SARA SAE PRIVATE LIMITED.

Management System Document Control Cover Sheet

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Procedure for Ultrasonic Testing	SES-26-702	2

	Name	Position	Signature	Date
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Revision Status

Revision No.	Effective Date	Description / Summary of Revision
0	23.06.2008	Initial Issue after NOV Sara
1	20.10.2011	Change of name of company from NOV Sara to SARA SAE
2	10.11.2012	Amendments added to highlighted clauses

Contents

1.0 PURPOSE

1.1 The purpose of this procedure is to establish the requirements for the detection of defects and corrosion in welds & other product forms*(plates, pipe, forged components,cast material etc)* using ultrasonic testing.

1.2 This procedure provides a system of general conditions and specific instructions as an aid to qualified personnel required to perform ultrasonic inspection.

2.0 SCOPE

2.1 This procedure gives the methods, techniques, quality, and reporting requirements necessary for the ultrasonic testing of welds using the ultrasonic pulse-echo technique.

2.2 This procedure covers the ultrasonic testing of fusion welded butt joints in plate and pipe welds, inclusive of the parent metal, weld metal and heat affected zones.

2.3 This is the Company approved procedure and shall be adhered to at all times except where the Client or Contract specifies other requirements.

3.0 DEFINITIONS

3.1	Company	-	SARA SAE PRIVATE LIMITED
3.2	Client	-	Those Companies, orOrganizations or Individuals to which the Company is contracted to provide Services.
3.3	Contract	-	The form of agreement for the provision of the Services to the Client by the Company.

4.0 REFERENCES

4.1	API RP 2X	-	Recommended Practice for UT and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians (latest edition).
4.2	ASME SECTION 1	-Latest Edition.	
4.3	ASME B31.1	-	Power Piping (latest edition).
4.4	ASME B31.3	-	Process Piping (latest edition).
4.5	ASME V	-	Non-destructive Examination (latest edition).

4.6	ASME VIII	-	Rules for the Construction of Pressure Vessels Division.1, 2 & 3 (latest edition).
4.7	ASME IX	-	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers and Welding Brazing Operators & (latest edition).
4.8	AWS D1.1 / D1.1 M	-	Structural Welding Code-Steel (latest edition).
4.9	API 570	-	Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In Service Piping Systems (latest edition)
4.10	API 510	-	Pressure Vessel Inspection Code In-service Inspection, Rating, Repair, and Alteration(latest edition)
4.11	API 653	-	Tank Inspection, Repair, Alteration and Reconstruction (latest edition).
4.12	API 1104	-	Welding of Pipelines and Related Facilities (latest Edition).

4.13 SARA SAE Quality assurance Manual

4.13.1 SDP-22-004 Personal Certification

4.13.2 SDP-27-009 Control of Non-conforming Products

4.14 American Petroleum Institute (API)

4.14.1 Specification 6A " Specification for Well Head and Christmas Tree Equipment"

4.14.2 Specification 16A " Specification for Drill Through Equipment"

4.14.3 Specification 16C "Specification for Choke and kill system"

4.14.4 Specification 16D "Specification for Control System for Drilling Well Control equipment"

4.15 American Society for Testing of Metals :

4.15.1 ASTM A-388 , " Ultra sonic Inspection of Heavy Steel forgings (Latest Edn)

4.15.2 ASTM E-213"Standard Procedure forUltra Sonic Examination of Metal Pipes and Tubing" (latest Edn)

5.0 RESPONSIBILITIES

5.1 The President/ Manager QA shall be responsible for ensuring that the necessary resources are made available for the requirements of this procedure to be carried out in a safe manner.

5.2 Department head shall be responsible for ensuring that the requirements of this procedure are fully implemented at all times.

5.3 All employees involved in the implementation of this procedure shall be responsible for adherence to the requirements stated within.

6.0 PROCEDURE INSTRUCTIONS

6.1 PERSONNEL QUALIFICATIONS

6.1.1 TRAINING, QUALIFICATION AND CERTIFICATION

6.1.1.1 The NDT Inspector shall be trained, qualified and certified to a minimum of ASNT Level II in for the particular product forms (Welds, Casting etc.)accordance with SARA SAE Written practice based on ASNT's SNT-TC-1A, "Recommended Practice for Non-Destructive Testing Personnel Qualification and Certification(SES-26-743)", or international equivalent, i.e., PCN or CSWIP Schemes in the applicable NDT method and other specific requirements of Client if any.

6.1.1.2 If required to examine T,K,Y connections or other variable configuration welds, the NDT Inspector shall demonstrate his ability to apply the specialist techniques required for such configurations, through practical tests on welds of similar geometry.

UT operators employed for examining critical joints like TKY joints, and weld joints subjected to fatigue stress shall satisfy API RP 2X or equivalent requirements.

6.2 EQUIPMENT

6.2.1 ULTRASONIC INSTRUMENT

6.2.1.1 Only pulse echo type ultrasonic flaw detectors which incorporate "A" scan CRT presentation *with direct contact coupling* shall be used.

6.2.1.2 The instrument shall be capable of fulfilling the following performance criteria

(a) Screen height linearity shall not exceed ± 5% deviation of full scale reading for all values from 20 to 80% full scale height.

(b) Amplitude control linearity shall be within the permissible tolerances as mentioned below.

Indication set at % of Full Screen	dB Control Change	Indication Limits % of Full Screen
80%	-6dB	32 to 48%
80%	-12dB	16 to 24%
40%	+6dB	64 to 96%
20%	+12dB	64 to 96%

The checks shall be carried out every 1 year for digital instruments & every 3 months for Analog instruments.

6.2.1.3 To enable the performance of instruments to be monitored, each instrument shall have a unique serial number.

6.2.1.4 All the original calibration certificates held at the Company Head Office , a photocopy to accompany each ultrasonic instrument while using at sites.

6.2.1.5 Instruments that do not meet the requirements shall be withdrawn from service until corrected.

6.2.2 PROBES

6.2.2.1 Compressional straight beam probes shall have a nominal frequency of 1.0 to 5 MHZ and an active area of not less than 78mm^2 and not more than 645mm^2.

6.2.2.2 Shear wave angle beam probes shall have a nominal frequency of *1.0* to 5.0 MHZ and an active area of not less than 12mm^2 and not more than 645mm^2.

6.2.2.3 The frequency chosen shall be as high as possible consistent with obtaining satisfactory transmission.

6.2.2.4 Both compressional straight beam probes and shear wave angle beam probes shall have the ability to resolve clearly 3 indications from the IOW calibration block.

6.2.2.5 Probe crystals may be either round, square or rectangular. Both single and twin crystal probes may be used.

6.2.2.6 The following shall be established for each probe :-

(a) An accurate probe index rechecked before each ultrasonic operation.

(b) Probe beam angle with an accuracy of ± 2° of the nominal probe angle.

6.2.2.7 The following shall be used as a guide for selecting the probe Frequency :-

THICKNESS RANGE	*PRODUCT FORMS*	*FREQUENCY*
COMPRESSION WAVE		
Upto 60 mm	*Plate,Pipe*	*4 or 5 MHz*
Upto 60mm	*Casting/coarse grain material*	*2MHz*
Greater than 60mm	*Plate,Pipe*	*2MHz*
Greater than 60mm	*Casting*	*1MHz*
SHEAR WAVE		
10-35mm	*Welds*	*4-5MHz*
Above 35 mm	*Welds*	*2-2.25 Mhz*

6.2.3 COUPLANT

6.2.3.1 The couplant used shall be capable of ensuring maximum ultrasound transmission.

6.2.3.2 The couplant used shall be the same for both calibration and examination.

6.2.3.3 Cellulose paste, liquid soap, glycerin, light machine oil or suitable equivalent may be used providing they are non-injurious to material under test.

6.2.4 REFERENCE AND CALIBRATION STANDARDS

6.2.4.1 Calibration blocks shall be of substantially the same material as that under test.

6.2.4.2 The following calibration blocks shall be used for calibration of equipment :-

(a) International Institute of Welding V1 block.
(b) Miniature Block / V2 block
(c) Institute of Welding IOW-Beam Profile Block

(d) ASME 19mm distance amplitude curve (D.A.C.) block
(e) ASME 38 mm distance amplitude curve (D.A.C.) block

6.3 INFORMATION REQUIREMENTS

6.3.1 The NDT Operator shall be supplied with the following details of the item to be examined before testing commences :-

(a) Material type.
(b) Joint details.
(c) Welding process.
(d) P.W.H.T. (if any).
(e) Any repairs carried out previous to the test.

6.3.2 The NDT Operator shall verify the extent of examination coverage and record any limitation of the test on the Test Report.

6.4 SURFACE CONDITION

6.4.1 Surfaces used for testing shall be free from weld spatter, scale or other irregularities which could impair adequate acoustic coupling.

6.4.2 Depending on the profile and condition of the weld face, dressing may be necessary to avoid the production of confusing surface echoes.

6.4.3 When the selected ultrasonic beam cannot cover the full cross section of the weld without the probe impinging up on the weld face, the weld face shall be ground smooth *to proceed with testing on approval from the relevant contracting authority, else* a limitation will be noted on the Test Report.

6.5 CALIBRATION FOR EXAMINATION

6.5.1 The Reject control shall be turned off for calibration and during examination.

6.5.2 Calibration shall be conducted for sensitivity and beam path distance prior to commencement of testing.

6.5.3 Recalibration shall be carried out after a change of operator,*change in test parameters,at the end of each inspection* or when the electrical circuit is disturbed in any way which includes the following:-

(a) Transducer change.
(b) Battery change.
(c) Electrical outlet change.
(d) Coaxial cable change.
(e) Power failure.

If any deviations are found during the above checks,corrections shall be carried out and all the previous examinations until the last correct calibration shall be repeated.

6.5.4 (a) Calibration for straight beam testing shall encompass and present at least two material thicknesses on the CRT screen.

(b) Sensitivity shall be adjusted so that the second back wall reflection is 80% full screen height.

6.5.5 Time base calibration for angle beam testing shall be adjusted to represent the maximum sound path distance covered.

6.5.6 Sensitivity levels of shear wave probes shall be in accordance with the relevant Specification.

6.5.7 *The noise Level during Weld Examination excluding spurious surface indications shall be 12 dB below the relevant evaluation level.*

6.6 MEASUREMENT OF TRANSFER LOSS

6.6.1 Transfer loss values shall be included within the standard sensitivity examination level.

6.6.2 Transfer loss measurement shall be made as follows:-

(a) Two angled probes of same type shall be used, one transmitting, one receiving. Position both probes at one full skip distance on V1 calibration block, maximize signal to 80% full screen height, and note dB setting.

