



BHARAT HEAVY ELECTRICALS LIMITED
DEPT.235 – TIRUCHIRAPALLI – 620 014
Non-Destructive Testing

BHE:NDT:PB:UT- 01
Revision 12
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PROCEDURE FOR ULTRASONIC EXAMINATION OF WELDS

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RECORD OF REVISION

SI No.	Date	Details of Revision
06	28-03-94	Revised in entirety.
07	01-08-96	Revised in entirety.
08	01-04-97	Revised to merge and replace BHE:NDT:PB:UT:01/01,01/02,01/03, 11,13,14,16,17 & 25 to represent as a single procedure.
09	16-03-16	Revised to incorporate ASME BPV Code edition 2015, Clause 2.1, 4.1, 8.1.1, 8.1.4, 8.1.5, 8.1.6, 8.2.2, 8.5.4, 25.3 added, 21.2.1 revised, 25.3 added, Fig 1, 2, 6 revised.
10	07-10-17	Clause 4.1, 6.1 modified.
11	21-10-17	Revised in entirety.
12	01-09-2018	2.1, 2.2, 23.6.2 & Fig (16) revised.



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1.0 SCOPE

1.1 This procedure defines the requirements of equipment, calibration, examination procedure and acceptance standards for ultrasonic examination of ferritic welds (carbon or alloy steel) by manual, contact method, that is required to be performed by ASME code for the following products:

a) Butt, Corner and Tee joints in components of boilers, Pressure vessels, heat-exchangers and HP / LP bypass Valves, with a dia greater than 120 mm and thickness equal to or greater than 10 mm.

b) Butt joints in pipes with Outer dia >120 mm and thickness ≥ 10 mm.

c) Butt joints in boiler pipes / tubes dia 31.8 to 120 mm and thickness 3.6 mm to 13 mm.

2.0 REFERENCE

2.1 ASME Section I, V, and VIII Division 1 & 2 – 2017.

2.2 ASME B 31.1 / 2016

3.0 EQUIPMENT

3.1 Equipment features

3.1.1 A Digital Ultrasonic Flaw Detector of pulse - echo, Manual contact method type that responds to frequencies 1 MHz to 6 MHz and equipped with a stepped gain control of 2 dB or less shall be used as the UT instrument. The equipment setting values shall be detailed in the report.

3.2 Equipment Calibration

3.2.1 The Screen height linearity and amplitude control linearity shall be performed in accordance with BHE: NDT: UT: Calib: 1 (latest revision) at the beginning of each period of extended use or every 3 months (for Analog) and 1 year for Digital equipment, whichever is less.

3.3 Probes

3.3.1 Probes can be either single or dual transducer elements. Probes with curved contact wedges may be used to improve ultrasonic coupling in which case calibration shall be done with contact wedges used during the examination.

3.3.2 Search unit of 2 MHz to 4 MHz frequency shall be selected to produce a desirable signal-to-noise ratio (S / N) from the material to be examined at the specified sensitivity. Probes / search unit can be either single or dual transducer elements. An S / N value of at least 3 to 1 shall be usually considered to be minimum. Frequency < 2 MHz will be used to assure adequate penetration, when coarse grain structures are encountered. Crystal size 8 x 9 mm / 20 x 22 mm / dia 10 mm / dia 25 mm shall be used as per the application. Usage of any other crystal size shall be demonstrated to fulfill the requirements. To achieve proper contact, ultrasonic coupling and sensitivity on the smaller diameter surface, probes with contour contact wedges / shoes may be used in which case calibration shall be done with contact wedges / shoes used during the examination.

3.4 Couplant

3.4.1 Grease and Servo 35 oil mix will be used as couplant. The couplant used for the examination shall be the same that is used for calibration.



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4.0 PERSONNEL QUALIFICATION

- 4.1 Personnel performing examinations shall be qualified in accordance with employer's written down document which is prepared in line with ANSI/ASNT CP-189 (2006) or ASNT SNT – TC -1A (2011). The testing shall be conducted by minimum Level-I Personnel (Under the supervision of Level II OR Level III) or Level II and the interpretation and evaluation shall be done by minimum Level-II personnel.

5.0 SURFACE PREPARATION

- 5.1 As welded or ground surface shall be acceptable for the examination of the weld. The surface shall be free of dirt, scale, weld spatter, rust, paint, or any other extraneous matter that could prevent the scanning.

6.0 EXAMINATION

6.1 GENERAL EXAMINATION REQUIREMENT:

- 6.1.1 The entire volume of the full weld length 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 from, with swiveling action of 10° to 15° on either side with overlap between successive scanning. Each pass of the probe shall overlap a minimum of 10 % of the crystal element dimension perpendicular to the direction of the scan. The rate of probe movement for examination shall not exceed 150 mm / sec.

6.2 STRAIGHT BEAM EXAMINATION:

- 6.2.1 For straight beam examination, longitudinal wave probes (0 degree) with crystal dimensions in the range of 10 to 25 mm shall be used.
- 6.2.2 The weld and fusion-zone of adjacent base material shall be scanned to the extent possible from one surface of the production part.

6.3 ANGLE BEAM EXAMINATION:

6.3.1 Scanning angle:

- 6.3.1.1 The search unit and beam angle selected shall be 45° or an angle appropriate for the configuration, groove angles and thickness of the weld being examined and shall be capable of detecting the calibration reflectors, over the required angle beam path.

6.3.2 Scanning Position and Directions:

- 6.3.2.1 Scanning shall be performed from both surfaces and from each side of the weld between 1/8 to 5/8 skip distances from the weld-centre line. (Fig 1.)
- 6.3.2.2 When examination is practical from one surface only, the 1/4-T volume lying below the examination surface, shall be examined from each side of the weld, by additionally positioning and moving the probe from 3/4-T to 1-T (full) skip distance. (Fig 2.)
- 6.3.2.3 When examination is practical from one surface and one side only two angle-beam probes shall be used. One of the angle-beam employed shall be 45 degree. The extent of limit coverage shall be noted in the examination report.



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- 6.3.2.4 For Corner joints the scanning directions shall be such that the entire volume of the weld is scanned by angle and straight probes. (Fig 3, 4)
- 6.4 Angle beam / Longitudinal flaw scanning:
- 6.4.1 The angle beam shall be directed at 90° to the weld axis. The probe shall be manipulated so that ultrasonic energy passes through the required volumes of weld and adjacent base material.
- 6.5 Angle-beam/ transverse flaw scanning:
- 6.5.1 Scanning with weld reinforcement: If the weld cap is not machined or ground flat, the examination shall be performed from the base material on both sides of the weld cap. While scanning parallel to the weld axis, the angle beam shall be directed from 0 deg. to 60 deg. with respect to the weld axis in both axial directions, with the angle beam passing through the required examination volume.
- 6.5.2 Scanning without weld reinforcement: If the weld cap is machined or ground flat, the examination shall be performed on the weld. While scanning, the angle beam shall be directed essentially parallel to the weld axis in both axial directions. The search unit shall be manipulated so that the angle beam passes through the required examination volume.
- 6.6 Scanning sensitivity:
- 6.6.1 The scanning shall be performed at a gain setting + 6 dB of the primary reference level. If detection and evaluation of all indications exceeding 20 % of FSH required, scanning shall be performed at +14 dB. Evaluation shall be performed with respect to primary reference level.
- 7.0 REPAIR**
- 7.1 Repaired welds in all the above materials shall be re-examined by the same procedure used for original testing.
- 8.0 REPORT**
- 8.1 A detailed report duly signed by a minimum Level II NDE personnel shall be issued in the approved format.
- 6.8.2 The reports shall be retained for a minimum period of Five years for products made as per ASME Section I and Section VIII Div 1 and 2.
- 9.0 POST EXAMINATION CLEANING**
- 9.1 After the examination is over the couplant applied on the surface shall be removed, if the residue couplant could interfere the further use of the test piece.
- 10.0 BUTT WELDS IN BOILER DRUMS, PRESSURE VESSELS AND VALVES**
- 10.1 BASIC CALIBRATION BLOCK:
- 10.1.1 The material from which the block is fabricated shall be of the same product form and material specification or equivalent P-Number grouping of the materials being examined with similar Heat treatment conditions. P-No.s. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent. 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.
- 10.1.2 The finish on the surfaces of the block shall be representative of the surface finishes on the production material.



