



CORPORATE STANDARD

AA 085 01 05

Rev. No. 01

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ULTRASONIC EXAMINATION, ACCEPTANCE STANDARDS AND CLASSIFICATION OF STEEL CASTINGS FOR HYDRO-TURBINES, HYDRO-GENERATORS & MOTORS

1.0 SCOPE:

This standard deals with the ultrasonic testing procedure, acceptance standards and classification of steel castings for hydro-turbines, hydro-generator and electrical motors.

This standard is not applicable for Austenitic castings.

2.0 STAGE OF EXAMINATION:

Ultrasonic examination shall be generally carried out after heat treatment and rough machining of the castings, as called for in the order/drawing. Ultrasonic examination shall be repeated after weld rectification, if any.

3.0 SURFACE PREPARATION:

Smooth "as cast" surface free from adhered or fused sand and irregularities is adequate for ultrasonic examination. Loose scales and excessive surface irregularities such as that caused by removal of runner and riser shall be ground off. While grinding care shall be taken to avoid surface undulations which would interfere with probe contact. To improve coupling efficiency of as cast surfaces or to remove rust or paint, shot blasting or sand-blasting may be carried out. Rough machined surfaces should have a minimum surface finish of 6.2 microns.

4.0 PERSONNEL REQUIREMENT:

Personnel performing the non-destructive examination and evaluation shall be qualified to the recommended practice SNT - TC - 1A or any other recognised practice.

5.0 EQUIPMENT CHARACTERISTICS:

5.1 Frequency range:

The equipment shall be capable of operating over a frequency range of at least 0.5 to 6 MHz.

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5.2 CRT Screen Presentation:

"A" scan presentation shall be used. The trace shall be well defined, easy to read and associated with permanent graticule scale marking for both range and amplitude.

5.3 Screen Height Linearity:

The amplifier shall be linear within $\pm 5\%$ upto at least 75% of full screen height and any deviation above this should be known to the operator. Suppression affects linearity and the effect of suppression over full range should be recorded.

5.4 Amplitude Control Linearity:

The equipment shall contain a signal attenuator or calibrated gain control that shall be accurate over its useful range to $\pm 20\%$ of the useful range (20% to 80% of screen height)

5.5 Linearity Of Time Base:

The time base shall be linear as far as possible and non-linearity should not exceed 2% of the full scale graticule reading.

5.6 Resolution:

The resolution of probe and flaw detection apparatus shall be such as to show separately the indication from three reflecting surfaces of the vertical grooves in the IIW 'V1' block.

5.7 Sensitivity of the Equipment:

The sensitivity of the equipment shall be checked with the longitudinal wave probe used by placing the probe on the metalised surface of the plastic insert of IS 4904/ IIW test block. The minimum number of multiple echoes from the plastic insert at full gain setting shall be as given below:

<u>Frequency range, MHz</u>	<u>Number of multiple echoes</u>
1	5
2	4
4 to 6	2

6.0 COUPLANT:

To ensure adequate transmission of ultrasonic energy between probe and casting, a suitable couplant having good wetting characteristics shall be used. Oil, glycerin or polycell paste may be used. For better adoption of cast surfaces, a thin protective plastic cover over the longitudinal probe is recommended.



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7.0 SEARCH UNIT:

7.1 Longitudinal wave internally grounded having a 1/2 to 1 in (13 to 25 mm) diameter or 1 in (25 mm) square piezo-electric elements. Based on the signal to noise ratio of the response pattern of the casting a frequency in the range from 1 to 5 MHz shall be used. The back ground noise shall not exceed 25% of the distance amplitude correction curve (DAC). Transducers shall be utilized at their rated frequencies.

7.2 Dual-Element, 4 MHz 1/2 by 1 in (13 by 25 mm), 12° included angle search units are recommended for sections 1 in (25mm) and under.

7.3 Other frequencies and sizes of search units may be used for evaluating and pin pointing indications.

8.0 TESTING PROCEDURE:

8.1 Selection of Probes:

For all ultrasonic examinations, the highest frequency compatible with the size, metallurgical condition and thickness of the casting shall be used.