(b) Repeat sequence on material to be examined, without altering instrument sensitivity.

(c) Measure the difference in dB setting.

(d) The difference in dB's between comparable peaks is the transfer loss value and shall be either added or subtracted as necessary to the standard examination sensitivity.

6.7 TESTING PROCEDURES

6.7.1 Prior to examination all specimens shall be marked with a reference datum line.

6.7.2 Parent Metal Examination

(a) The area of the parent metal *on either side of the weld* used for scanning shall be checked for laminations prior to angle probe testing using a compression wave probe.

(b) The area to be checked shall be large enough to detect laminar defects that could interfere with shear wave propagation.

(c) The lamination scan shall be carried out regardless of whether the parent metal has been ultrasonically tested previously.

(d) During the lamination scan attenuation characteristics, material thickness and any flaws found shall be noted and recorded if necessary.

(e) Sensitivity level shall be as described in 6.5.4.

(f) Evaluation of indications shall be made using the 6dB drop technique.

6.7.3 Shear Wave Examination

(a) Standard sensitivities shall be in accordance with the relevant Specification. All examination sensitivities shall be conducted at 6 dB above standard sensitivity.

(b) The length of the scans shall be selected in such a way that the ultrasonic energy travels through the weld and the H.A.Z

(c) All scans must overlap by 10% crystal diameter

(d) Scanning speed shall not exceed 152 mm/sec.

(e) A Zig-Zag scanning pattern shall be employed throughout.

(f) All flaws shall be evaluated at standard sensitivity.
(g) The sizing of flaws shall be carried out using the beam boundary technique.
(h) Height of flaws shall be sized by the 20 dB drop technique and length shall be sized by the 6 dB drop technique.
(i) Unless otherwise specified 100% of the weld length shall be tested.

6.8 SCANNING TECHNIQUES

6.8.1 The maximum scanning rate shall be 150mm per second.

6.8.2 Scanning techniques shall consist of :-

(a) Compression probe scan of parent material in accordance with 6.7.2.

(b) Angle beam scan of weld metal using appropriate angled probes.

6.8.3 As a minimum each pass of the probe shall overlap a minimum of 10% of the transducer width.

6.8.4 For scanning purposes, the sensitivity shall be set 6 dB higher than the standard sensitivity. When an indication is noted, the sensitivity shall be adjusted to the standard sensitivity.

6.8.5 Whenever feasible the examination shall be carried out from both sides of the weld.

6.8.6 The beam shall be pointed at the weld length normally.

6.8.7 As a minimum two (2) different angle probes shall be used.

6.8.8 In addition the 45° probe shall be used for "angled" scanning of the weld to search for transverse flaws.

6.8.9 For illustrations of scanning techniques see Attachment 7.1

6.9 ACCEPTANCE STANDARDS

6.9.1 Acceptance standards shall be in accordance with the appropriate Specification or to Clients requirements.

6.10 EXAMINATION OF REPAIRS

6.10.1 Repairs shall be re-examined using the same procedure utilised for the original examination.

6.10.2 The extent of the examination shall include the repaired area of the weld plus 100mm at either end of the repaired section.

6.10.3 A new report, with relevant repair number, shall be written for all repaired welds retested.

6.11 POST INSPECTION CLEANING

6.11.1 When required, post inspection cleaning shall be accomplished to remove residual inspection materials (couplant) by flushing with a solvent based cleaner then finally wiping with rags.

6.12 REPORTING

6.12.1 Reporting requirements shall be as specified by the Client or the Contract Document.

6.12.3 Reports shall be completed for each and every examination on the same day that testing was carried out.

6.12.4 Indications shall be sentenced in accordance with the applicable Specification and shall be supported by drawings indicating size i.e. length, cross section and orientation.

6.12.5 Flaws shall be classified as planar, linear or spherical and every effort shall be made to state the nature of the defect.

6.12.6 In the absence of 6.12.1, compilation of report shall be according but not limited to the following : -

(a) Job Order Card (if applicable)

(b) Client Information (if applicable)

(c) Inspection Reports

6.12.7 UT subcontractors must use this examination method and acceptance criteria in performing the examination.

6.13 SAFETY

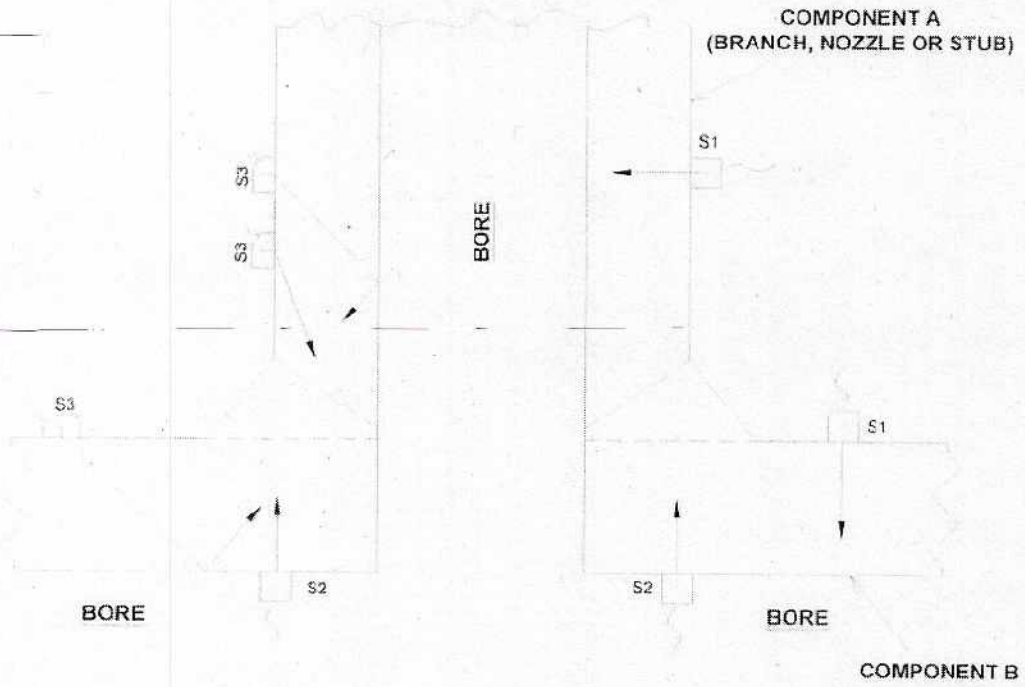
6.13.1 Care shall be exercised during inspection with due regard to the fact that the standard Ultrasonic Flaw Detectors used by the Company are NOT considered intrinsically safe and Hot Work Permits shall be required for hazardous areas.

7.0 ATTACHMENTS

7.1 Illustration of Scanning Techniques

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

A - NOZZLE SET ON WELD



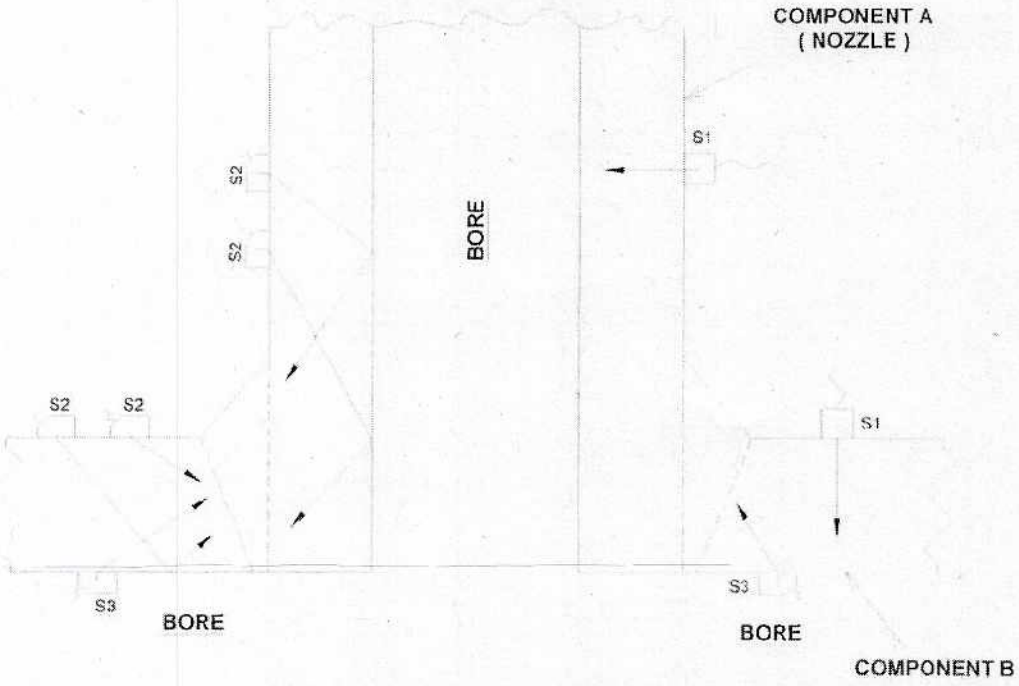
(A) 0º compression probe scan S1 on parent metal to check for laminations and to verify wall thicknesses. The side wall component B shall be scanned from the bore of B wherever possible using 0º compression probe (scan S2).

(B) Angle probe scan S3 (minimum of 3 Probes - 45º, 60º, 70º) from weld cap between the half and full skip distance plus weld cap width for full coverage.

NOTE : Sound beam to be maintained perpendicular to the weld axis while scanning.