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- 10.1.3 The temperature difference between the examination and basic calibration block surfaces shall be within 14 degree C.
- 10.1.4 For examination in materials where the examination surface dia is greater than 500 mm, either a block of essentially the same curvature or a flat basic calibration block shall be used.(Fig. 5)
- 10.1.5 For materials with examination surface diameter 500 mm or less, the basic calibration block shall be curved. A single curved basic calibration block may be used to calibrate, examination of surfaces, in the range of 0.9 to 1.5 times the basic calibration block diameter. (Fig. 6)
- 10.1.6 The block thickness shall be as per Fig. (5). When the block thickness ± 25 mm spans two of weld thickness ranges in the table in Fig.5, the block's use shall be acceptable in those portions of each thickness range covered by 25 mm of the calibration bloc thickness. (E.g. A calibration block with thickness 38 mm could be used for weld thickness of 13 mm to 64 mm).
- 10.1.7 In cases such as single sided access welds (corner), if the calibration block detailed in Figure 5 does not provide the necessary sound path distances to the reference reflectors to provide distance-amplitude correction (DAC) that will fully cover the area of interest for the straight beam technique, a second calibration block is required whose thickness (T) and reference reflector locations are based on the sound path distance that provides for coverage of the area of interest.
- 10.1.8 No point on the DAC curve shall be less than 20% of full screen height (FSH). When any portion of the DAC curve will fall below 20% FSH, a split DAC shall be used. The first calibration reflector on the second DAC shall start at $80\% \pm 5\%$ FSH. When reflector signal-to-noise ratio precludes effective indication evaluation and characterization, a split DAC should not be used.

10.2 Calibration Confirmation

- 10.2.1 When any part of the examination system is changed, a calibration check shall be made on the calibration block to verify that distance range points and sensitivity settings satisfy the requirements of 8.3. A calibration check on at least one of the basic reflectors in the basic calibration block shall be made at the finish of each examination, every 4 hrs. During the examination and when examination personnel are changed.

10.3 Confirmation Acceptance values

- 10.3.1 Distance range points: If any distance range point has moved on the sweep line more than 10% of the distance reading or 5% of full sweep, whichever is greater, then the sweep range calibration shall be corrected and recorded. All recorded indications since the last valid calibration shall be re-examined with corrected calibration and their values changed on the data sheets.
- 10.3.2 Sensitivity settings: If any sensitivity setting has changed by more than 20% or 2 dB of its amplitude, correct the sensitivity calibration and record. If the sensitivity setting has decreased, all the data sheets since the last calibration or calibration check shall be considered invalid. A new calibration shall be made and recorded. The invalid areas covered shall be re-examined. If the sensitivity setting has increased, all recorded indications since the last valid calibration or calibration check shall be re-examined and their values shall be changed on the data sheets or re-recorded.

11.0 SCANNING ADJACENT BASE MATERIAL

- 11.1 The scanning of adjacent base material shall be performed with straight-beam probe to detect reflectors that might affect interpretation of angle beam results. Locations and areas of such reflectors shall be recorded. This adjacent base material examination is not to be used as acceptance - rejection examination.



12.0 TECHNIQUES FOR ANGLE BEAM CALIBRATION

12.1 SWEEP RANGE:

12.1.1 The Sweep range is calibrated using IIW Block. The multiple reflection signals from 100 mm quadrant in IIW block are adjusted such that first reflection coincides with 5th division and 2nd signal at 10th division for 200 mm range. Similar settings shall be done for the different sweep ranges according to the thickness and skip distances used for scanning (Fig 7)

12.2 DISTANCE AMPLITUDE CORRECTION (DAC): Fig (8)

12.2.1 The probe is to be positioned for maximum response from the SDH, which gives the highest amplitude

12.2.2 The sensitivity control is to be adjusted to get an indication of 80% of full screen height (FSH) and the peak is to be marked on the screen.

12.2.3 The probe is to be positioned from another SDH for maximum response without altering the gain settings.

12.2.4 The peak point is to be marked on the screen.

12.2.5 The third SDH is positioned and the peak point is marked on the screen.

12.2.6 The 3/4T SDH is positioned for maximum amplitude after the beam bounces back from the opposite surface. The peak point is to be marked on the screen.

12.2.7 All the screen marks are to be connected for the required DAC

12.3 CALIBRATION CORRECTION FOR RECTANGULAR NOTCHES:

12.3.1 The probe shall be positioned for maximum amplitude from the notch on the opposite surface and the peak of the indication marked with an 'X' on the screen. The opposition surface notch may give an indication 2 to 1 above DAC for 45 degree shear wave, but only ½ DAC for a 60° shear wave. Therefore, the indication from the notch shall be considered when evaluating reflectors at the opposite surface. (Fig 9)

12.3.2 When a vessel or other component with a thickness of 13 mm or less and a diameter equal or less than 500 mm, the angle beam calibration for DAC may be performed as given in 17.1.

13.0 STRAIGHT BEAM CALIBRATION

13.1 The Sweep range is calibrated using IIW Block. The multiple reflection signals from 25 mm thickness in IIW block are adjusted such that first reflection coincides with 2.5 division, 2nd signal at 5th division, 3rd signal at 7.5 division and 4th signal at 10th division for a range of 100 mm. Similar settings shall be done for the different sweep ranges according to the thickness and skip distances used for scanning. (Fig. 10.)

13.2 Distance Amplitude Calibration (DAC) for Straight beam shall be done as in 10.2.1 to 10.2.5 and 10.2.7. (Fig. 11.)



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14.0 NOZZLE SIDE WELD FUSION ZONE AND ADJACENT NOZZLE PARENT METAL EXAMINATION

14.1 CALIBRATION BLOCK

14.1.1 The calibration block configuration shall be as in figure (15). The block size and the reflector location shall be adequate to perform calibrations to cover the nozzle side weld fusion zone and the adjacent nozzle parent metal

14.1.2 Thickness: The calibration block shall be the maximum thickness of the nozzle wall adjacent to the nozzle weld plus 19 mm.

14.1.3 Curvature: For examination of nozzles with an inside diameter equal to or less than 500 mm, the contact surface of the calibration block shall have the same curvature or be within the range of 0.9 to 1.5 times the diameter (Fig 6).

14.1.4 Calibration reflectors: the calibration reflectors shall be side drilled holes that are in accordance with the requirements of figure (5).

14.1.5 Alternative calibration blocks may be used for similar types of examination, provided the sound path distance(s) to the block's reflector(s) is (are) within 6 mm of what is required and the side drilled hole is the same or a smaller diameter than what is required.

