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Standard Guide for Material Selection and Fabrication of Reference Blocks for the Pulsed Longitudinal Wave Ultrasonic Testing of Metal and Metal Alloy Production Material¹

This standard is issued under the fixed designation E1158; 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 guide covers general procedures for the material selection and fabrication of reference blocks made of metal or metal alloys and intended to be used for the examination of the same or similar production materials by pulsed longitudinal ultrasonic waves applied perpendicular to the beam entry surface. Primary emphasis is on solid materials but some of the techniques described may be used for midwall examination of pipes and tubes of heavy wall thickness. Near-surface resolution in any material depends upon the characteristics of the instrument and search unit employed.

1.2 This guide covers the fabrication of reference blocks for use with either the immersion or the contact method of ultrasonic examination.

1.3 Reference blocks fabricated in accordance with this guide can be used to determine proper ultrasonic system operation. Area-amplitude and distance-amplitude curves can also be determined with these reference blocks.

1.4 This guide does not specify reference reflector sizes or product rejection limits. It does describe typical industry fabrication practices and commonly applied tolerances where they lend clarity to the guide. In all cases of conflict between this guide and customer specifications, the customer specification shall prevail.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address 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 to determine the applicability of regulatory limitations prior to use.*

¹ This guide is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Method.

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2. Referenced Documents

2.1 *ASTM Standards:*²

E127 Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Standard Reference Blocks³

E428 Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing

E1316 Terminology for Nondestructive Examinations

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, see Terminology E1316.

4. Summary of Guide

4.1 This guide describes a method of selecting suitable reference block material from current or previous production and the subsequent fabrication and checking of the resulting ultrasonic reference blocks.

5. Significance and Use

5.1 This guide is intended to illustrate the fabrication of ultrasonic reference blocks that are representative of the production material to be examined. Care in material selection and fabrication can result in the manufacture of reference blocks that are ultrasonically similar to the production material thus eliminating the reference block as an examination variable.

6. Material Selection

6.1 It is good practice to use a sample removed from the production lot of material as the reference block material. When this is not possible the following guidelines should be followed.

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 reference blocks in Practice E127 are used to check the performance of ultrasonic examination equipment and for standardization and control of ultrasonic examinations of aluminum alloy products. The ultrasonic response of the blocks in Practice E127 is evaluated against a standard target. The blocks described in this standard are used for the examination of production material and may be used to establish accept-reject criteria.

6.2 The reference block material should be of the same general shape and dimensions, surface finish, chemical composition, and microstructure as the production material to be examined.

6.3 To ensure that the material chosen is suitable for use as reference block material and is free of potentially interfering reflectors, ultrasonically examine the reference block material at the anticipated frequency and at a sensitivity that produces an acoustic noise level of 20 % screen height. The entire block should be scanned from the surface which will be used for standardization. Any discrete indication that exceeds 40 % screen height should be cause to remove the material from consideration as an ultrasonic reference block.

6.4 Reference block material that meets the guidelines of 6.3 should then be examined at a sensitivity that produces multiple reflections from the back surface (between 3 and 5 reflections in most metals and metal alloys). The production material should be examined at the same sensitivity level to determine that the same number of back reflections are obtained. This procedure may have to be repeated several times and an average number of back reflections determined in the case of some materials (see Note 1).

NOTE 1—In some highly attenuative materials more than one or two back reflections may not be attainable. In these cases, selection of the reference block material may be based on similar acoustic noise levels from both the production material and that chosen for a reference block.

7. Reference Block Configuration

7.1 There are many different types of reference blocks used in industry depending upon the size and shape of the material to be examined. Some of the more common flat bottom hole (FBH) types are described in 7.2 through 7.7, and shown in Figs. 1-7. An alternate method for fabricating FBH's is described in the annex.