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

B - NOZZLE SET THROUGH WELD



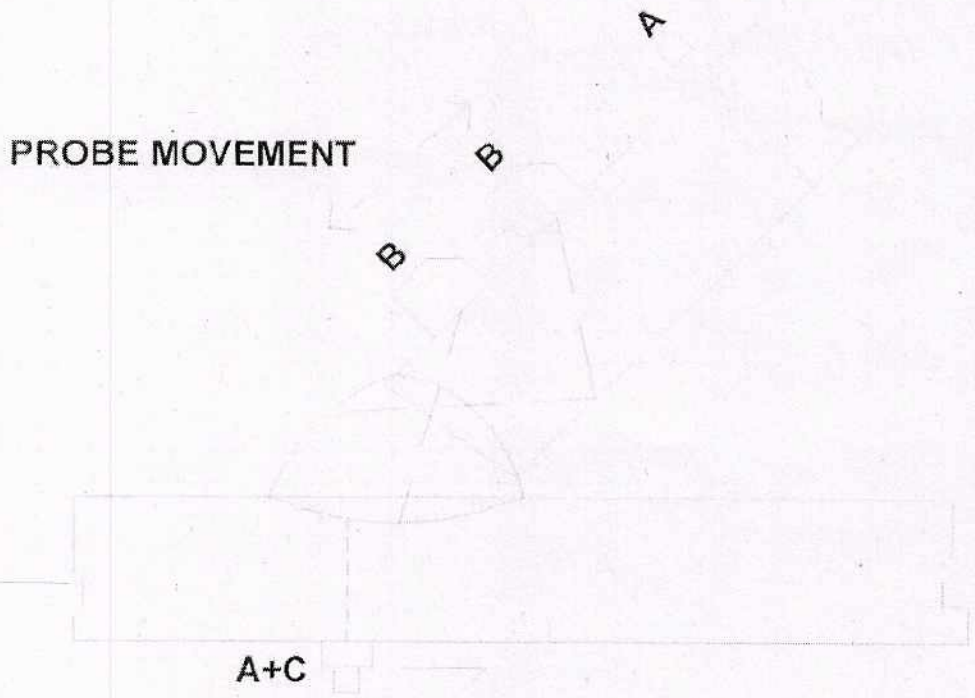
(A) 0º compression probe scan S1 on parent metal to check for laminations and to verify wall thicknesses.

(B) Angle probe scan S2 (minimum of 3 Probes - 45º, 60º, 70º) from weld cap between the half and full skip distance plus weld cap width for full coverage. Where possible the side wall of component B shall be scanned from the bore of component B (scan S3).

NOTE : Sound beam to be maintained perpendicular to the weld axis while scanning.

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

C - TYPICAL "Y" (NODE) WELD



(A) 0º compression probe scan on parent metal to check for laminations and to verify wall thicknesses.

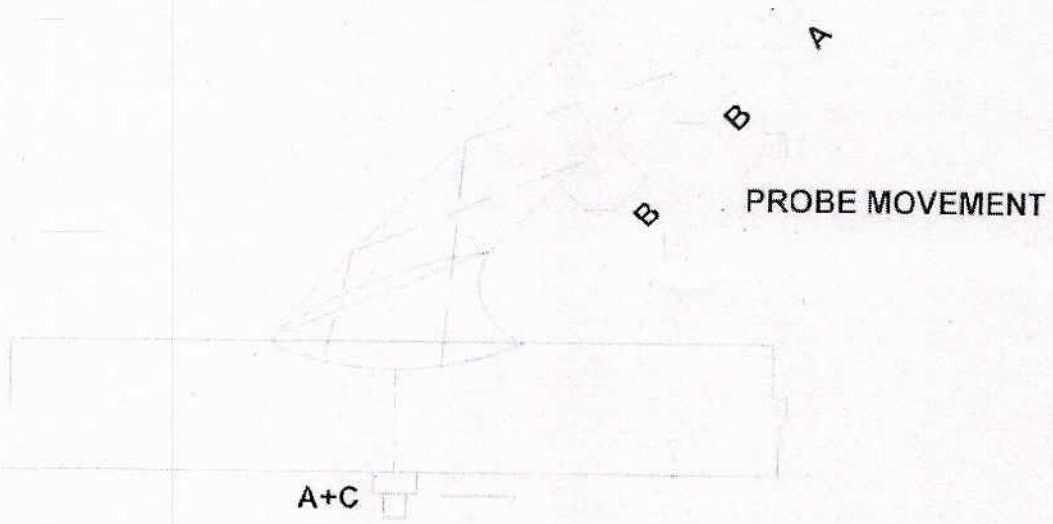
(B) Angle probe scan (minimum of 3 Probes - 45º, 60º, 70º) from weld cap to full skip distance plus weld cap width for full coverage.

(C) 0º compression probe scan to check for fusion defects (when accessible).

NOTE : Sound beam to be maintained perpendicular to the weld axis while scanning.

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

D - <u>TYPICAL "Y" (NODE) WELD</u>



(A) 0º compression probe scan on parent metal to check for laminations and to verify wall thicknesses.

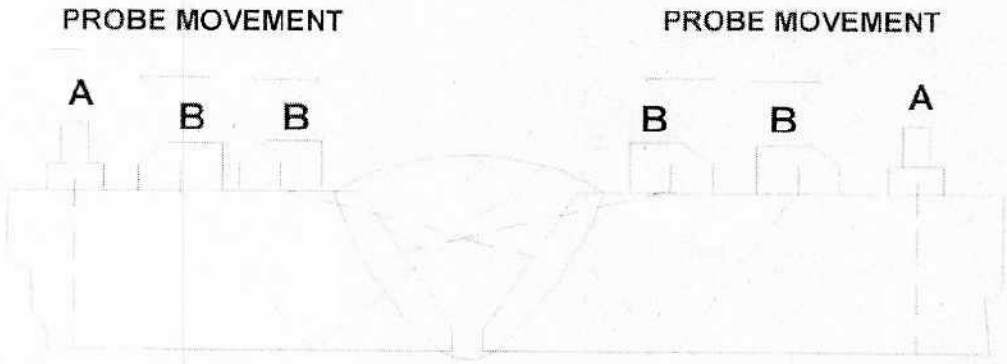
(B) Angle probe scan (minimum of 3 Probes - 45º, 60º, 70º) from weld cap to full skip distance plus weld cap width for full coverage.

(C) 0º compression probe scan to check for fusion defects (when accessible).

NOTE : Sound beam to be maintained perpendicular to the weld axis while scanning.

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

E - <u>SINGLE "V" BUTT WELD</u>

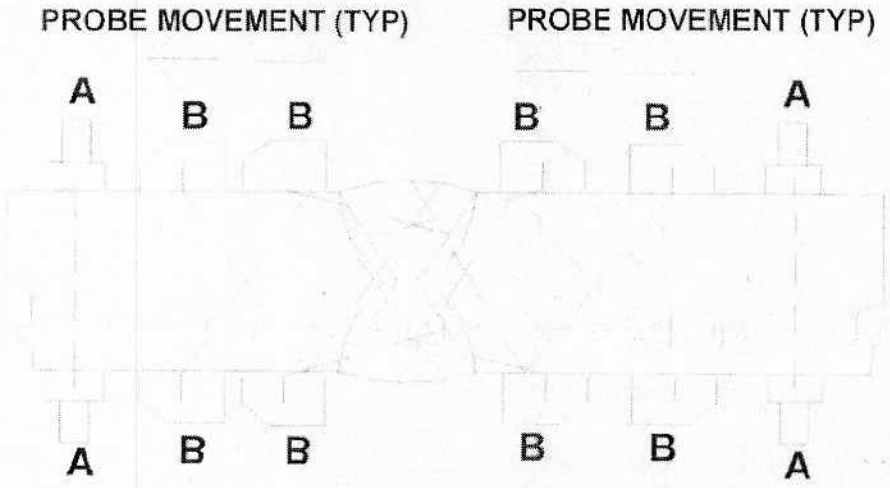


(B) 0° compression probe scan on parent metal to check for laminations and to verify wall thicknesses.

(B) Angle probe scan (minimum of 3 probes – 45°, 60°, 70°) from weld cap to full skip distance plus weld cap width for full coverage.

ILLUSTRATION OF SCANING TECHNIQUES

F - <u>DOUBLE "V" BUTT WELD</u>



(A) 0º compression probe scan on parent metal to check for laminations and to verify wall thicknesses.

(B) Angle probe scan (minimum of 3 probes - 45º, 60º, 70º) from weld cap to full skip distance plus weld cap width for full coverage.

ATTACHMENT 7.1
ILLUSTRATION OF SCANING TECHNIQUES

G - <u>TYPICAL "T" WELD</u>

I N D E X

1.0 PURPOSE

This Procedure is used to Calibrate Ultrasonic Flaw Detectors & the search Units & to verify their performance.

2.0 SCOPE

This Procedure elaborates the Calibration & Performance assessment for Ultrasonic Flaw Detectors & Search Units.

3.0 REFERENCE DOCUMENTS :

ASTM E317
ASME SECTION V
WP/QIIS/001/2009
Manufacturer's Manual
Safety Procedure WP/QIIS/017/2009, Rev.00

4.0 PERSONNEL QUALIFICATION :

The qualification of NDT Inspector to carry out this testing should be minimum ASNT Level II (UT) / or Company's Level II (UT) in accordance to Company's Written Practice , which is in accordance to ASNT SNT TC 1A & ANSI CP 189 - 2006

5.0 ULTRASONIC TEST UNIT :

5.1 All Methods described in this Procedure are applicable to test Units of pulse-echo. 'A' scan rectified video presentation with gain or attenuation controls calibrated in steps of not greater than 2 dB.

5.2 Ultrasonic test units shall be capable of generating frequencies of 1.0 – 10.0 MHz.

5.3 A performance check/calibration shall be carried out with the suppression / reject control on 'off' position.

5.4 The Ultrasonic test unit shall have both single and double transducer function and shall have a flat screen which may be viewed at varying angles without distortion of the time base.

5.5 Documentation of all Test unit performance check shall be maintained.

6.0 ULTRASONIC PROBES/SEARCH UNITS :-

6.1 All probes shall be examined for physical damage and excessive shoe wear prior to use.

6.2 Shoe flatness shall be determined by keeping the probe against relatively flat surface. Check for concavity and convexity along and across the probe axis. Slight changes on probe shoe flatness may be corrected by rubbing with fine sand –paper.

6.3 Probe frequency, refracted angle, and crystal size shall clearly be marked on the probe exterior.

7.0 CALIBRATION BLOCKS : -

7.1 All test blocks surfaces shall be free of dirt, grit or any other loose particle prior to use.

7.2 The Calibration block material shall be completely examined in all possible direction with a straight beam search units. All calibration blocks shall be free of any discontinuity that may be confused with the test unit and probe calibration systems.