14.1.6 Calibration confirmation as per 8.3 shall be ensured.

14.2 EXAMINATION-specific requirements:

14.2.1 The requirements of clause 6, are applicable. The full circumference of the nozzle shall be scanned to cover the entire nozzle side fusion zone of the weld plus 25 mm beyond the weld toes. The search unit may be moved either circumferentially around or axially across the examination zone, as shown in figures 3 and 4. The screen range shall cover as a minimum, 1.1 times the full thickness of the nozzle wall. Nozzles that cannot be fully examined (e.g., restricted access that prevents hand placement of the search unit) shall be noted in the examination report.

15.0 EVALUATION:

15.1 Any imperfection which causes an indication in excess of 20% DAC shall be interpreted to determine the identity, shape and locations of all such imperfections to characterize them for their nature and type.

15.2 Indications that are determined to originate from metallurgical structure such as weld metal to austenitic clad interface shall be classified as spurious indications.

15.3 To classify an indication as geometric, reflected coordinates are to be verified and plotted and a cross sectional sketch of the weld shall be prepared showing the reflector position and surface discontinuities such as root and counter-bore.

16.0 RECORDING:

16.1 All indications having signal amplitudes equal to and above 50% of the reference level shall be recorded.



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17.0 FLAW SIZING: Fig. (12)

- 17.1 Indications from discontinuities that remain from 100% DAC to 30% of DAC, the length of the reflector shall be obtained by recording the position and location along the lengths of the weld as determined by 50% level of maximum amplitude for each end of reflector (6 dB drop).
- 17.2 Indications that exceed the reference level the length of the reflector shall be determined by recording the position and location along the lengths of the weld until the maximum amplitude echo just falls below the 100% DAC reference response curve (0 dB drop).

18.0 ACCEPTANCE STANDARD:

- 18.1 Indications characterized as cracks, lack of fusion of incomplete penetration are not acceptable regardless of length.
- 18.3 Indications from other imperfections are not acceptable if the indications exceed the reference level and have lengths which exceed
- a) 6 mm for 't' up to 19 mm,
 - b) 1/3t for t from 19 mm to 57 mm
 - c) 19 mm for t over 57 mm
- Where 't' is thickness of weld excluding any allowable reinforcement.
- 18.3 For a butt weld joining two members having different thickness at the weld 't' is the thinner of the thickness. If a full penetration weld includes a fillet weld, the thickness of 'throat' of the fillet shall be included in 't'.

19.0 WELDS IN PIPES WITH OUTER DIAMETER > 120 MM AND THICKNESS ≥ 10 MM

- 19.1 The basic calibration block configuration and reflectors (notches) shall be as shown in Fig 13. Thickness, T, shall be ± 25% of the nominal thickness of the component to be examined. The block size and reflector locations shall be adequate to perform calibrations for the beam angle(s) and distance range(s) to be used.
- 19.2 For examination in materials where the examination surface dia is greater than 500 mm, either a block of essentially the same curvature or a flat basic calibration block shall be used.(Fig. 13). For materials with examination surface diameter 500 mm or less, the basic calibration block shall be curved. A single curved basic calibration block may be used to calibrate, examination of surfaces, in the range of 0.9 to 1.5 times the basic calibration block diameter. (Fig. 6).
- 19.3 The surface finish of the calibration block shall be representative of the surface finish of the piping.
- 19.4 Calibration confirmation as per 8.3 shall be ensured.

20.0 ANGLE BEAM CALIBRATION:

- 20.1 The angle beam shall be directed toward the notch that yields the maximum response. The gain control shall be set so that this response is 80% ± 5% of full screen height. This shall be the primary reference level. The search unit shall then be manipulated, without changing instrument settings, to obtain the maximum responses from the calibration reflectors at the distance increments necessary to generate a three-point distance-amplitude correction (DAC) curve. Separate calibrations shall be established for both the axial and circumferential notches. These calibrations shall establish both the distance range calibration and the distance amplitude correction.



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21.0 ANGLE BEAM EXAMINATION:

21.1 Scanning angle:

21.1.1 For angle beam examination one shear wave angle beam probe of 45° shall be generally used. Other beam angles 60° or 70° will be used when it is appropriate to the configuration of piping being examined, its thickness and groove angle employed for welding. (Fig 14)

21.1.3 For angle beam examination the crystal dimensions shall be selected appropriate to the contact examination surface and generally be in the range of 8 mm to 35 mm.

21.2 Scanning Position and Directions:

21.2.1 Scanning shall be performed from outer surface only and from each side of the weld between 1/3 to one full skip distance.

21.2.3 When examination is practical from one surface and one side only two angle beam probes shall be used. One of the angle-beam employed shall be 45 degree.

22.0 EVALUATION:

22.1 Any imperfection which causes an indication in excess of 20% DAC shall be interpreted to determine the identity, shape and locations of all such imperfections to characterize them for their nature and type.

22.2 Indications that are determined to originate from surface conditions such as weld root geometry, counter-bore, and weld reinforcement shall be classified as 'geometry indications'.

22.3 Recording:

22.3.1 All indications having signal amplitudes equal to and above 50% of the reference level shall be recorded.

22.4 Flaw length measurement:

22.4.1 The measurements shall be made as in 15.0

22.5 ACCEPTANCE STANDARD:

22.5.1 The acceptance shall be same as in 16.0

23.0 WELDS IN PIPES / TUBES OUTER DIA (OD) ≤ 120 mm

23.1. This procedure is applicable to induction pressure welds (IPW) & fusion welds in boiler tubes for the purpose of detecting radial-type defects having their major dimension circumferentially relative to the tube axis.

23.2. BASIC CALIBRATION BLOCK

23.2.1. The basic calibration block shall be a section of the pipe / tube with an outer diameter (OD) within 0.9 to 1.5 times the OD of the test pipe / tube, and thickness within $\pm 30\%$ of that of the test pipe / tube. The material of the block shall meet the requirements specified in clause 10.1.1.

23.2.2. The calibration reflectors shall be circumferential notches on both the inner and outer surface. The calibration reflectors shall be of length ≥ 25 mm, depth 8%T minimum to 11%T maximum



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(where T is the thickness of the test pipe). Notch width shall be maximum 6 mm.

23.2.3. The notches in the calibration piece shall be kept clean. If contaminated by Couplant or accumulated dirt the notches shall be cleaned by washing with a stream of water directed into and along the notch and rinsed with acetone, or other rapid drying solvent.

23.3. ANGLE BEAM CALIBRATION:

23.3.1. The angle beam probe shall be directed toward ID notch that yields the maximum response, adjusting the instrument settings to 80% of full screen height (FSH), in half node if practicable or in 1.5 skip or more so that this indication appears around 50 % of the time-base. The left end of the gate shall be adjusted to this position on the CRT.

23.3.2. The probe shall be then positioned at distance necessary to resolve the OD notch and the right end of the gate shall be adjusted to this sweep position on the CRT. The gate length just established will be the area for acceptance or rejection of indication when combined with the proper transducer position. The OD notch shall be used as reference to establish the gate length only.

23.4. ANGLE BEAM SCANNING:

23.4.1. Only longitudinal flaw scanning shall be performed from outer surface and from each side of the weld up to 2 skip distances using 70 deg. shear-wave probe.

23.5. EVALUATION:

23.5.1. Indications that are determined, by careful evaluation of the examination area, to originate from surface conditions such as weld root geometry, counter-bore, weld reinforcement, mismatched upset on ID and OD they shall be classified as geometry indications.