8.2 Testing Techniques:

While selecting testing technique the following factors must taken into account:

- i. Type, orientation, position and incidence of defects likely to be encountered in the casting under consideration.
- ii. Thickness and profile of the section.
- iii. Structural condition.

All parts of the casting surface where a contact probe can be used, shall be tested by overlapping scans 15% with normal beam probes, irrespective of casting geometry and availability of reference back echo. Normal beam probe of 1 to 5 MHz frequency shall be used.

9.0 EQUIPMENT CALIBRATION:

9.1 Depth Range:

The depth range of the equipment shall be adjusted for normal and shear wave probes using known thickness of the casting or standard calibration block. When latter is used, velocity difference, if any, should be taken into account.



9.2 Sensitivity:

The scanning sensitivity of the apparatus shall be adjusted using either DGS diagram or standard test block with flat bottomed hole so that maximum acceptable equivalent defect will give an indication height of 75% of screen height +6 db. When test block is used for sensitivity calibration, distance amplitude curve shall be plotted on CRT screen to facilitate correct defect size assessment. While estimating the size of the defect compensation shall also be made for the difference in the surface condition and attenuation in the test block and casting.

10.0 ACCEPTANCE STANDARD:

Following reference blocks shall be used for ultrasonic examination.

- A. Calibration block as indicated in Fig.1 shall be used for normal beam scanning.
- B. Calibration block as indicated in Fig.2 shall be used for double crystal probe scanning.
- C. Calibration block as indicated in Fig.3 shall be used for angle beam scanning.

10.1 Acceptance criterion for quality levels are specified in the table given below. Applicable quality level/ levels shall be specified in the drawing or the purchase order. Applicable quality level for weld zones, bearing seating areas, deep machining zones, etc., shall be clearly specified in the drawing.

10.2 No indication equal to or greater than DAC over an area specified for applicable quality level of Table 1.

10.3 Indications producing a continuous response equal to or greater than DAC with a dimension exceeding a maximum length shown for the applicable quality level shall be unacceptable.

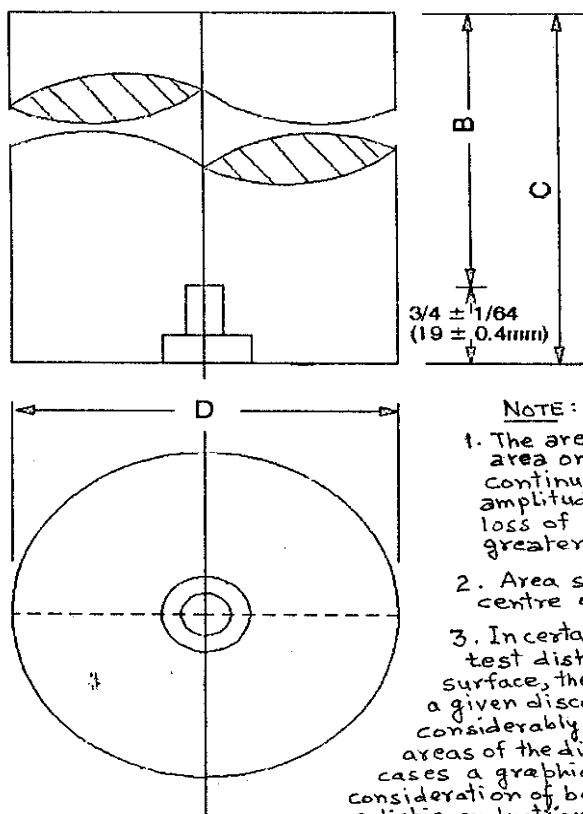
10.4 No reduction of back reflection of 75% or greater that has been determined to be caused by a discontinuity over an area specified for the applicable quality level of Table.1