8.0 FREQUENCY OF CHECKS : -

8.1 ULTRASONIC TEST UNITS : -

8.1.1	Time base Linearity and prior -	:	At the beginning of each working shift Testing of each individual component.
8.1.2	Gain / Attenuator Control Accuracy	:	Monthly
8.1.3	Amplifier Linearity	:	Weekly
8.1.4	DB Accuracy	:	Every two Months
8.1.5	Probe/Test Unit Combined Resolution	:	Weekly
8.1.6	Maximum Penetrative Power	:	Weekly

8.2 ULTRASONIC SEARCH UNITS / PROBES : -

8.2.1	Beam Exit Points testing of	:	Initial calibration and prior to each individual component.
8.2.2	Probe Refracted Angle testing of	:	initial calibration and prior to each individual component.
8.2.3	Beam Profile (20 Db) thereafter more recorded	:	Initial calibration and weekly or when the refracted angle varies than 10° from the previously angle.
8.2.4	Beam Axis Abnormality	:	Daily

8.2.5 Internal Reflectors change of	:	Initial calibration, after every shoe and weekly, thereafter.
8.2.6. DAC Curves completion at	:	Before commencement and at of every working shift confirmation each examination location.
8.2.7. Transfer Correction	:	Prior to testing of each individual component.

9.0 PERFORMANCE OF ULTRASONIC TEST UNITS : -

This section describes the methods which will be used by the Ultrasonic technicians for checking the performance of all Ultrasonic testing units prior to and during utilization.

9.1 TIME BASE LINEARITY CHECK : -

9.1.1 Place a compressional wave probe on IIW-V1 (25 mm) or IIW-V2 (12.5 mm) to obtain a minimum of 5 backwall echoes. Adjust the time base so that the first and last backwall echo indications coincide with appropriate graticule scale lines.

9.1.2 Bring the successive backwall echo in turn, to approximately the same height (e.g. 80% full screen height). The leading edge of each echo should line up with the appropriate graticule scale lines.

9.1.3 Record any deviations from linearity and express the deviations as percentage of the time base range.

9.1.4 Repeat steps above using 10 backwall echoes.

TOLERANCE

Deviation of the time base linearity shall not exceed plus or minus 2% of the time base range.

9.2. **EQUIPMENT GAIN CONTROL / ATTENUATOR ACCURACH CHECK :**

9.2.1 Position a compression wave probe on IOW Beam Profile Block to obtain indication from 25 mm deep, 1.5 mm diameter side drilled hole.

9.2.2 Adjust the gain to set the signal to 80% full screen height (slight probe manipulation may be necessary to achieve this exact signal height) and note the value of the calibrated gain control (dB). Adjust the calibrated gain control to increase the gain by 2 dB, the signal should increase to full screen height (100%). Restore the gain to its original value and

then reduce it to a further 6 dB. The signal should fall to 40% screen. Reduce the gain by further 12 dB. The signal should fall to 10% full screen height. Reduce the gain by further 6 dB. The signal should fall to 5% full screen height.

TOLERANCE : -

Gain (dB)	Expected Screen Height	Acceptable Limit
+2	100%	Not less than 90%
0	80%	
-6	40%	35 to 40 %
-8	10%	8 to 12 %
-24	5%	Must be visible above the base line

9.3 **EQUIPMENT AMPLIFIER LINEARITY CHECK :**

9.3.1 Position a compression wave probe to obtain indication from 25 mm deep, 1.5 mm diameter side drilled hole together with indication from the back wall of the IOW Beam Profile Block.

9.3.2 Position a compression wave probe on IOW Beam Profile Block to obtain indication from 25 mm deep, 1.5 mm diameter side drilled hole.

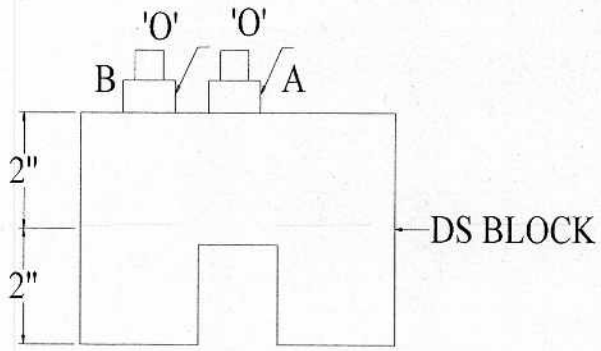
9.3.3 With the gain control and probe manipulation adjust the back wall indication to 80% F.S.H. and the indication from the hole to 40% F.H.S. Without further change in the signal height ratio. Set the larger signal to 100%, 60%, 40% and 20% F.S. H. with the use of equipment gain control and at each setting, note the height of the signal from the hole.

TOLERANCE:

The difference between the smaller signal and half of the larger signal shall not exceed 5% of the full screen height.

9.4 DB ACCURACY CHECK:

9.4.1 Place a compression wave probe on position 'A' on the DS Block (ref : sketch below) to obtain indication from the 2" thick section. Adjust the time base range so that the first back wall reflection is at horizontal mid-screen. With the equipment gain control and probe manipulation, set this signal to exactly 40% of full screen height.



9.4.2 Increase the calibrated gain control by 6 dB. Record the 6 dB setting in column 'a' and the actual screen height in column 'b' on the certification report, line 1 (see Att. No 2)

9.4.3 Move the probe towards position 'B' until the signal has dropped to exactly 40% of full screen height.

9.4.4 Repeat step 9.4.2 and the record the information on the next consecutive line on the certification report.

9.4.5 Repeat steps 9.4.3, 9.4.4 and 9.4.2 consecutively until the backwall echo from the 2" thick section is still discernible.

9.4.6 Determine the average screen value from column 'b' disregarding the first three and the last tree tabulations; enter the figure as the 2% on the certification report.

9.4.7 The corrected dB value of column 'c' of the certification report, shall be calculated by the use of the formula below :

$$DB2 = \frac{20\% \times \log (\%2)}{\%1} + dB1$$

Where : dB2 = corrected dB (Column 'c')
: %2 = average echo height value % F.S.H.
: %1 = actual echo height value % F.S.H. (column 'b')
: dB1 = db reading (column ' a ')

9.4.8 The dB (column 'd') on the certification report shall be calculated by deducting the corrected dB (column'c') from the actual dB reading (column 'a') the resultant value shall be noted and entered in the column provided. Note that the value may be either negative or positive.

9.4.9 The collective dB error 9 column 'e') on the certification report shall be determined as follows : beginning with the dB error value (column 'd') nearest to 0.0 collectively add the dB error values up and down placing the subtotals in column ' e'.

9.4.9 To determine the total qualified range of the test unit, move vertically up and down from the average% line (%2) , find the largest vertical span in which the top bottom collective dB error remain at or below 2 dB count the number of
vertical spaces of movement. Subtract one, and multiply the remainder by 6.
This value is the acceptable range of the test unit.

9.4.10 The acceptable range of the test unit may also be shown,. Graphically by the use of the dB Accuracy Evaluation Graph (see example on Attachement No 4) in conjuction with the date entered in the certification report as follows.

(i) With the data from each line on the certification report, mark with a dot on the point where the collective dB error (column 'e') intersects with the dB reading (column 'a')

(ii) Establish a curved line passing through this series of point.

(iii) Apply a 2 dB high horizontal window over this curve, positioned vertically so that the largest section is completely encompassed with in the 2 dB error height.

9.4.11 The acceptable range of the test unit may also be shown, graphically by the use of the 'dB' Accuracy Evaluation Graph (see example on Attchment no. 3) in conjuction with the date entered in the certification report as follows

(iv) This window length represents the acceptable dB range of the test unit and shall be entered on the certification report.

9.4.12 he minimum total qualified range expected should be 60 dB. Test units that do not meet this requirement may be used provided

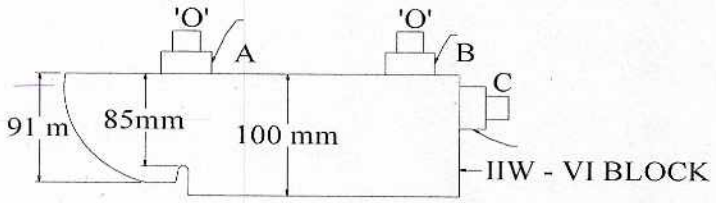
(i) That weld testing and flaw evaluation is kept within the documented acceptable vertical linearity range of the test unit.

(ii) That correction fctor figures are used (ie. The dB error figures, column 'd')

9.5. **CHECKING OF PROBE / TEST UNIT COMBINED RESOLUTION**

9.5.1 COMPRESSIONAL WAVE PROBE : -

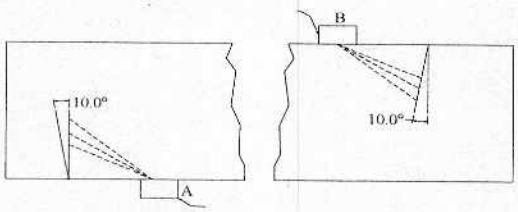
9.5.1.1 Place a compressional wave probe at position ' A' (ref : sketch below). Three signals from 85 mm ——, 91 mm, and 100 mm surface should be clearly displayed.



9.5.1.2 Position at 'B' and 'C' to determine the near surface resolution or the dead zone of the probe. If the reflection from Perspex disc at 10mm (C) and 5 mm (B) could not be displayed, it should be noted that reflectors within that region (dead zone) would not be detected.

9.5.2 **SHEAR WAVE PROBE**

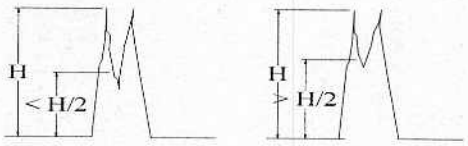
9.5.2.1 Place a shear wave angle probe on position 'A' or 'B'. The signal from the side drilled holes should be distinguishly displayed (ref : sketch below)



9.5.2.2 Rear surface resolution of shear wave angle probes can be determined by using block with simulated side drilled holes near the surface.

TOLERANCE

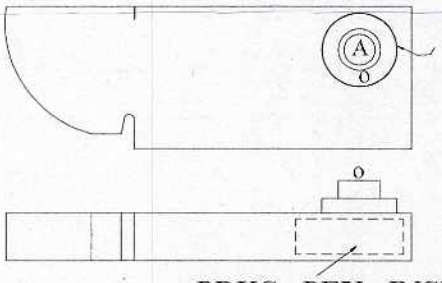
The signal amplitude of subsequent signals should be clearly separated as indicated in the sketch below.



9.6 ASSESSMENT OF MAXIMUM PENETRATIVE POWER

This check can only be used as an indication f maximum penetrative power by direct comparison of different units i.e. flaw detectors and/ or probes. Two zero degree compressional wave probes shall be used for the assessment, one low frequency and high frequency, for comparison.

9.6.1 The Probe shall be palced at position 'A' on the IIW calibration block (ref. Sketch below) using a time base range of 500 mm.