23.5.2. Indications contained within the OD upset may be removed and re-examined provided the OD reinforcement has not been reduced below the specified minimum wall thickness.

23.6. ACCEPTANCE STANDARD:

23.6.1. Any flaw-indication exceeding the primary reference shall be unacceptable.

23.6.2. On Induction Pressure welded tube joints, UT need not be carried out in case if visually unacceptable joints found viz. Offcentre > 1.5 mm, Peak, Melt, Overlap and Mismatch on OD (as shown in Fig.16) and are not acceptable.

23.6.3. Any indication arising out of root geometry which gives echo response at any level with respect to primary reference and only one side of weld scanning is acceptable.

24.0 POST CLEANING:

24.1 When post cleaning is required by the procedure, it should be conducted as soon as practical after evaluation and documentation using a process that does not adversely affect the part.

Table-1
ESSENTIAL AND NON- ESSENTIAL VARIABLES

Sl. No	Requirement	Type of variable	Applicable clauses in the procedure
01	Weld configuration to be examined- Thickness, dimension, base material product form	Essential	Clause 1.1 & 5.1
02	Surface from which examination performed	Essential	Clause 6.2.2,6.3.2
03	Technique	Essential	Straight beam, Angle beam(contact) Clause 6.2,6.3
04	Angle and mode	Essential	Clause 6.2.1 & 6.3.1.1
05	Search unit type, frequency and dimensions	Essential	Clause 3.3.2, 6.2.1
06	Special search unit when used	Essential	Clause 3.3.2
07	Ultrasonic instrument	Essential	Clause 3.1
08	Calibration blocks and techniques	Essential	Clause 8, 12,17,18, Fig. 5,6,13,14 & 15
09	Direction and extent of scanning	Essential	Clause 6.1, 6.2, 6.3
10	Scanning (Manual)	Essential	Clause 6.1
11	Method for discriminating geometry and flaw	Essential	Clause 13.3
12	Method of sizing indications	Essential	Clause 15
13	Computer enhanced data acquisition	Essential	Not Applicable
14	Scan overlap(decreased only)	Essential	Clause 6.1
15	Personnel performance requirement	Essential	Clause 4.1
16	Personnel qualification requirement	Non Essential	Clause 4.1
17	Surface condition	Non Essential	Clause 5
18	Couplant: brand name or type	Non Essential	Clause 3.4
19	Post examination cleaning technique	Non Essential	Clause 24.1
20	Automatic alarm and recording equipment	Non Essential	Not applicable.
21	Records including minimum calibration data to be recorded (e. g- Instrument settings)	Non Essential	Equipment setting values & calibration data covered in the report

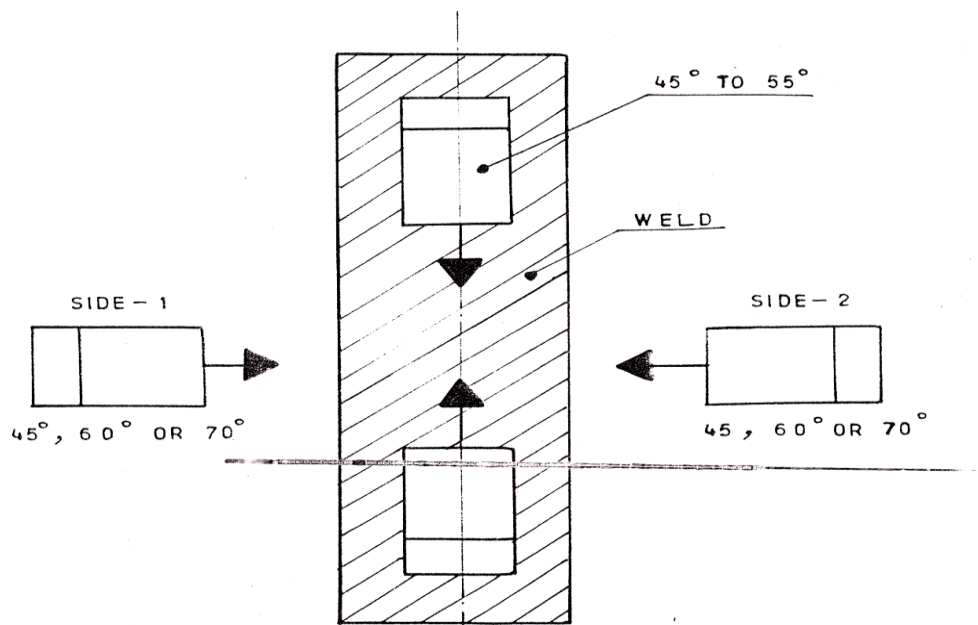
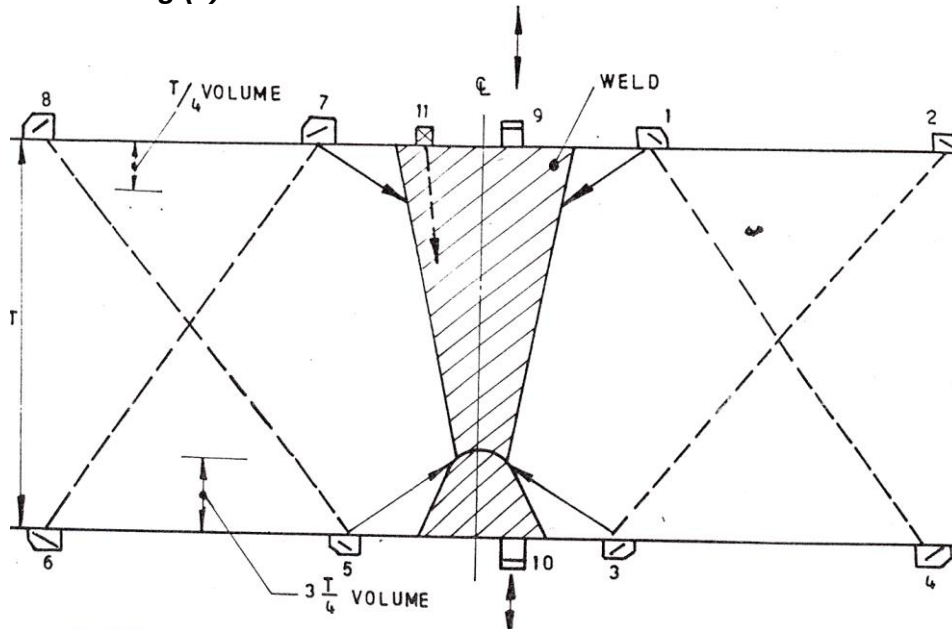


Fig (1): SCANNING DIRECTION FOR ANGLE BEAM



Probe position: 1 to 8: scanning perpendicular to weld axis- angle beam
9 & 10: scanning along weld axis- angle beam
11 : straight beam scanning

Evaluation area: $\frac{1}{4}$ TO $\frac{5}{4}$ T on sweep line

Fig (2): SCANNING DIRECTIONS AND EVALUATION AREAS FOR BUTT WELDS

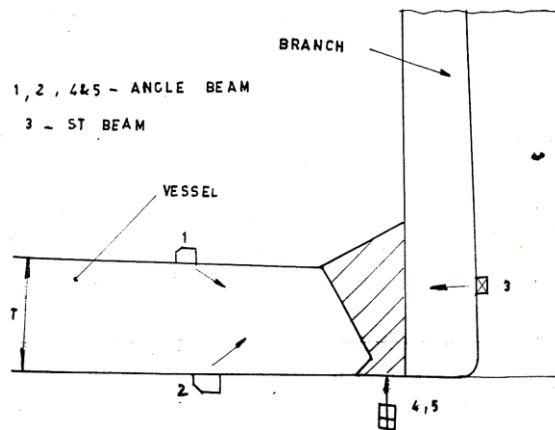


Fig (3): SCANNING DIRECTIONS FOR FULL PENETRATION CORNER WELDS (SET – THROUGH)

