Designation: A 939 – 96 (Reapproved 2001)

Standard Test Method for Ultrasonic Examination from Bored Surfaces of Cylindrical Forgings[1]

This standard is issued under the fixed designation A 939; 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 test method covers a basic procedure of ultrasonically inspecting cylindrical forgings with bores from the bore surface.

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

1.3 This test method applies to cylindrical forgings having bore sizes equal to or greater than 2.5 in. (63.5 mm).

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

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. Significance and Use

2.1 This test method 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.

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

2.3 This test method specifies dual search units, which depending on the angle, are sensitive only to 2 to 3 in. into the metal from the bore surface.

3. General Requirements

3.1 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 stepdowns and other local configurations.

3.2 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.

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

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

3.5 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.

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

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

4. Pulsed Ultrasonic Reflection Equipment and Accessories

4.1 *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 test method involves a 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 bans 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.

4.2 *Amplifier*—The amplifier and the cathode ray tube shall provide linear response (within ±5 %) up to 1½ in. (38.1 mm) sweep to peak. An equipment calibration plan that is acceptable to both the purchaser and the supplier shall be available.

4.3 *Signal Attenuator*—The instrument 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).

4.4 *Search Units*—Dual longitudinal wave search units of known effective frequency should be used for scanning. Each ¼ - by 1-in. (6.35 by 25.4-mm) 2.25 MHz transducer, used with the 1-in. dimension parallel to the longitudinal axis of the

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forging, will provide a desirable combination of resolution and beam width. Search units shall have interchangeable plexiglass shoes that are machined to various diameters for matching different bore diameters.

5. Preparation of Forging for Ultrasonic Inspection

5.1 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.

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

6. Procedure

6.1 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.

6.2 Check the distance calibration for linearity.

6.3 Using only one transducer connected with pulse delay, mark the location of the reflected signal from the curved surface of the plexiglass shoe as the bore surface.

6.4 Record the distance from the bore surface to the side of the calibrations hole.

6.5 Adjust the sweep length control to position the back reflection approximately three fourths of the distance across the cathode ray tube.

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

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

6.8 Record all indications for radial distance and axial distance.

7. Report

7.1 Report the following information:

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

7.1.2 Axial locations of all indications,

7.1.3 Radial and circumferential locations of all indications,

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

7.1.5 All reflection losses of 20 % or more.

8. Keywords

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