PBKS . PEX . INSERT

9.6.2 The control can be set to give maximum gain and maximum pulse energy.

9.6.3 Determine the number of multiple echoes obtained from the bottom of the plastic inset in the block and the amplitudes of the echoes.

TOLERANCE

(i) At least three echoes should be obtained with the use of 2.-2.5 MHz probe.
(ii) At least two echoes should be obtained with the use of 4 – 5 MHz probe.

10.0 PERFORMANCE MONITORING OF ULTRASONIC SEARCH UNITS

This section describes the methods which will be used by the Ultrasonic technicians for checking the performance of Ultrasonic search units prior to utilization.

10.1 LOCATING BEAM EXIT POINT

10.1.1 Position the angle probe on the IIW-V1 or IIW-V2 calibration block to obtain the maximized signal from the 100 mm radius (IIW-V1) or 25 mm / 50 mm radius (IIW –V2) curve.

10.1.2 Mark with indelible marker ,the point on both sides of the probe that coincides with the datum line on the calibration block.

10.1.3 Repeat this procedure for all probes to be used.

10.1.4 The beam exit point shall be marked as accurately as possible, since all physical measurements will be made from this point.

10.2 **DETERMINATION OF PROBE REFRACTED BEAM ANGLE :-**

10.2.1 Place the angle probe in the approximate position of the angle scribed on the IIW-V1 or IIW-V2 calibration block that corresponds to the nominal angle of the probe being tested.

10.2.2 Maximise the signal from the reference hole and adjust as necessary.

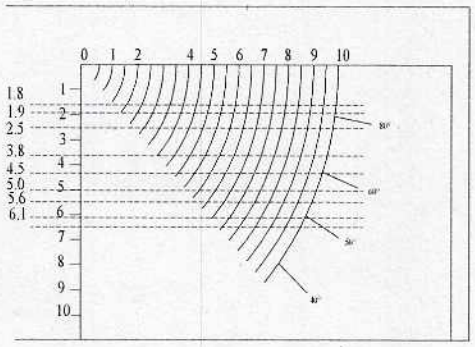
10.2.3 Correlate the probe index point as indicated in 10.1 to the corresponding scribed graduations on the calibration block to determine the exact angle of the main beam axis.

10.2.4 Probe actual angle shall be within plus or minus 2% of the designed angle.

10.3 **BEAM PROFILE DETERMINATION**

10.3.1 To establish the vertical beam profile within the limits of the 20 dB isobars, the 4 x 1.5mm diameter individual side drilled holes of the IOW beam profile block will be used. At least three reflectors of different depths shall be used to determine the beam profile within the applicable range.

10.3.2 Using a beam plotting chart, the depths of the appropriate holes in relation to the surface being scanned will be lined in across the calibrated chart at the corresponding depth increments parallel to the line representing the surface
(see illustration below.)



10.3.3 The maximized echo from the 1.5 mm diameter hole will be used as the intial working point. With the calibrated gain control adjust this echo to 80% of ull screen height and add an additional 20 dB.

The probe is then moved forward parallel to be block edge with the beam traversing the drilled hole until the echo amplitude drops back to 80% and the beam path length or stand –of distance noted to determine the trailing edge of the 20 dB beam profile. Following this the probe is moved backward until the echo rises to maximum and drops back to 80%. The beam path length or stand off distance is also noted to determine the leading edge of the 20 dB beam profile.

10.3.4 The steps described in 4.3.3 are subsequently repeated with further holes and all the results transferred onto the beam plotting chart. (see attachment no.4 for the schematic presentation of the steps described above)

10.3.5 Draw a straight line through the plotted reflectors as accurately as possible. Obvious anomalies in the results as represented in the chart shall be rechecked as stated to achieve a consistent beam profile.

10.3.6 The beam profile plotted shall be used by the Ultrasonic technicians for on-site evaluation of reflectors and shall be checked regularly for changes due to excessive probe shoe wear.

10.3.7 This procedure may also be used to determine the actual refracted angle of the probes.

10.4. BEAM AXIS ABNORMALITY CHECK :

10.4.1 Probe to be used for evaluation of reflectors shall be examined to ascertain that the beam has only one major axis. This abnormality, check is achieved by using the IOW beam profile block, maximizing an echo from one of the holes ner the opposite surface of the block from the one in contact with the probe. Slow back and forth movement of the probe parallel to the edge of the block until the echo disappears should produce a reasonably smooth decay of the reflection on both sides of the beam axis. An abrupt rise in echo height as the amplitude is decaying will denote a beam profile abnormality.

TOLERANCE

The intensity of any reflection rise from a secondary axis shall not exceed 10% of the major axis intensity.

10.5 PERFORMANCE MONITORING OF ULTRASONIC SEARCH UNITS

10.5.1 STRAIGHT BEAM SEARCH UNITS

10.5.1.1 The time base shall be adjusted to represent the actual beam path distance to be used by using the IIW block.

10.5.1.2 The calibrated gain control shall be adjusted so that the first backwall echo from the 25 mm section of the block is at 50% to 75% of full screen height.

10.5.1.3 Remove the probe from the calibration block without changing any other equipment adjustments.

10.5.1.4 Increase the Calibrated gain control by 20 dB. The CRT screen area beyond 13 mm sound path and above the reference level height established in 10.5.1.2 shall be free of any indication.

10.5.2 **ANGLE BEAM SEARCH UNITS**

10.5.2.1 The time base shall be adjusted to represent the actual beam path distance to be used the IIW block..

10.5.2.2 Position the angle beam probe on the IIW block to obtain a maximized signal from the 1.5 mm diameter side drilled hole.

10.5.2.3 Adjust the maximized signal to 80% of full screen height by using the calibrated gain control.

10.5.2.4 Remove the probe from the calibration block without changing any other equipment adjustments.

Increase the calibrated gain control by 20 dB. The CRT screen beyond 13mm sound path and above reference level height established in 10.5.2.3 shall be free of any indication.

10.5.2.5 DISTANCE AMPLIOTUDE CORRECTION

10.5.2.6 DAC curves shall be constructed for each probe to be employed for weldment examination, as applicable, using the IOW beam profile block.

10.5.2.7 Position the probe on the block to obtain a maximized signal from the 1.5 mm hole nearest to the surface.

10.5.2.8 Adjust the signal to approximately 80% of full screen height using the calibrated gain control. Mark the peak of this indication on the CRT screen by using an indelible fine tipped felt marker.

10.5.2.9 Repeat step 10.6.1 and 10.6.2 using the signals off every 1.5mm diameter hole within the beam bath length of the test range to be used.

10.5.2.10 Connect all points marked with a smooth curving line. This line will be referred to as the DAC curve for the particular probe.

NOTE : -

10.5.2.11 DAC curve may be marked with directly over the CRT screen cover or superimposed using a clear plastic or Perspex overlays.
If any point of the DAC has deviated by plus or minus 2 dB of its amplitude, a new DAC curve shall be reconstructed and the previous one be voided.

10.6 TRANSFER CORRECTION

The difference in signal amplitudes between the reference block and the test component due to test surface roughness, contour, coating and acoustical attenuation characteristics shall be compensated by the use of transfer correction method.

10.6.1 Measurement of this value is achieved by using two angle beam probes of the same type, one acting as a transmitter and the other as a receiver with the test unit set to dual mode. Position the probes on the reference block directed at each other to obtain the maximum signal at full skip distance.

10.6.2 Adjust the maximized to approximately 75% of full screen height with the use of the calibrated gain control. Mark the peak of this signal over the CRT screen cover or transparent overlay and take note of the dB gain value.

10.6.3 Without alerting the test unit sensitivity, reposition the probes to obtain a maximized signal at two skip distance and mark the peak of this signal on the screen cover or on the same transparent overlay used on step 10.7.2.

10.6.4 Draw a straight line connecting the set of peaks obtained. This line represents the reference line in determining the transfer correction value to be used on the test component.

10.6.5 Repeat step 10.7.1 on the test component and align the peak of the maximized signal with the line established in step 10.7.4. Note the dB value and subtract the value obtained in step 10.7.2. The resultant figure shall be added as the transfer correction value. This value shall be added to the reference level prior to examination of the test component. Note that this value may be positive or negative.

CALIBRATION REPORT FOR ULTRASONIC FLAW DETECTOR

REPORT NO.: DATE :

EQUIPMENT DETAILS :

PROBE DETAILS :

PROCEDURE NO. :

	VARIATION IN HPRIZONTAL LINEARITY%	VARIATION IN VERTICAL LINEARITY %
NORMAL PROBE		
ANGLE PROBE		

REMARKS :

TESTED BY :

NAME :

SIGN :

DATE :

APPENDIX 1

SCREEN HEIGHT LINEARITY

To Verify the ability of the Ultrasonic instrument to meet the linearity requirement of **6.2**, position an angle beam search unit as shown in Fig. 1.1 so that indications can be observed from both the ½ and ¾ T holes in a basic calibration block. Adjust the search unit position to give a 2:1 ratio of amplitudes between the two indications, with the larger set at 80% of full screen height. Without moving the search unit, adjust the sensitivity (gain) to successfully set the larger indication from 100% to 20% of full screen height, in 10% increments (or 2dB steps if fine control is not available), and read the smaller indication at each setting.The reading must be 50% of the larger amplitude, within 5% of full screen height. The settings and readings must be estimated to the nearest 1% of full screen. Alternatively, a straight beam search unit may be used on any calibration block which will provide amplitude differences, with sufficient signal separation to prevent overlapping of the two signals.