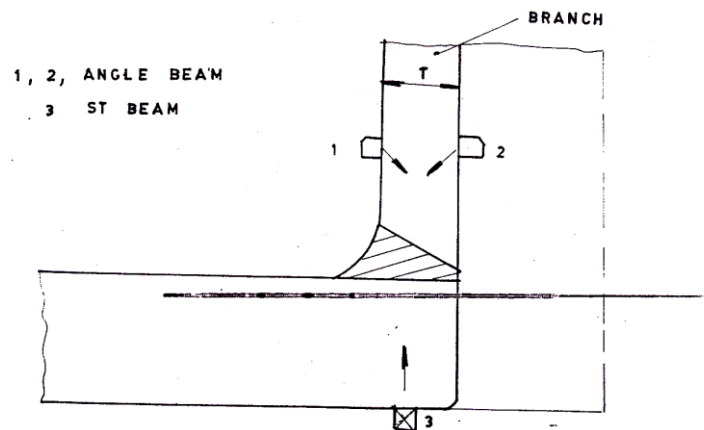
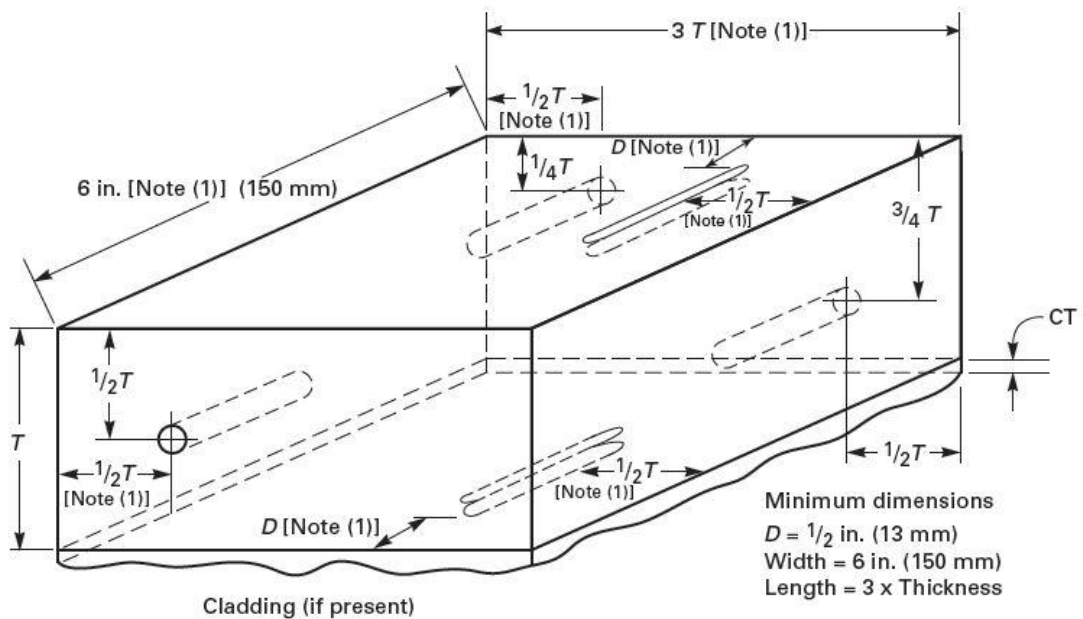


Fig (4): SCANNING DIRECTIONS FOR FULL PENETRATION CORNER WELDS (SET- ON)





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PROPRIETARY DATA NOT TO BE
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Wall Thickness (t) (mm)	Calibration Block Thickness (T) mm	Hole Diameter-mm
Up to 25	19 or t	2.5
Over 25 through 50	38 or t	3
Over 50 through 100	75 or t	5
Over 100	$T \pm 25$	For each increase in weld thickness of 50 mm or fraction thereof over 100 mm, the hole diameter shall increase 1.5 mm.

Notch Dimensions	
Notch Depth (mm)	1.6% T to 2.2 %T
Notch Width (mm)	6 mm Maximum
Notch Length	25 mm minimum

GENERAL NOTES:

- (a) Holes shall be drilled and reamed to a minimum length of 38 mm, essentially parallel to the examination surface.
- (b) For components equal to or less than 500 mm in diameter, calibration block diameter shall meet the requirements of Clause 8.1. Two sets of calibration reflectors (holes, notches) oriented 90 deg. from each other shall be used. Alternatively, two curved calibration blocks may be used.
- (c) The tolerance for hole diameter shall be ± 0.8 mm. The tolerance for hole location through the calibration block thickness (i.e., distance from the examination surface) shall be ± 3 mm.
- (d) For blocks less than 19 mm in thickness, only the 1/2T side-drilled hole and surface notches are required.
- (e) All holes may be located on the same face (side) of the calibration block, provided care is exercised to locate all the reflectors (holes, notches) to prevent one reflector from affecting the indication from another reflector during calibration.
- (f) When cladding is present, notch depth on the cladding side of the block shall be increased by the cladding thickness, CT (i.e., 1.6% T + CT minimum to 2.2% T + CT maximum).
- (g) Maximum notch width is not critical. Notches may be made by EDM or with end mills up to 6.4 mm in diameter.
- (h) Weld thickness, t, is the nominal material thickness for welds without reinforcement or, for welds with reinforcement, the nominal material thickness plus the estimated weld reinforcement not to exceed the maximum permitted by the referencing Code Section. When two or more base material thicknesses are involved, the calibration block thickness, T, shall be determined by the average thickness of the weld; alternatively, a calibration block based on the greater base material thickness may be used provided the reference reflector size is based upon the average weld thickness.

NOTES:

- (1) Minimum dimension.