TABLE 1:- Ultrasonic testing Quality level

Area in ² (cm ²)	Max. Length in (mm)
0.8 (5)	1.5 (40)
1.5 (10)	2.2 (55)
3.0 (20)	3.0 (75)
5.0 (30)	3.9 (100)
8.0 (50)	4.8 (120)
12.0 (80)	6.0 (150)
16.0 (100)	6.9 (175)

NOTE: SEE PAGE 5

FIG. 1 Ultrasonic Standard Reference Block



- NOTE:
1. The areas in the table refer to the surface area on the casting over which a continuous indication exceeding the amplitude reference line of a continuous loss of back reflection of 75% or greater is maintained.
 2. Area shall be measured from the centre of the search unit.
 3. In certain castings, because of very long test distances or curvature of the test surface, the casting surface area over which a given discontinuity is detected may be considerably larger or smaller than the actual areas of the discontinuity in the casting, in such cases a graphic plot that incorporates the consideration of beam spread should be used for realistic evaluation of the discontinuity.

Notes:

1. Opposite ends of reference block shall be flat and parallel within 0.001 in (0.025 mm)
2. Bottom of flat-bottom hole shall be flat within 0.002 in (0.050 mm) and the finished diameter shall be $1/4 + 0.002$ in (6.4 + 0.050 mm)
3. Hole shall be straight and perpendicular to entry surface within 0°, 30 min. and located within 1/32 in (0.80 mm) of longitudinal axis.
4. Counter bore shall be 1/2 in (13mm) diameter by 1/8 in (3 mm) deep.

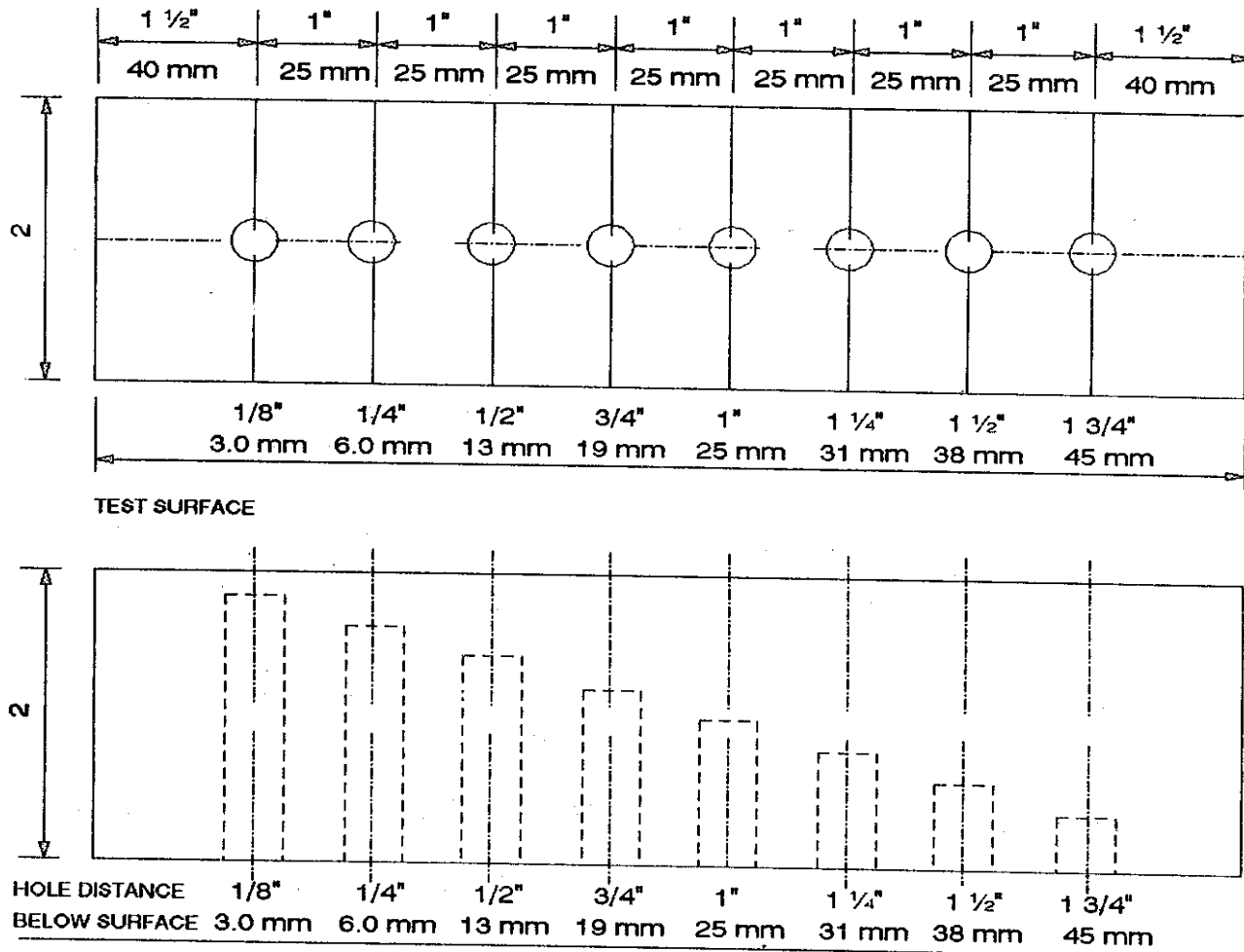
Dimensions and Identification of Reference blocks in the basic set (See Fig. 1)

