



# AMENDMENT - NOTIFICATION

AA 085 01 18 REV.No. 01

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## AA 085 01 18:ULTRASONIC TESTING CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS

### 1.0 PAGE 1 OF 6; Cl 1.0 SCOPE:

Last sentence of the para is modified as follows:

"This standard does not apply to austenitic steel forgings  
for which AA 085 01 19 may be referred to."

### 2.0 Cl 3.2 Sensitivity:

Title of the left hand column of the table is modified as  
"Frequency, MHz" in place of Frequency range, MHz.

### 3.0 PAGE 2 OF 6; Cl 5.0 COUPLANT:

Last line is modified as "or water shall be used."

### 4.0 Cl 6.1: Eight line is modified as follows:

"shall not exceed 150mm/second. The following techniques"

Please see instructions on the reverse.

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|------------------|------------|----------|-----------|---------|---------------|
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# CORPORATE STANDARD

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## ULTRASONIC TESTING, CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS

### 1.0 SCOPE:

This standard deals with the ultrasonic testing of steel forgings, billets and blooms. The procedure covers pulse echo direct contact manual ultrasonic flaw detection technique. This standard does not apply to austenitic steel forgings.

### 2.0 PERSONNEL REQUIREMENT:

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

### 3.0 EQUIPMENT CHARACTERISTICS:

#### 3.1 Frequency range:

The ultrasonic equipment shall be suitable for operating at frequencies within the range of 0.5 to 6 MHz.

#### 3.2 Sensitivity:

The sensitivity of the equipment shall be tested to ensure that the number of full screen back wall echo is not less than that given below, when the appropriate probe is placed on the metalised surface of plastic insert of the Indian Standard reference block (IS:4904)/IIW block.

| <u>Frequency range, MHz</u> | <u>Min.No. of full screen back echoes</u> |
|-----------------------------|-------------------------------------------|
| 1                           | 5                                         |
| 2                           | 4                                         |
| 4 to 6                      | 2                                         |

#### 3.3 Resolution:

The resolution of the equipment and probe combined shall be such as to show separately indications of the three grooves in the IIW - VI block.

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**4.0 SURFACE CONDITION:**

The test surface shall be free from loose scales, rust and such other extraneous material that would interfere with the ultrasonic energy transmission. In case of machined surface, it is desirable to have a surface finish of 6.25 microns or better. A gramophone record type of finish and tear produced by machining tools shall be avoided since these give rise to spurious echoes and cause probe wear.

**5.0 COUPLANT:**

To ensure adequate transmission of ultrasonic energy between the probe and the test object, a suitable couplant having good wetting characteristics such as oil, grease, water, glycerine or cellulose paste shall be used.

**6.0 TESTING TECHNIQUE:**

6.1 Selection of testing technique shall be made after giving due consideration to the method of manufacture and shape of the object tested. Testing technique should be such that each and every part of the object volume is scanned at least once. Successive scans shall overlap a minimum of 15% of the probe width. Uniform contact shall be maintained between probe and object and scanning speed shall not exceed 100 mm/ second. The following techniques are considered to be minimum for providing adequate coverage.

**6.2 Scanning Scheme (Solid And Hollow Forgings):**

Complete length of the forging shall be scanned radially from sides / cylindrical surface through 360° using longitudinal wave probe. Whenever practicable the forging shall be scanned in axial direction also. Hollow forgings, and when necessary, solid forgings also shall be scanned using appropriate shear wave probes to detect axial and radial cracks. Hollow forgings are the forgings made hollow on the press by punching or ring rolling operation.

**6.3 Solid Rectangular Forgings, Billets And Blooms:**

Complete length of the object shall be scanned from two adjacent faces and whenever practicable one end face using longitudinal wave probe.

6.4 Radial cracks on round sections which can not be detected by normal testing method may be subjected to other crack detection methods such as MPI.

**7.0 SCANNING:****7.1 Probes and Frequency:**

Overall scanning shall be done using 2 MHz nominal, 20-25 mm diameter probes except when large grain size and path length make it necessary to use a lower frequency. Smaller probes may be used when necessary. However, for forgings intended for backing material for white metal lined bearings, the examination shall be carried out by 4 MHz probes.



7.2 Time Base Calibration:

The time base shall be calibrated using a calibration block or a known dimension of forging under examination.

7.3 Sensitivity:

7.3.1 When Calibrated Attenuator Is Not Available:

Reference sensitivity of equipment shall be set such that the maximum acceptable defect equivalent flat bottomed hole in the test block is equal to 75% of the full screen height. Testing shall be carried out at the highest sensitivity possible.

7.3.2 When Calibrated Attenuator Is Available:

The sensitivity of the equipment during scanning shall be set 6 dB more than the sensitivity required to give a full screen height echo from the maximum acceptable size of defect.

Note: The above sensitivity level adjustment is purely for scanning purposes. Once a defect is encountered, the sensitivity shall be brought down to estimate the size of defect for evaluation of the material under test.