Fig (5):NON-PIPING CALIBRATION BLOCKS

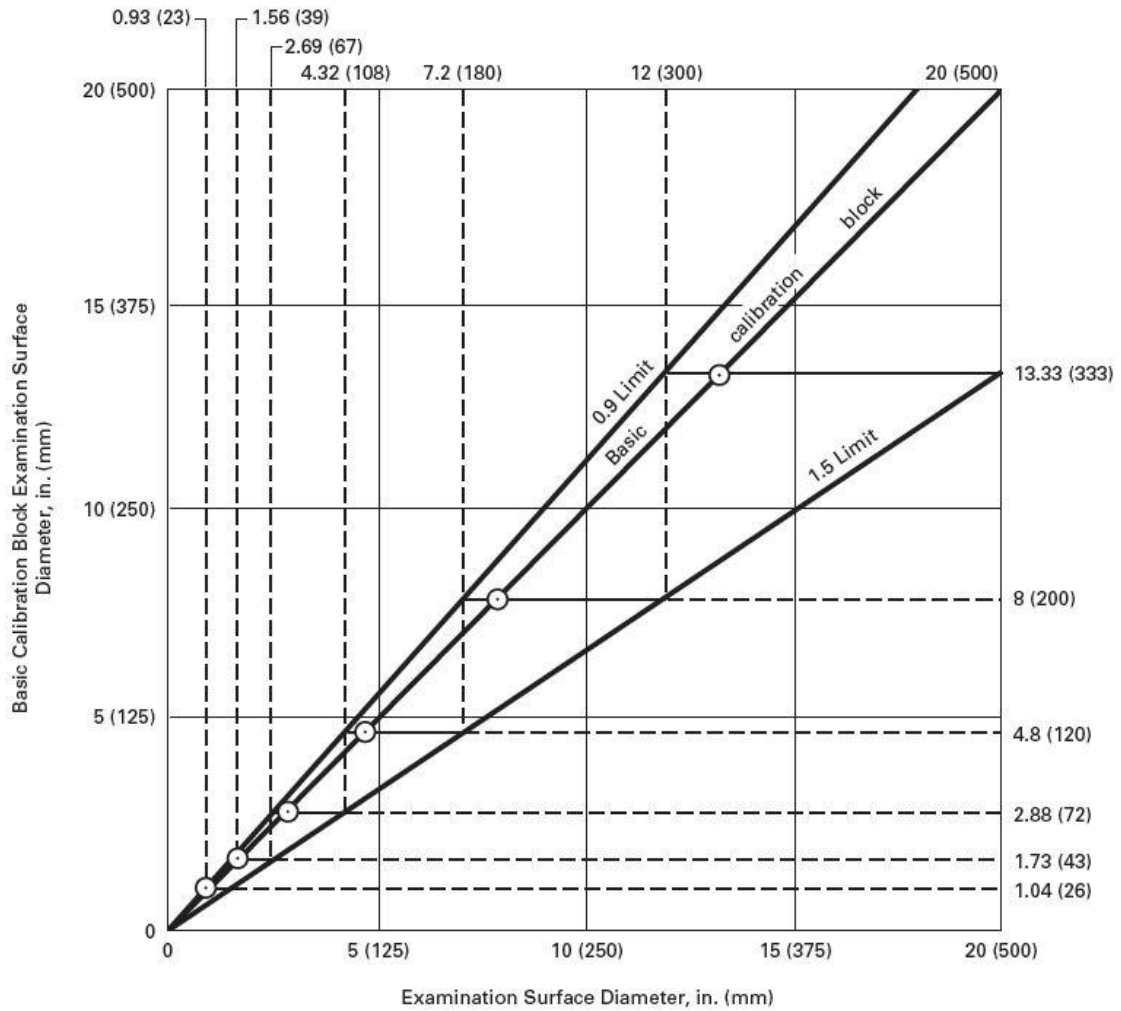


Fig (6): RATIO LIMITS FOR CURVED SURFACES

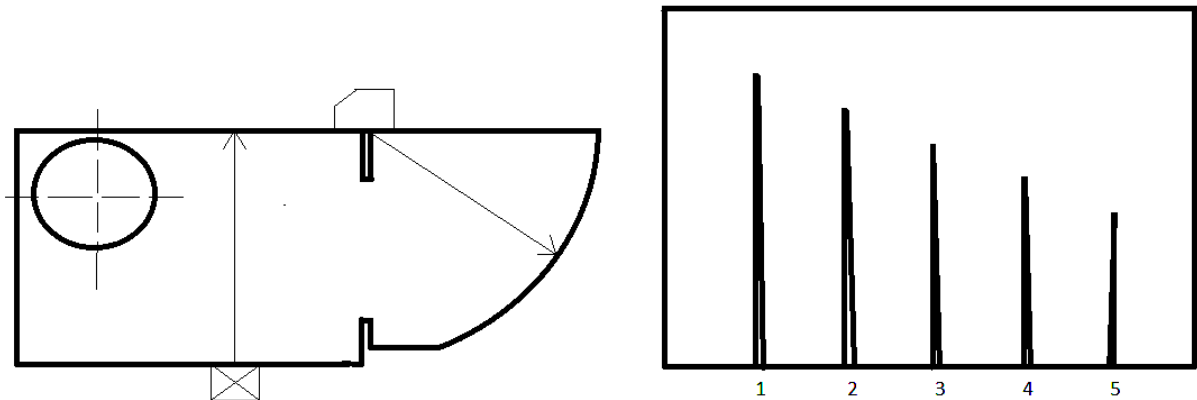


Fig (7): SWEEP RANGE (ANGLE BEAM)

SENSITIVITY AND DISTANCE-AMPLITUDE CORRECTION (SIDE-DRILLED HOLES)

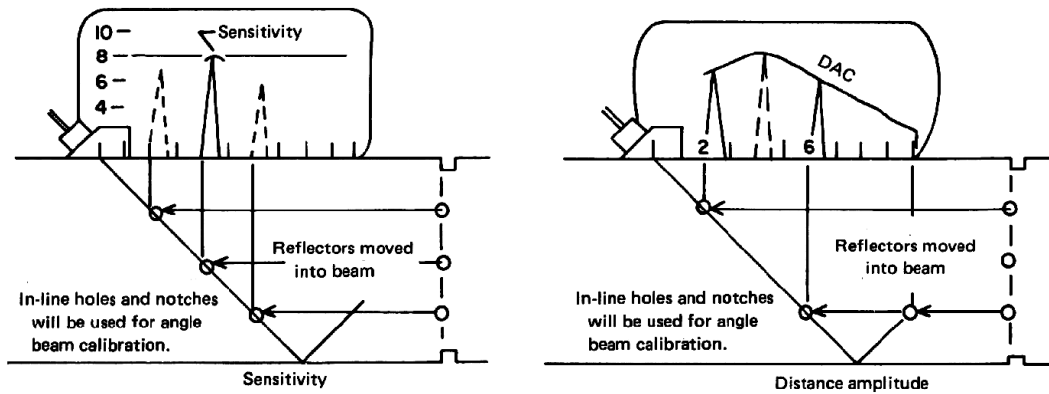


Fig (8): DISTANCE-AMPLITUDE CORRECTION (ANGLE BEAM)

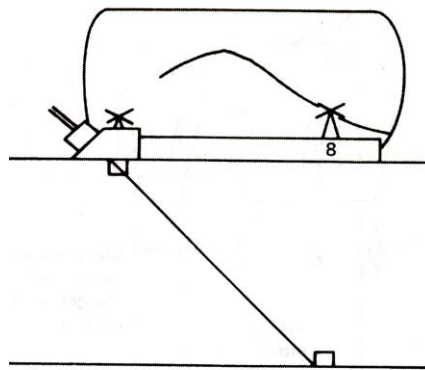


Fig (9) :(ANGLE BEAM) PLANAR REFLECTIONS

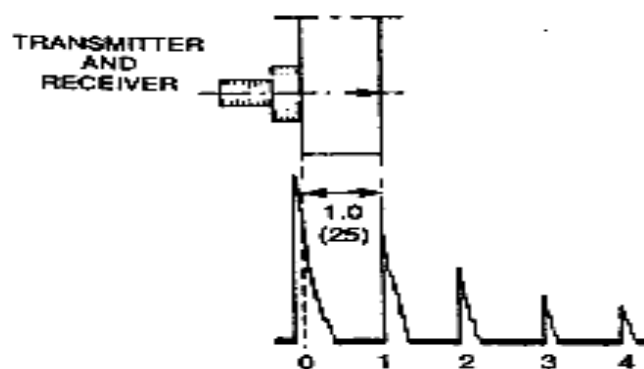


Fig (10): SWEEP RANGE (STRAIGHT BEAM)