Hole diameter, in 1/64ths. in.(mm)	Metal distance (B) ^A in.(mm)	Overall length C in.(mm)	Width or diameter D min. in.(mm)	Block Identification number
16(6.30)	1(25)	1 3/4(45)	2(50)	16-0100
16(6.30)	2(50)	2 3/4(70)	2(50)	16-0200
16(6.30)	3(75)	3 3/4(95)	2(50)	16-0300
16(6.30)	6(150)	6 3/4(170)	3(75)	16-0600
16(6.30)	10(255)	10 3/4(275)	4(100)	16-1000
16(6.30)	B	B + 3/4 (B + 20)	5(125)	16-B00 ^B

A - Tolerance $\pm 1/8$ in. (3 mm)

B - Additional supplemental blocks for testing thickness greater than 10 in. (250 mm).

FIG. 2 Ultrasonic Standard Reference Block for Dual-Search Unit Calibration



Note 1: Entrant surface shall be 250 μ in. (6.3 μ m) or finer.

Note 2: The 3/32 in. (2.4 mm) flat bottom hole must be flat within 0.002 in. (0.050 mm). Diameter must be within +0.005 in. (0.13 mm) of the required diameter. Hole axis must be perpendicular to the block and within an angle of 0°, 30 min.

Note 3: Hole shall be plugged following checking for ultrasonic response.

in.	(mm)	in.	(mm)
1/8	(3)	1 1/4	(32)
1/4	(6)	1 1/2	(38)
1/2	(13)	1 3/4	(44)
3/4	(19)	2	(50)
1	(25)	10	(254)

Nominal production material thickness (t), in. (mm)	Basic Calibration Block thickness (T) in. (mm)	Hole Diameter (d) in. 1.002 (mm \pm 0.05)	Minimum depth (D) in. (mm)
Upto 1 (25) incl.	1 (25) or t	3/32 (2.4)	1 1/2 (40)
Over 1 to 2 (25-50)	2 (50) or t	1/8 (3.2)	1 1/2 (40)
over 2 to 4 (50-100)	4 (100) or t	3/16 (4.8)	1 1/2 (40)
over 4 to 6 (100-150)	6 (150) or t	1/4 (6.3)	1 1/2 (40)
over 6 to 8 (150-200)	8 (200) or t	5/16 (7.9)	1 1/2 (40)
over 8 to 10 (200-250)	10 (250) or t	3/8 (9.5)	1 1/2 (40)
over 10 (250)	t	See Note 1	1 1/2 (40)