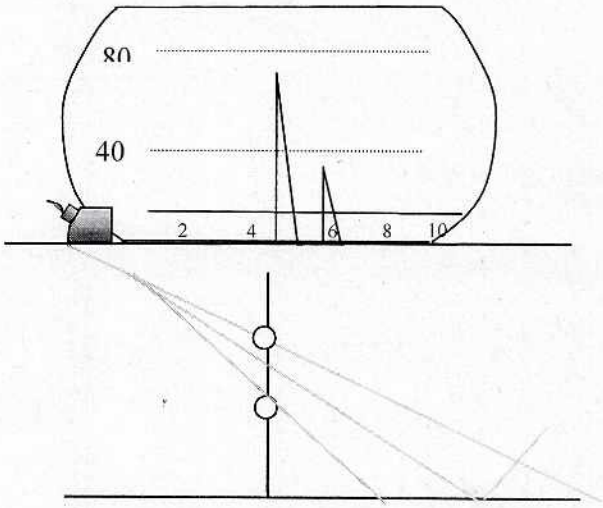


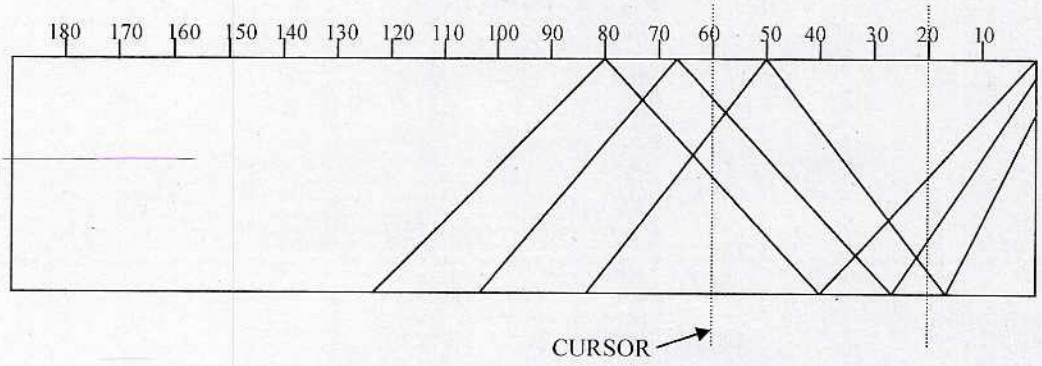
Figure 1.1 LINEARITY

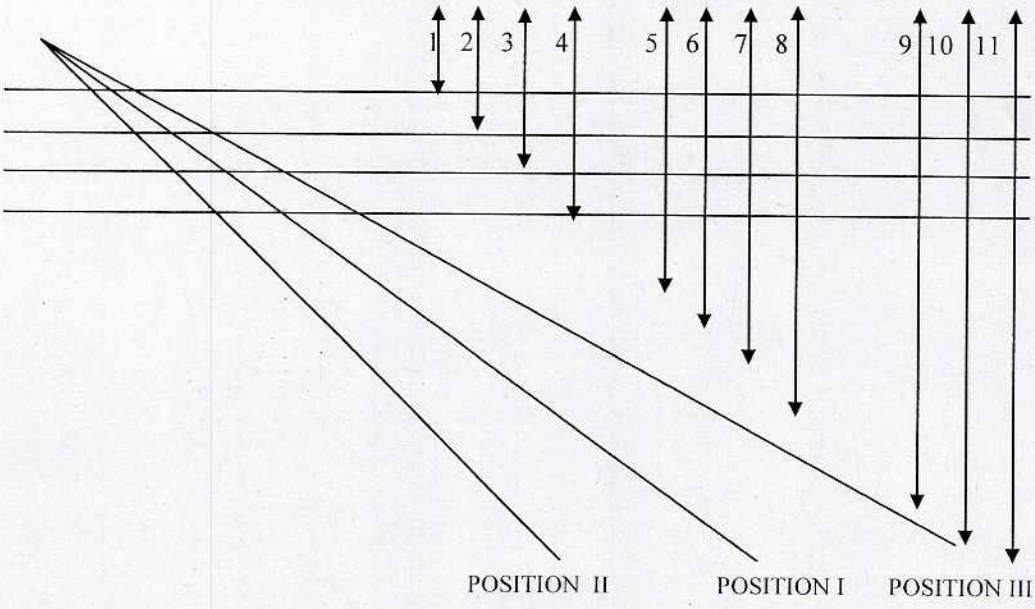
AMPLITUDE CONTROL LINEARITY

To verify the accuracy of the amplitude control of the ultrasonic instrument , as required in **6.3**, position an angle beam search unit as shown in figure 1.1 so that the indication from the ½ T hole in a basic calibration block is peaked ½ T hole in a basic calibration block is peaked on the screen. With the increases and decreases in attenuation shown in the following table, the indication must fall within the specified limits. Other convenient reflectors from any calibration block may be used with angle or straight beam search units.

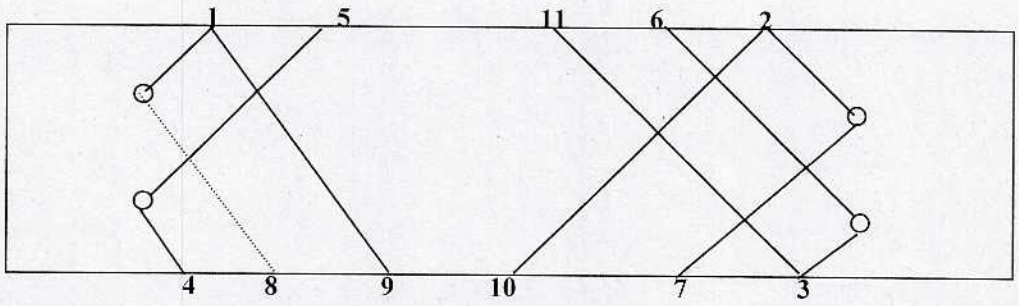
Indication Set at % of Full Screen	dB Control Change	Indication Limits % of Full screen
80%	- 6dB	32 to 48 %
80%	-12 dB	16 to 24 %
40%	+6 dB	64 to 96 %
20 %	+12 dB	64 to 96 %

APPENDIX 2



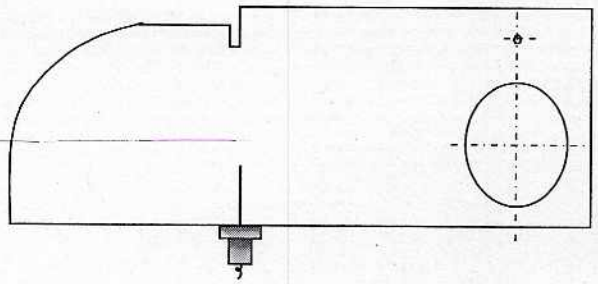


USE PROTRACTOR TO DETERMINE ANGLES FROM OVERLAY

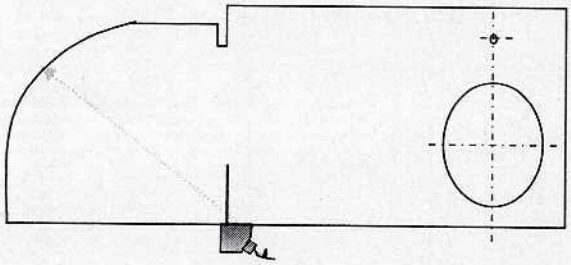


TO DETERMINE -20 dB BEAM LIMITS

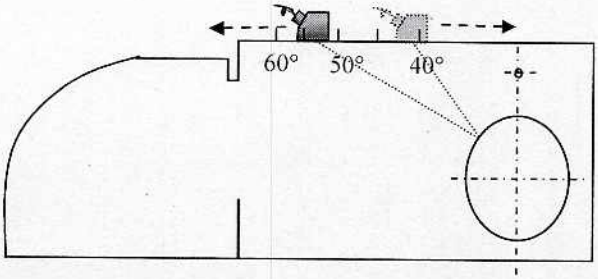
APPENDIX 3



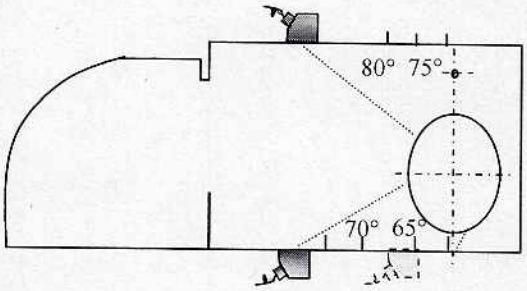
(a) Probe Resolutions Check



(b) Probe Index- Checking Time base

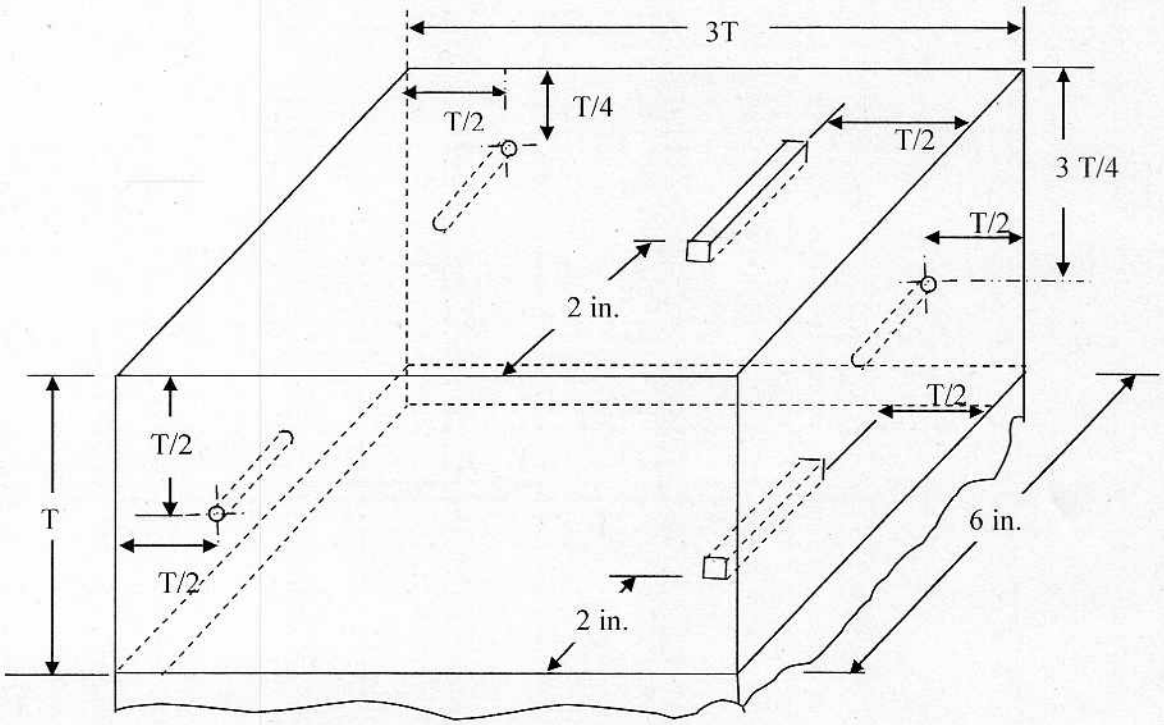


(c) Probe Angle Determination



(d) Probe Angle Determination

APPENDIX 4



(**Figure 4.1**)

Weld Thickness t	Basic Calibration Block Thickness	Hole Diameter	Notch Size
1 in. or less	¾ in. or t	3/32 in.	Width = 1/8" to ¼ "
Over 1 in. thro 2 in.	1 ½ in. or t	1/8 in.	
Over 2 in. thro 4 in.	3 in. or t	3/16 in.	Depth = 2%T or 0.04"
Over 4 in. thro 6 in.	5 in. or t	¼ in.	whichever is
Over 6 in. thro 8 in.	7 in. or t	5/16 in.	greater, into
Over 8 in. thro 10 in.	9 in. or t	3/8 in	the base metal.
Over 10 in.	t ± 1 in.	[Note (1)]	Length = 2 in.min.