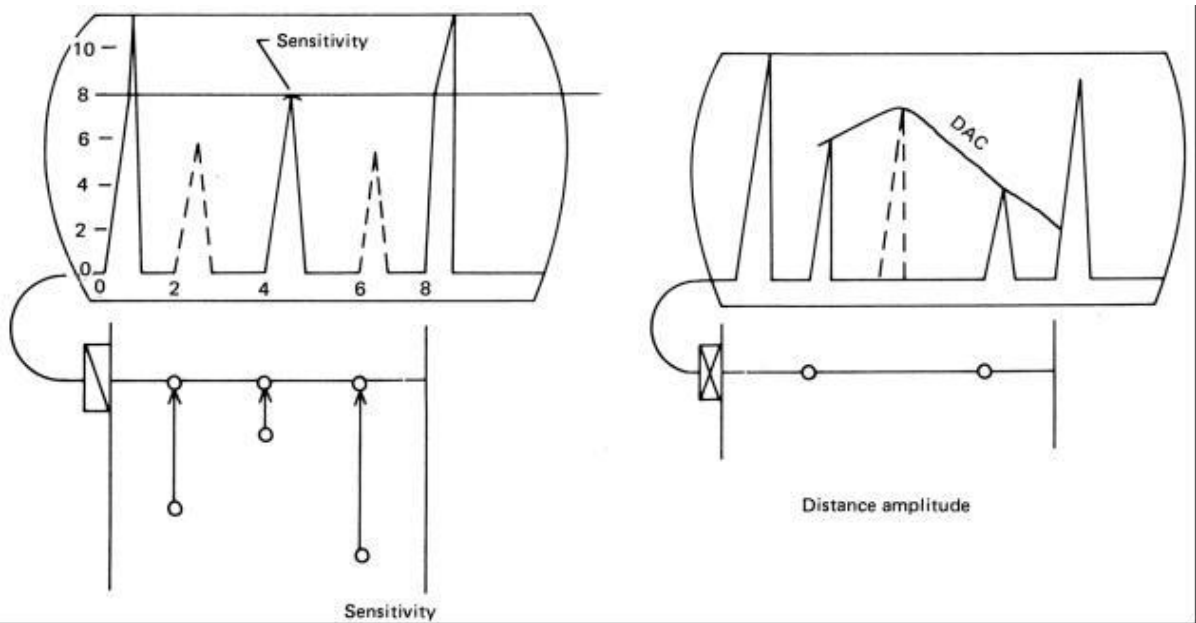


Fig (11): Sensitivity and Distance Amplitude Correction

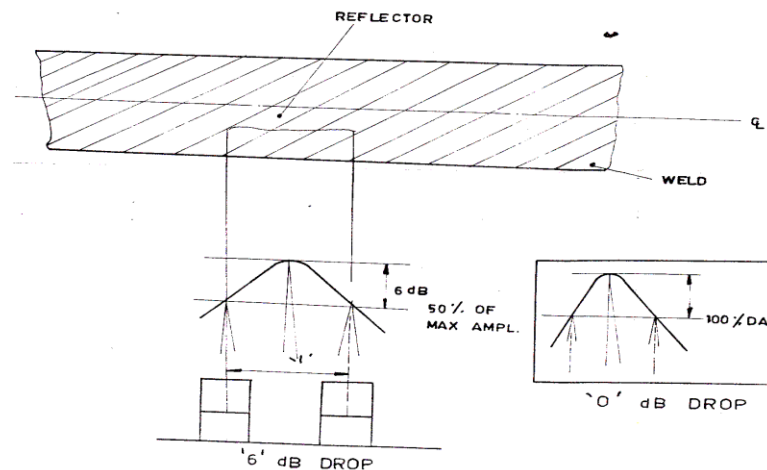
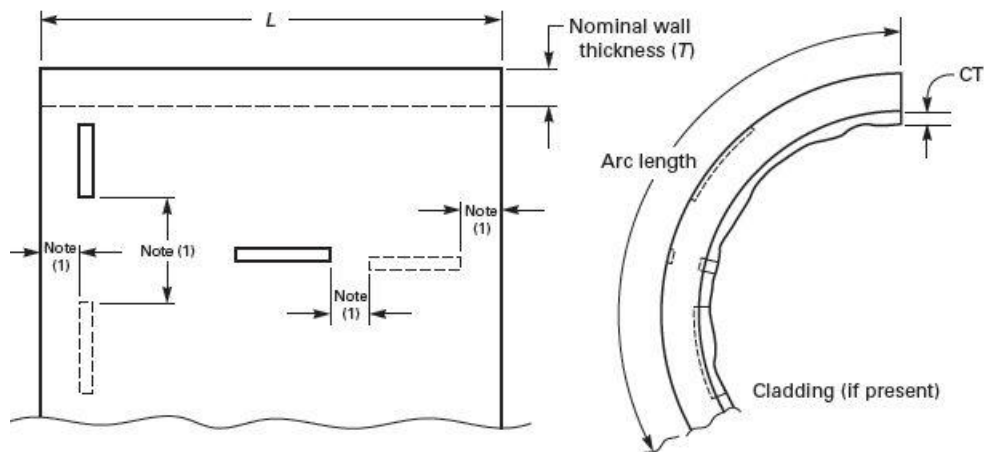


Fig (12): MEASUREMENT OF LENGTH OF REFLECTOR



General Notes:

- The minimum calibration block length, L, shall be 200 mm or 8T, whichever is greater.
- For OD 100 mm or less, the minimum arc length shall be 270 deg. For OD greater than 100 mm, the minimum arc length shall be 200 mm or 3T, whichever is greater.
- Notch depths shall be from 8% T minimum to 11% T maximum. Notch widths shall be 6 mm maximum. Notch lengths shall be 25 mm minimum.
- Maximum notch width is not critical. Notches may be made with EDM or with end mills up to 6 mm in diameter.
- Notch lengths shall be sufficient to provide for calibration with a minimum 3 to 1 signal-to-noise ratio.
- Two blocks shall be used when a weld joining two different thicknesses of material is examined and a single block does not satisfy the requirements of Clause 17.
- When a flat block is used as permitted by Clause 17.2, the two axial notches may be omitted and the block width may be reduced to 100 mm provided the I.D. and O.D. notches are placed on opposite examination surfaces of the block. When cladding is not present, only one notch is required provided each examination surface is accessible during calibrations.

NOTE: (1) Notches shall be located not closer than $1/2T$ or $1/2$ in. (13 mm), whichever is greater, to any block edge or to other notches.

