
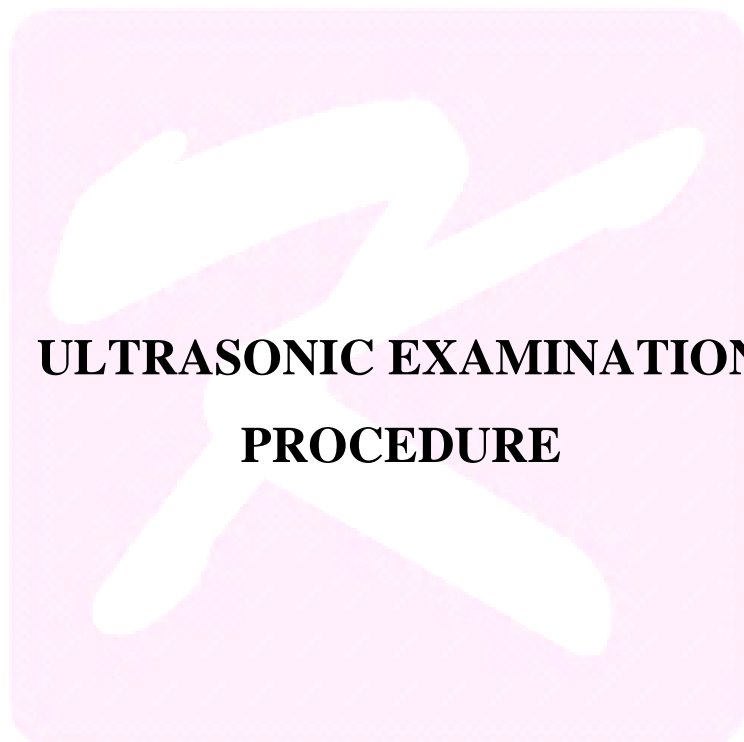


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| | | Date: 15.09.2012 |



ULTRASONIC EXAMINATION PROCEDURE

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| PREPARED & APPROVED BY NDE- Level III | CERTIFIED BY | REVIEWED BY |

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1. SCOPE

- This procedure explains the requirements for manual A-scan, pulse echo, contact technique of ultrasonic examination of weldments and materials of carbon and low alloy steel in pressure vessels.

2. REFERENCE DOCUMENTS

- ASME Boiler and Pressure Vessel Code Section V, Edition 2010.
- ASME Boiler and Pressure Vessel Code Section VIII Division-1, Edition 2010.
- ASME Boiler and Pressure Vessel Code Section VIII Division-2, Edition 2010.
- ASME Boiler and Pressure Vessel Code Section IX Edition 2010.

3. RESPONSIBILITIES

- The NDT Inspector shall be responsible for conducting and reporting the results of inspection in accordance with project contract.

4. QUALIFICATION OF PERSONNEL

- The personnel involved in Ultrasonic examination, interpretation and evaluation shall be certified as per ASNT-SNT-TC-1A and as per Kalkars NDT Services written practice for NDE Personnel Qualification.
- When the written practice is revised, the certification of NDE personnel remains valid to the requirements of the previous revision until the expiry date of the personnel qualification certificate; then, recertification to the requirements of the new revision is required.

5. EQUIPMENT:

- The examination shall be conducted with A scan type pulse echo ultrasonic equipment that generates frequencies over the range of 1MHz to 5MHz and shall be equipped with a stepped gain control in units of 2 dB or less.
- The reject control shall be in the 'off' position for all examination.
- The equipment shall have valid calibration and stickered mentioning the date of expiry.