- Holes shall be drilled and reamed a min. of 1 ½ in. deep, essentially parallel to exam. Surface.
- The tolerance for hole diameter shall be ± 1/32 in.The tolerance on notch depth shall be +10% and -20 %.The tolerance on hole location thro' thickness shall be ± 1/8 in.

Note:

(1) For each increase in weld thickness of 2 in. or fraction thereof over 10 in.,hole diameter shall increase 1/16 in.

APPENDIX 5

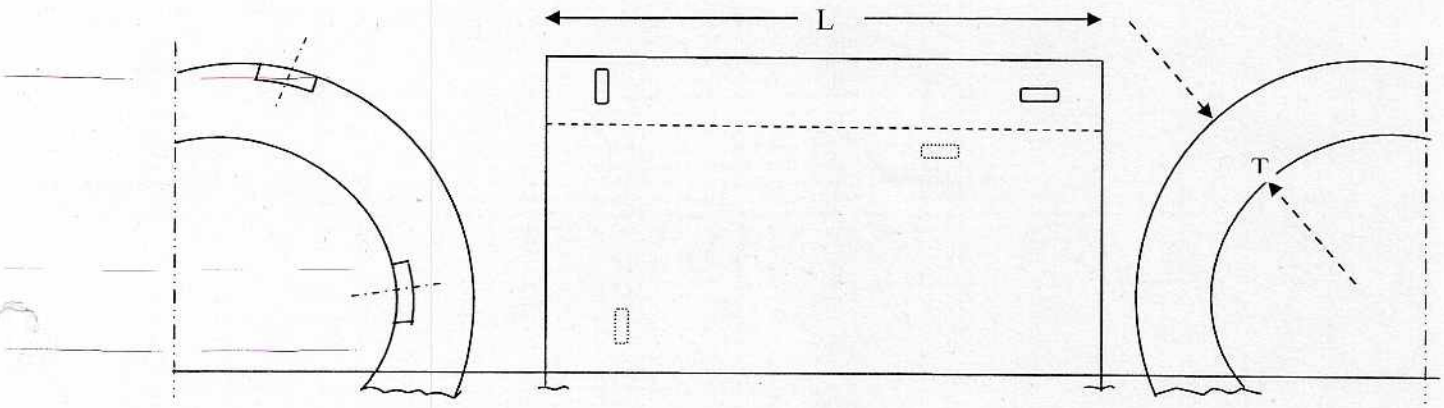


Figure 5.1
TYPICAL BLOCK DIMENSION

Length (L) 8 in. or 8T whichever is greater

Arc Length (AL) 8 in. or 270°

BASIC CALIBRATION

Weld Thickness (t)	Block Thickness (T)
1 in. or less	¼ in. or t
Over 1 in, through 2 in.	1 ½ in. or t
Over 2 in. through 4 in.	3 in. or t
Over 4 in. through 6 in.	5 in or t

SPECIFIC NOTCH DIMENSION

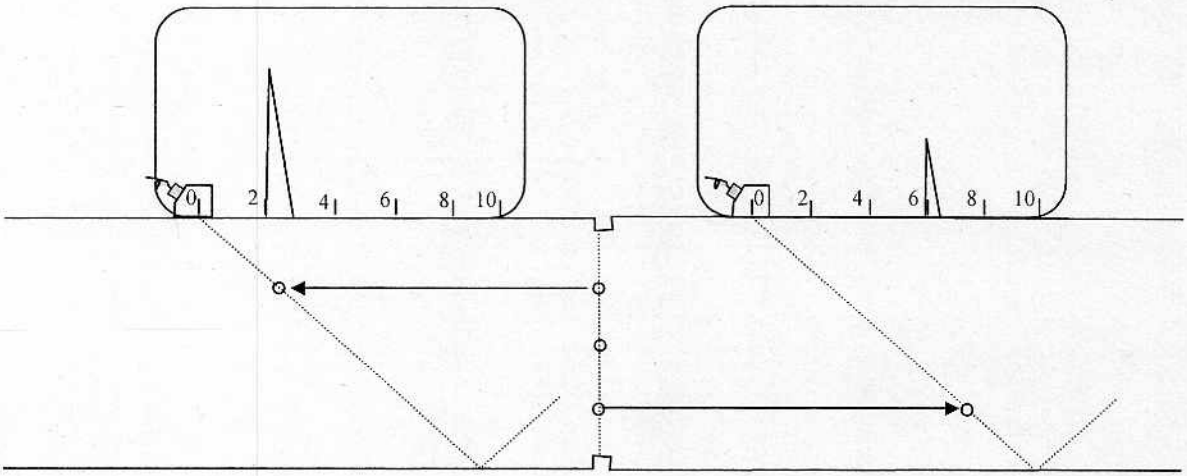
Length (L) - 1 in. Minimum

Depth (D) - 10 % T with Tolerance D ± 10 % of depth
± 20 % of depth

Width - ½ inch to ¼ in.

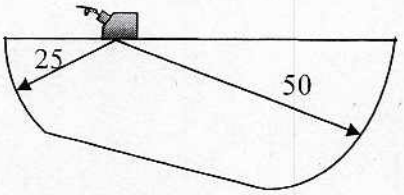
Location - not closer than T from any block edge