Fig (13).CALIBRATION BLOC FOR PIPE

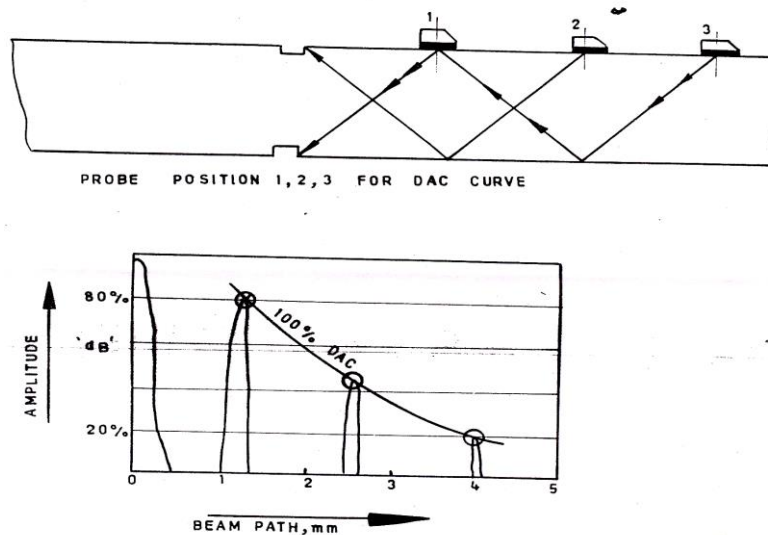
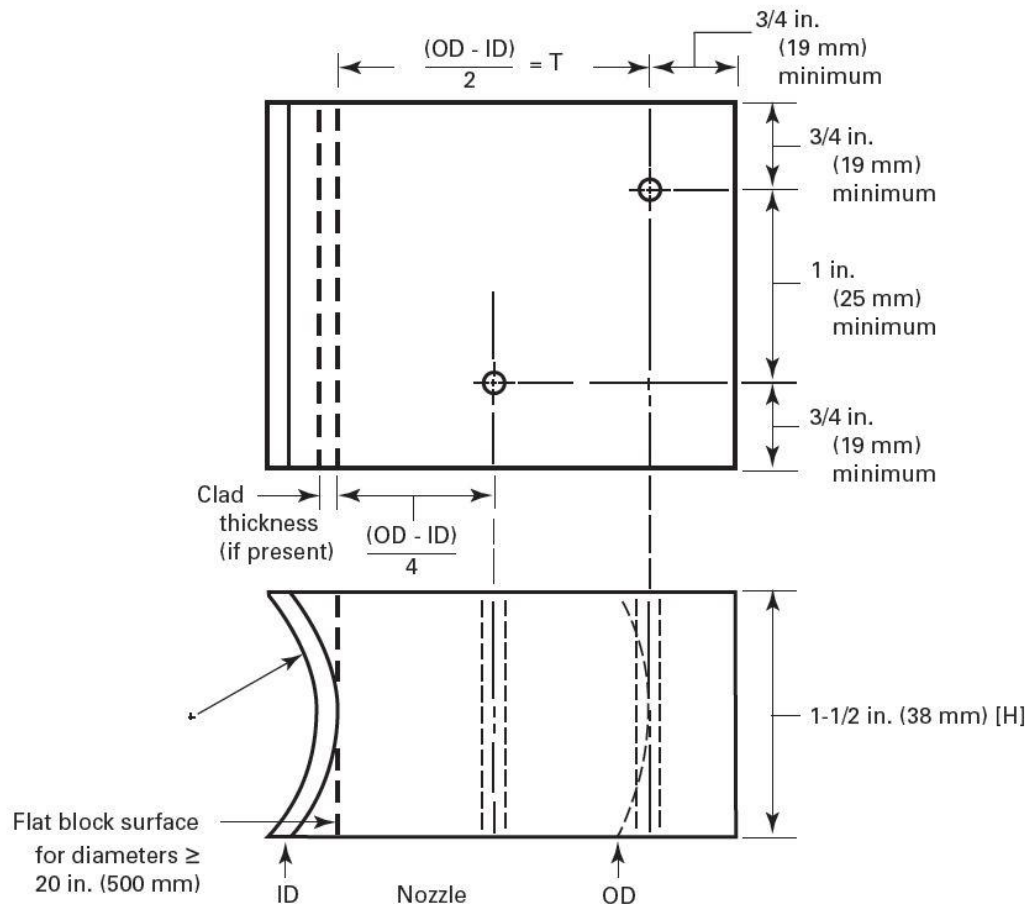


Fig (14): DISTANCE AMPLITUDE CORRECTION (ANGLE BEAM)



Calibration block wall thickness(mm)	Hole location 5/8 T	Hole location 6/8 T	Hole location 7/8 T
>50 through 75		X	
>75	X		X

GENERAL NOTES:

- (a) The thickness (T) of the calibration block $(OD - ID)/2$ shall be selected for the maximum nozzle wall thickness under the nozzle attachment weld.
- (b) Side-drilled holes shall be drilled and reamed the full height [H] of the block.
- (c) The diameter of the side-drilled holes shall be selected for the maximum nozzle wall thickness per (a) above and Fig (5).
- (d) For nozzle side examinations, when the wall thickness of the calibration block exceeds 50 mm, additional side-drilled holes shall be placed in the block as required in the table below.

Fig (15): Calibration block-nozzle side weld fusion zone and adjacent nozzle parent metal examination

Fig (16): Surface Conditions over which UT need not be carried out

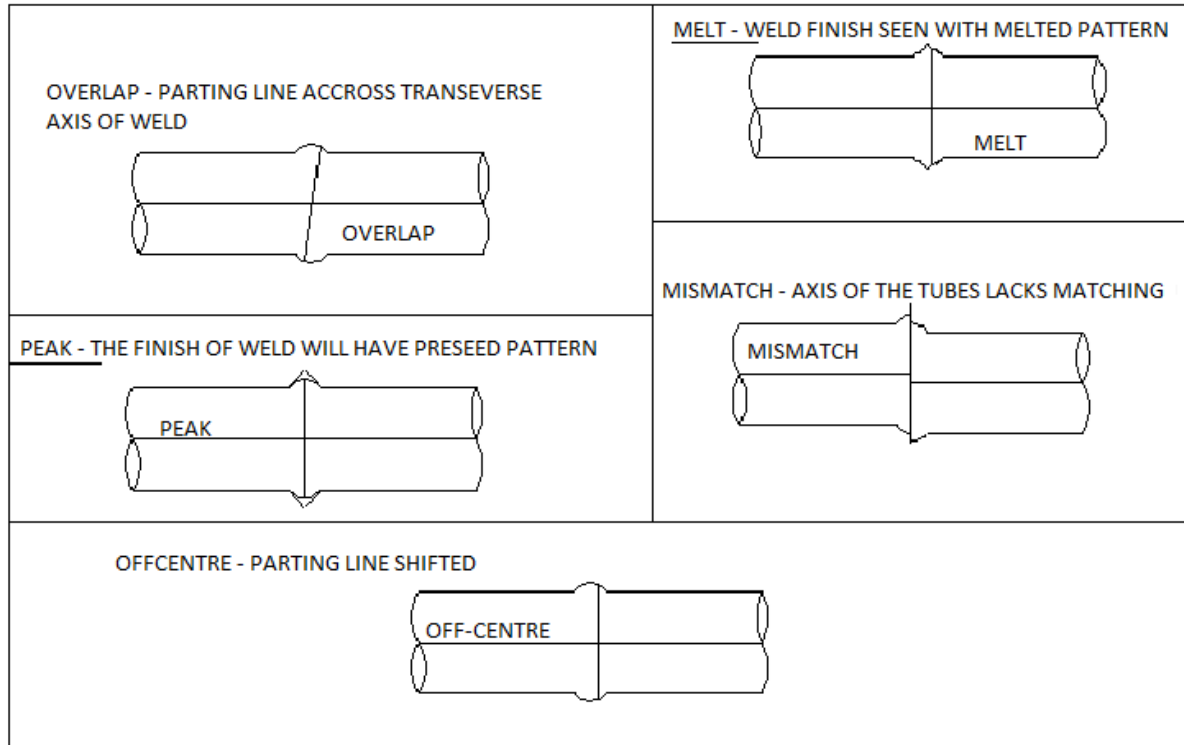


FIG:16

NOTE:

- (1).Off-Centre,>1.5 mm, Peak, Melt, Mismatch and overlap are not acceptable
- (2).UT need not to be done in case if IPW tube is found to be having such unacceptable defects mentioned in point No 1 above.