6. SEARCH UNITS:

- Search units may contain single crystal/dual crystal transducers.
- For straight beam examination longitudinal wave probes (0°) shall be used. For angle beam examination shear wave probes of 45° shall generally be used and other angles up to 70° shall be used appropriate to the configuration being examined. Groove angle and thickness shall be considered in selecting the probe angle other than 45°
- For straight beam examination, the crystal dimensions shall be selected in the range of 5 mm to 25 mm. For angle beam examination, the crystal dimensions shall be selected appropriate to the contact available with examination surface and will generally be 8x9 mm 14x14 or 20x22 mm.
- Probes of frequencies between 2.5 MHz and 4 MHz shall be used for both straight beam and angle beam examination.

7. SURFACE CONDITION:

- The finished contact surface shall be free from weld spatter and surface irregularities which will impair the free movement of the search unit.
- The weld reinforcement shall be ground flush smooth with adjacent base material, if required

8. COUPLANT:

- Grease/oil may be used as couplant. The couplant used for the examination shall be the same as that used for calibration.
- Couplant used on nickel base alloys shall not contain more than 250 ppm of sulfur.
- Couplants used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (Chlorides plus fluorides).

9. CALIBRATION OF EQUIPMENT:

- The basic reference reflectors shall be used to establish a primary reference response of the equipment. The material from which the block is fabricated shall be of the same product form and material specifications or equivalent P - Number grouping (P. Nos. 1, 3, 4 and 5 , 5A through 5C and 15A through 15F are considered equivalent) as one of the material being examined.
- Reference blocks for dissimilar metal welds, the material selection shall be based on the material on the side of the weld from which the examination will be conducted. If the examination will be conducted from both sides, calibration reflectors shall be provided in both materials.
- Reference blocks shall receive Precast the minimum tempering treatment required by the material specification for the type and grade.
- When two or more base material thicknesses are involved, the reference block thickness shall be determined by the average thickness of the weld.
- The thickness and the location and size of holes in the basic reference block to be used shall be as indicated.
- The finish on the surface of the reference block shall be representative of the surface finish on the component. Variation in component configuration and surface finish, require transfer correction to be calculated.
- The reference block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back reflection shall not be used as block material.
- When the component has flat surfaces or curved surface with a diameter greater than 20 inches, a flat basic reference block shall be used (Figure - 1).
- When the component is curved and has a diameter less than 20 inches, a curved basic reference block shall be used. The components to be tested can have a curvature between 0.9 to 1.5 times of basic reference block diameter.

- For testing a weld thickness 't', the calibration block of the same thickness will be ideal. However, the thickness of the calibration blocks acceptable for use shall be

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| For weld thickness 25mm or less | - | 19mm |
| For weld thickness 25mm through 50mm | - | 38mm |
| For weld thickness 50mm through 100mm | - | 75mm |
| For weld thickness over 100mm | - | t±25mm |

- The reference blocks manufactured in house, shall be inspected and certified by NDT Level III.

10. CALIBRATION TECHNIQUES:

Technique for Straight Beam Calibration:

- The sweep range for straight beam is set on the equipment using the IIW V1 block.
Distance - Amplitude Correction:
- The probe is positioned for maximum response from the hole that gives the highest amplitude and set to 80% ($\pm 5\%$) full screen height.
- The peak of the indication is marked on the screen with a glass marking pencil. Without disturbing the sensitivity controls of the unit, the probe is positioned for maximum response from the other two hole indications and their peaks marked on the screen.
- The screen marks are connected and extended through the thickness to provide the distance amplitude correction (DAC) curve using flat bottom holes.

Technique for Angle Beam Calibration:

- The basic calibration block shall be used for distance amplitude correction and position calibration.
- The sweep range is selected and the equipment is calibrated to the selected range using IIW - V1 or V2 blocks.

Distance - Amplitude Correction (DAC):

- To construct a DAC a basic calibration block having drilled holes at $\frac{1}{4}T$, $\frac{1}{2}T$ and $\frac{3}{4}T$ shall be used. The gain is adjusted to provide an 80% $\pm 5\%$ of full screen indication from the $\frac{1}{4}T$ hole.