8.0 ESTIMATION OF FLAW SIZE:

8.1 Large Size Flaws:

The size of large flaws can be estimated by moving the probe in all directions and plotting the midpoint of the probe when echo falls to 50 percent or 6 dB.

8.2 Small Size Flaws:

8.2.1 When Calibrated Attenuator Is Not Available:

8.2.1.1 The size of the flaw may be estimated by comparing with the echoes of the flat bottomed holes at appropriate depths in a test block of ultrasonically similar material.

8.2.1.2 The size of the flaw may also be estimated by moving probe successively in all the four directions at right angles to each other and plotting the mid point of the probe when echo height falls to 50% or 6 dB. Due allowance shall also be made for beam spread, depth and orientation of flaw and diameter of the forging if the scanning is done from the curved surface.

8.2.2 When Calibrated Attenuator Is Provided With The Equipment:

The size of the flaw (smaller than the beam spread) can be estimated accurately in millimetres of equivalent circular flaw with the help of Krautkramer's DGS (Distance - gain - size) diagram. Method of estimating flaw size using a DGS diagram is given in Annexure - A.

**9.0 CLASSIFICATION OF FORGINGS, BILLETS AND BLOOMS:**

9.1 Forgings, billets and blooms are classified into the following five categories depending upon the defect size admissibility for the purpose of ultrasonic testing:

| <u>Category</u> | <u>Unacceptable defects</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1               | <ul style="list-style-type: none"><li>(i) Cracks, flakes, seams &amp; laps.</li><li>(ii) Defects giving indication larger than that from a 2 mm diameter equivalent flaw.</li><li>(iii) Groups of defects with maximum indication less than that from a 2 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 70%.</li><li>(iv) Defects giving indications of 1 to 2 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.</li></ul> |
| 2               | <ul style="list-style-type: none"><li>(i) Cracks, flakes, seams &amp; laps.</li><li>(ii) Defects giving indication larger than that from a 4 mm diameter equivalent flaw.</li><li>(iii) Groups of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 50%.</li><li>(iv) Defects giving indications of 2 to 4 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.</li></ul> |
| 3               | <ul style="list-style-type: none"><li>(i) Cracks, flakes, seams &amp; laps.</li><li>(ii) Defects giving indication larger than that from a 6 mm diameter equivalent flaw.</li><li>(iii) Groups of defects with maximum indication less than that from a 6 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 40%.</li><li>(iv) Defects giving indications of 3 to 6 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.</li></ul> |
| 4               | <ul style="list-style-type: none"><li>(i) Cracks, flakes, seams &amp; laps.</li><li>(ii) Defects giving indication larger than that from a 10 mm diameter equivalent flaw.</li><li>(iii) Groups of defects with maximum indication less than that from a 10 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 20%.</li></ul>                                                                                                                                                                        |



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- (iv) Defects giving indications of 5 to 10 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.
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- (i) Cracks, flakes, seams & laps.
- (ii) Defects giving indication larger than that from a 15 mm diameter equivalent flaw.
- (iii) Groups of defects with maximum indication less than that from a 15 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 10%.

**Note:** Loss of back wall echo not attributable to the presence of defects or geometry and exceeding the limits mentioned in item (iii) of each category of unacceptable defects shall be a cause for rejection.

### ANNEXURE - A

The equivalent flaw size curves of the DGS diagram is prepared by plotting the amplitude in decibels from a series of circular reflectors with increasing distance from the probe in water and so the graph incorporates only the loss in water. When it is found that the attenuation in the material under test is more (this can be checked using back echo curve of DGS diagram), this shall be taken into account while calculating the flaw size. Corrections will not be required for majority of heat treated forgings when tested with 2-4 MHz probes.

A step by step method of estimating flaw size using universal DGS diagram is given below:

- (a) Adjust the depth range of the equipment to the required depth.
- (b) Adjust the back echo to 70% of screen height from a defect free area parallel wall of the material under test or ultrasonically similar test block and note the dB value (A) on the calibrated gain control.
- (c) Mark on the back echo curve of the diagram, the back wall of the distance in terms of near field in millimetres in the case of universal DGS diagram.
- (d) Move the probe to the defective area and get the maximum defect echo. Read off the flaw depth. Increase the gain with the calibrated gain control until echo height reaches 70% of screen height. Note the attenuator reading in dB (B).
- (e) Calculate the gain (G) in dB by subtracting 'A' from 'B'. Count off the gain 'G' downwards from the marked point on the back echo curve, and then move horizontally to intersect the vertical line from the base line corresponding to the flaw depth 'D' in terms of near field in the case of universal diagram.

- (f) Note the equivalent flaw size curve passing through the above point. Multiply the reduced flaw dimension (S) of the curve by the probe diameter to give the equivalent flaw size in millimetres.

## ANNEXURE - A

## KRAUTKRAMER'S DGS DIAGRAM