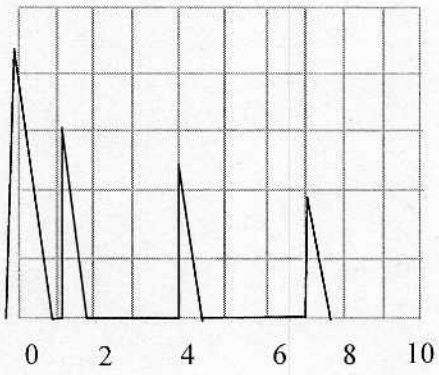
APPENDIX 6



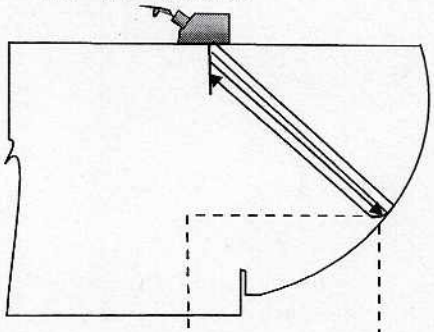
SWEEP RANGE CALIBRATION WITH ASME BLOCK

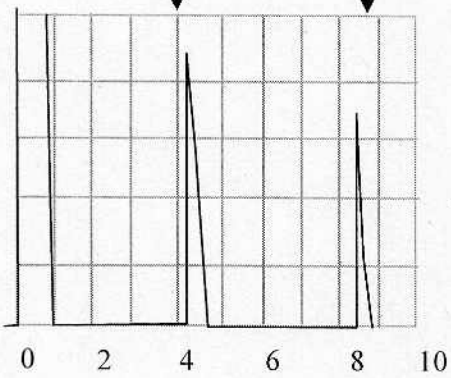
IIW V2 BLOCK



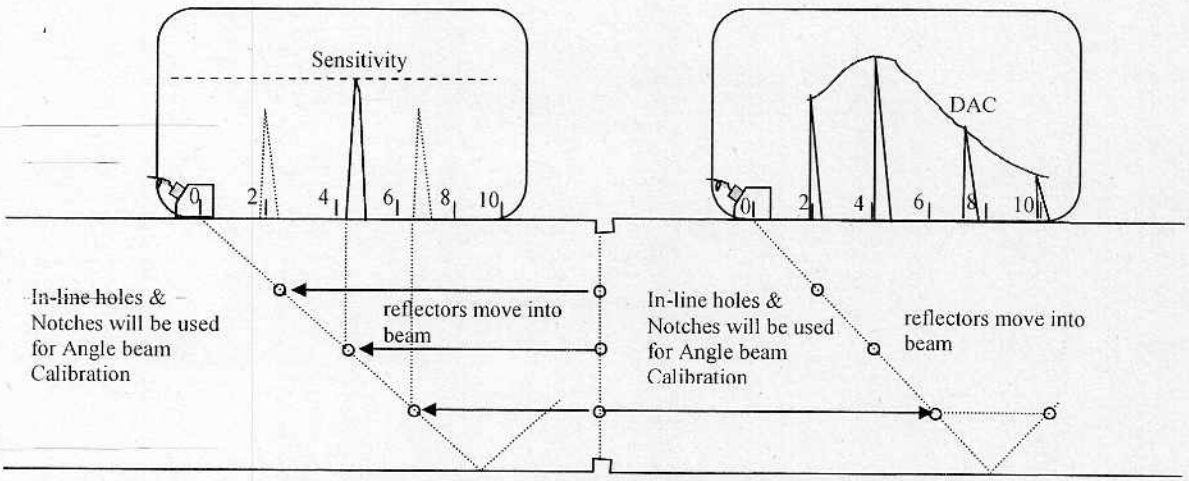


IIW V1 BLOCK

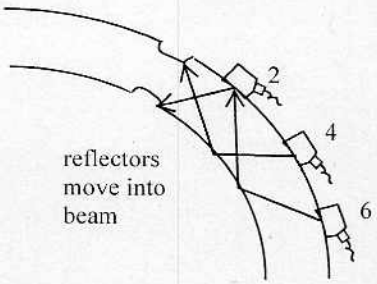




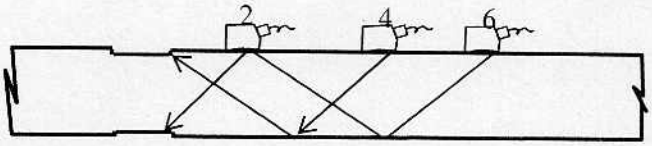
APPENDIX 7



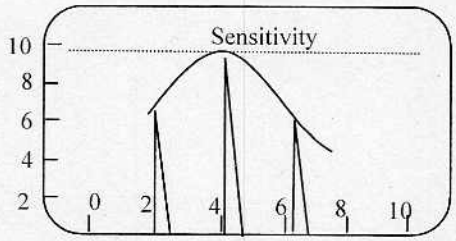
Sensitivity



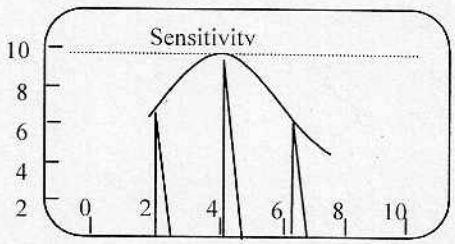
Distance Amplitude



reflectors move into beam



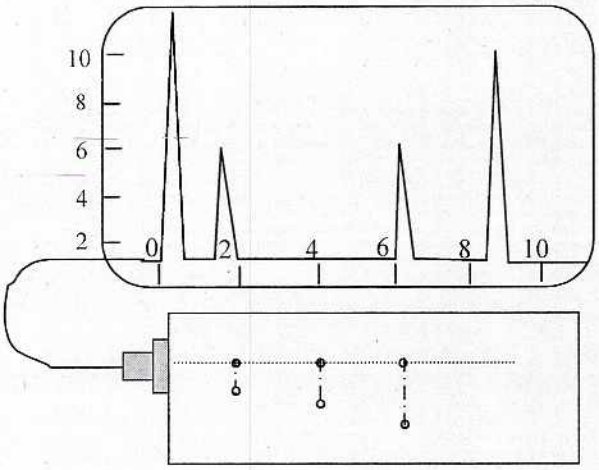
Sensitivity & Distance amplitude correction on Curvature



Sensitivity & Distance amplitude correction on Longitudinal

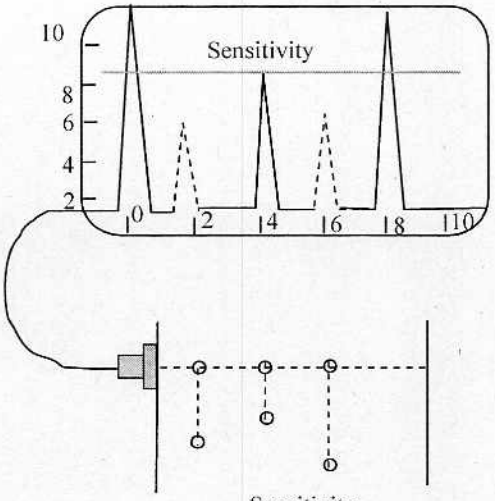
FOR TUBULAR PRODUCT

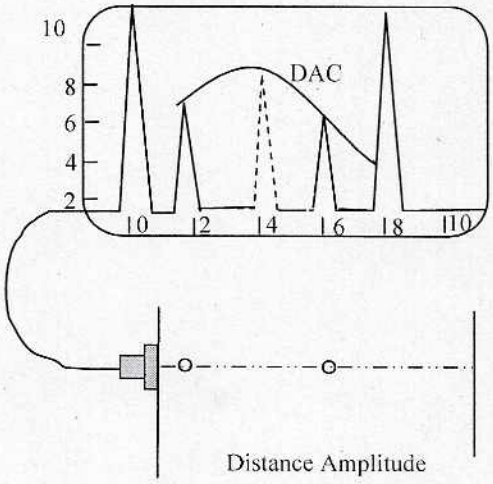
APPENDIX 8



Staggered holes will be used for Straight beam

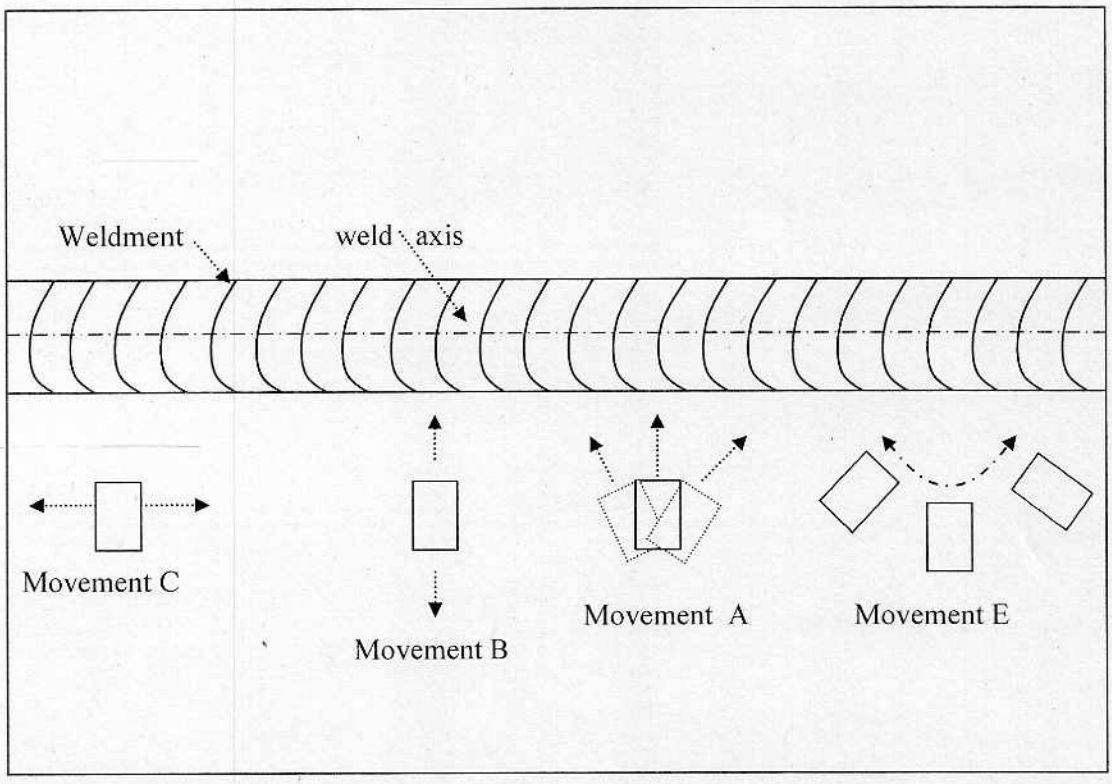
Sweep Range Calibration





Sensitivity and Distance Amplitude Correction

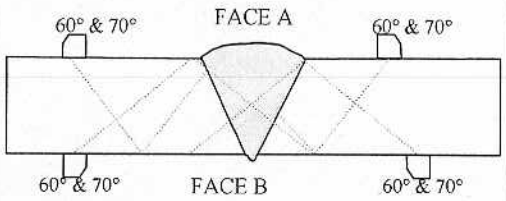
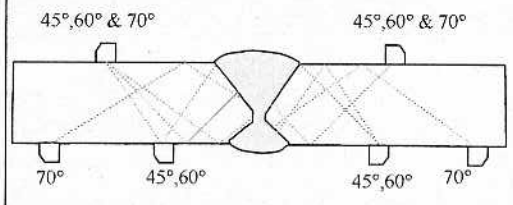
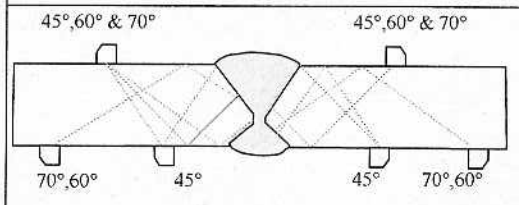
APPENDIX 9



SCANNING TECHNIQUES :

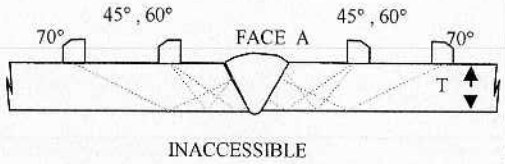
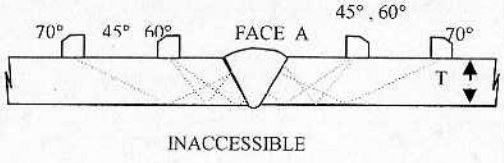
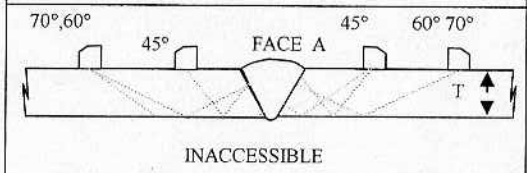
Movement B& C	: Lateral Scanning
Movement B	: Transverse Scanning
Movement A	: Rotational Scanning
Movement E	: Orbital Scanning

APPENDIX 10

APPLICABLE THICKNESS	TYPE OF JOINTS	TYPICAL WELD AND SCANNING GEOMETRY	PROBE TO BE USED			SCANNING SKETCH		
			Frequency	ANGLE	SIZE	SKIP	SCANNING FACE 1	SCANNING FACE 2
T ≤ 25	PLATE BUTT JOINTS		4 MHz	60° & 70°	8x9	FULL	FACE 'A' & FACE 'B'	BOTH SIDES
25<T≤45				45° & 60° & 70°		FULL		
T >45			2 MHz	45° & 60° & 70°		HALF		

Note : (1) Face 'A' Shall mean the face of Material from which the initial scanning is done
Face 'B' Shall be opposite the face 'A' on same plate
Face 'C' Shall mean the face opposite the weld on the connecting member or a 'T' or corner joint
(2) " Both Sides" shall mean the scanning from both sides of the weld joint

APPENDIX 11

APPLICABLE THICKNESS	TYPE OF JOINTS	TYPICAL WELD AND SCANNING GEOMETRY	PROBE TO BE USED			SCANNING SKETCH		
			Frequency	ANGLE	SIZE	SKIP	SCANNING FACE 1	SCANNING FACE 2
T ≤ 25	PLATE BUTT JOINTS SINGLE SIDED WELDING		4 MHz	60° & 70°	8x9	FULL	FACE 'A'	BOTH SIDES
25<T≤45				45° & 60° & 70°		FULL		
T >45			2 MHz	45° & 60° & 70°		HALF		

Note : (1) Face 'A' Shall mean the face of Material from which the initial scanning is done
Face 'B' Shall be opposite the face 'A' on same plate
Face 'C' Shall mean the face opposite the weld on the connecting member or a 'T' or corner joint
(2) " Both Sides" shall mean the scanning from both sides of the weld joint

Sara Sae