- The peak of the indication is marked on the screen with a glass marking pencil. Without disturbing the settings, the probe is positioned for maximum response from the $\frac{1}{2}T$, $\frac{3}{4}T$ holes and $T+\frac{1}{4}T$ hole after the beam has bounced from the opposite surface. The peak marks of the indications from the side drilled holes are connected to provide DAC curve.
- When calibrated using notched specimen, indication from the root notch is brought to 80% of screen height and the sensitivity level is noted.
- A calibration check on Precast one of the basic reflections in the basic calibration block shall be made to ensure proper functioning of the equipment, at the beginning and finish of each examination or series of similar examinations, every 4 hours during the examination and when examination personnel are changed.
- The sensitivity (in dB) used for DAC shall be evaluation sensitivity or reference level.
- Transfer correction if any obtained, shall be added to test / evaluation sensitivity.

11. EXAMINATION SURFACE:

STRAIGHT BEAM EXAMINATION

- For straight beam examination the weld and base material shall be scanned progressively along and across the weld surface to the extent possible from at least one surface of the part. Each pass of the search unit shall overlap a minimum of 15% of the transducer dimension clause to the direction of scan indexing.

ANGLE BEAM SCANNING:

Defects parallel to the Weld:

- The angle beam shall be directed at 90° to the weld axis, from two directions where possible. The probes shall be manipulated so that the ultrasonic energy passes through the required volumes of the weld and adjacent base material.

Defects Transverse to Weld:

- For detection of transverse defects the weld shall be examined using 45 deg. angle beam probe.
- For butt joints the angle beam shall be directed essentially perpendicular to the weld axis. The probe shall be manipulated so that the angle beam passes through required volumes of the weld and adjacent base metal. The probe shall be rotated at 180° and examination shall be repeated.

12. SCANNING SENSITIVITY:

- Scanning sensitivity shall be a minimum of +6dB above the reference level. However evaluation of indications shall be performed at the primary reference level.

13. EXAMINATION COVERAGE:

- For the angle beam examination the entire volume of the weld inclusive of adjacent base metal shall be examined by moving the probe over the examination surface.
- During scanning, the probes shall be moved to and fro with swiveling action of 10° to 15° on either side with overlap between successive scanning.
- Each pass of the probes shall overlap a minimum of 15% of the crystal element dimension perpendicular to the direction of the scan.
- In any case the rate of probe movement for examination shall not exceed 125mm per second.

14. CALIBRATION CONFIRMATION:

- A calibration check shall verify the sweep range calibration and distance amplitude correction.

SWEEP RANGE CORRECTION:

- If a point on the DAC curve has moved on the sweep line more than 10% of the sweep reading or 5% of full sweep whichever is greater, the sweep range calibration shall be corrected. All recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and the value changed.

DAC CORRECTION:

- If a point on the DAC curve has changed 20% or 2dB of its amplitude, all recorded indications since the last valid calibration check shall be re-examined with the corrected calibration.

15. EVALUATION:

- Imperfections that cause an indication greater than 20% of the reference level shall be investigated to the extent that the ultrasonic examination personnel can determine their shape, identity, and location, and evaluate them
- Discrimination of flaw indication from geometric indications shall be carried out by manual finger damping.
- Sizing of the defect shall be carried out by 6 dB drop method.

16. ACCEPTANCE STANDARD

- ASME SEC. VIII DIV.1
- APPENDIX - 12 ASME SEC.VIIIDIV.2
- ASME SEC. IX

17. POST EXAMINATION CLEANING:

- After the examination is completed the couplant applied on the surface shall be removed to the pre-inspection condition.

18. REPAIR & RETEST:

- Repaired weld regions shall be ultrasonically re-examined by the same procedure used for original testing.

19. REPORT:

- Details of inspection of original weld and repaired area shall be recorded as per Exhibit No: KNS/UT/01/f01.REV 0 Date: 12.9.2012
- Recording all reflections from uncorrected areas having responses that exceed 50% of reference level shall be made.