7.2 Fig. 1 shows the typical reference standards used for ultrasonic examination when the product to be examined consists of large round bar stock, between 1 to 10 in. (25.4 to 245.0 mm) in diameter. With such products it is often necessary to correct for the loss of signal with increasing examination distance (distance-amplitude-correction, or DAC). Therefore, a stepped block, as shown in Fig. 1 is commonly used. This type of block is typically referred to as a distance-amplitude-block. It contains a number of holes of the same size at various distances from the scan surface. A typical FBH size found in many such blocks is 5/64 in. (1.98 mm) or larger depending

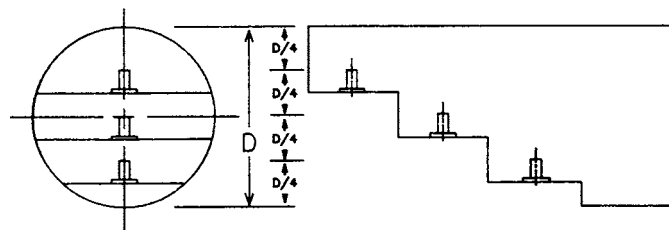


FIG. 1 Typical Distance-Amplitude Reference Block Configuration for the Ultrasonic Testing of Large Metal and Metal Alloy Bars from 1 to 10 in. (25.4 to 254.0 mm) Diameter and Larger

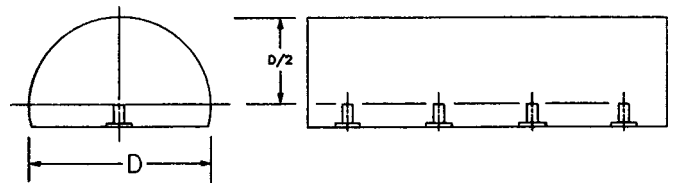


FIG. 2 Typical Area-Amplitude Reference Block for use in Ultrasonic Testing of Round Bars as in Fig. 1

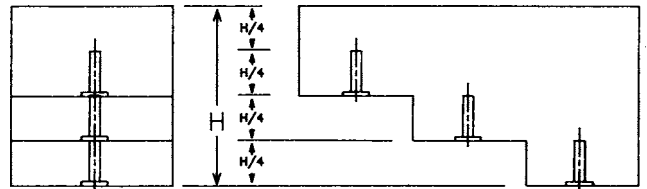


FIG. 3 Typical Distance-Amplitude Reference Block for the Ultrasonic Testing of Large Square or Rectangular Bars Greater than 1 in. (25.4 mm)

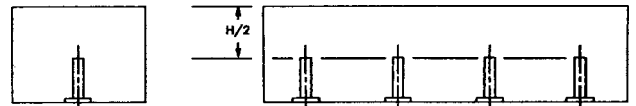


FIG. 4 Typical Area-Amplitude Reference Block for the Ultrasonic Testing of Square or Rectangular Bars

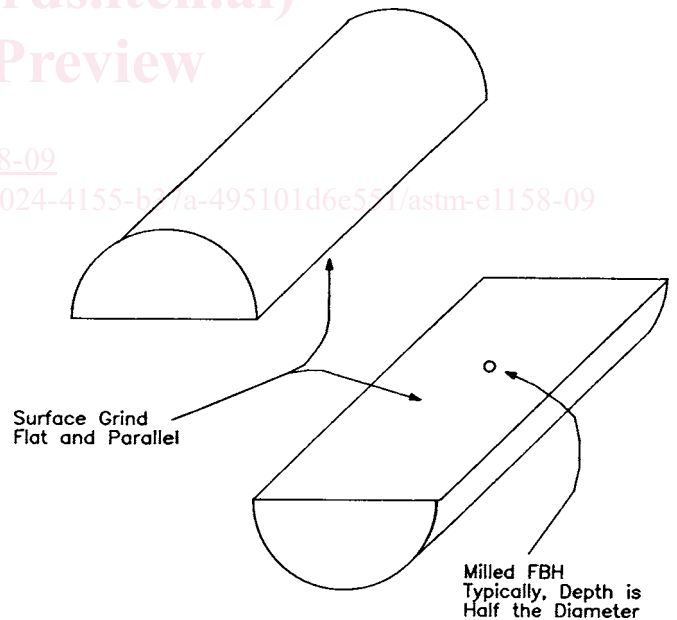


FIG. 5 Typical Example of a Diffusion Bonded Reference Block for Small Diameter Round Bars

upon the ultrasonic attenuation, or the internal structure of the product, or both. For even larger diameter bars the distance amplitude correction reference standard may contain even larger FBH's, possibly 1/4 in. (6.35 mm) or greater.