; 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 covers a basic procedure of ultrasonically inspecting cylindrical forgings with bores from the bore surface.

1.2 This practice applies to the manual testing mode. It does not restrict the use of other testing modes, such as mechanized or automated.

1.3 This practice applies to cylindrical forgings having bore sizes equal to or greater than 2.5 in. [64 mm].

1.4 This practice is expressed in inch-pound and SI units; however, the inch-pound units shall apply unless the purchase order or contract specifies the applicable "M" specification designation (SI units). 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 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 *ASNT Standard:*[2]

SNT-TC-1A Recommended Practice for Non-destructive Personnel Qualifications and Certification

3. Significance and Use

3.1 This practice shall be used when ultrasonic inspection from the bore surface is required by the order or specification for inspection purposes in which the acceptance of the forging is based on limitations of the number, amplitude, or location of discontinuities or a combination thereof, which leads to ultrasonic indications.

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

3.3 This practice requires pitch-catch search unit with twin transducers, which depending on the angle, are sensitive only to 2 to 3 in. [50 to 75 mm] into the metal from the bore surface.

4. General Requirements

4.1 As far as possible, the entire bore surface shall be subjected to ultrasonic inspection. It may be impossible to inspect some small portions of the bore surface because of chamfers at step-downs and other local configurations.

4.2 The bore ultrasonic inspection shall be performed after the final austenitizing and tempering heat treatment for mechanical properties of the forging, and may be performed either prior to or after any subsequent stress relieving heat treatment.

4.3 The ultrasonic beam shall be introduced radially for overall scanning.

4.4 Forgings may be tested either when stationary or while rotated by means of a lathe or rollers.

4.5 To ensure complete coverage of the bore surface, the search unit shall be indexed approximately 75 % of the transducer width with each pass of the search unit.

4.6 A frequency of 2.0 or 2¼ MHz shall be used unless additional transducer frequencies are specified by the purchaser.

4.7 The bore hole diameter and calibration hole(s) shall be as specified on the purchaser's drawing or order.

5. Personnel

5.1 Personnel performing ultrasonic examination to this practice shall be qualified and certified in accordance with a written procedure conforming to SNT-TC-1A or another national standard that is acceptable to both the purchaser and the supplier.

[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.

Current edition approved Nov. 1, 2012. Published November 2012. Originally approved in 1995. Last previous edition approved in 2012 as A939 – 07 (2012). DOI: 10.1520/A0939_A0939M-12.

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

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

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6. Pulsed Ultrasonic Reflection Equipment and Accessories

6.1 *Electronic Apparatus*—A pulse echo instrument permitting inspection frequencies of 1, 2.25, and 5 MHz is required. The accuracy of discontinuity amplitude analysis using this practice involves knowledge of the true operating frequency of the complete inspection system. One of the best ways to obtain the desired accuracy is by use of a tuned pulser and narrow band amplifier of known frequency response, with either a broad band transducer or a narrow band tuned transducer of known and matching frequency. An equipment calibration plan that is acceptable to both the purchaser and the supplier shall be available.

6.2 *Amplifier*—The amplifier and the instrument screen shall provide linear response (within ±5 %) up to 1½ in. [38 mm] sweep to peak. An equipment calibration plan that is acceptable to both the purchaser and the supplier shall be available.

6.3 *Signal Attenuator*—Instruments shall contain a calibrated gain control or signal attenuator (accurate within ±5 % in each case) that will allow indications beyond the linear range of the instrument to be measured. It is recommended that these controls permit signal adjustment up to 25 to 1 (28 dB).

6.4 *Search Units*—Pitch-catch longitudinal wave search units of known effective frequency should be used for scanning. Each unit, containing twin ¼- by 1-in. [6 by 24-mm] 2.0 or 2.25 MHz transducers, shall be used with the 1-in. [25 mm] dimension parallel to the longitudinal axis of the forging, to provide a desirable combination of resolution and beam width. Search units shall have interchangeable shoes that are machined to various diameters for matching different bore diameters.

7. Preparation of Forging for Ultrasonic Inspection

7.1 The surface of the bore shall be free of tool tears, loose scale, grinding particles, or other foreign material at the time of ultrasonic testing and shall have a surface finish of 63 µin. [1.08 µm] or better.

7.2 Bore surfaces should be honed for bore diameter uniformity to maintain a near constant energy transmission from the transducer into the forging.

8. Procedure

8.1 Establish the inspection sensitivity such that the reflection amplitude equals 100 % of the screen height throughout the entire inspection, using the calibration hole, specified by the purchaser, drilled parallel to the bore surface.

8.2 Check the distance calibration for linearity.

8.3 Using only one transducer connected with pulse delay; mark the location of the reflected signal from the curved surface of the shoe at the bore surface.

8.4 Record the distance from the bore surface to the side of the calibration hole.

8.5 Adjust the sweep length control to position the back reflection approximately three fourths of the distance across the instrument screen.

8.6 Record all indications axially and circumferentially as a percentage of the calibration hole sensitivity.

8.7 Support the search unit with structural means at regular intervals.

8.8 Record all indications for radial distance and axial distance.

9. Report

9.1 Report the following information:

9.1.1 Amplitudes of all indications as a percentage of the calibration hole sensitivity,

9.1.2 Axial locations of all indications,

9.1.3 Radial and circumferential locations of all indications,

9.1.4 Areas with high densities of indications as levels of 5 % increments, and

9.1.5 All reflection losses of 20 % or more.

10. Keywords

10.1 bore inspection; bored turbine rotor; forgings; ultrasonic examination

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A939 – 07 (2012)) that may impact the use of this standard. (Approved Nov. 1, 2012.)

(1) Changed to dual unit practice.

(2) Clarified transducer details and replaced term "cathode ray tube."

(3) Added bore surface finish and personnel requirements.

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