## Table of Contents

# 1 PURPOSE

This procedure specifies the application of phased array technology for the testing of fusion welded joints in metallic materials coated by thermal sprayed aluminium (TSA) equal to and above 5.0mm thickness. It is intended for use In-service welded joints of simple geometry in plates, pipes, and vessels, where both the weld and parent material are low alloyed carbon steels.

It explains methods for inspecting the most common weld joint configurations in accordance with BS EN ISO 13588 - Ultrasonic testing - Use of automated phased array technology and shall be used in conjunction with the client / job specific requirements as itemised with appendix 1.

# 2 SCOPE

The requirements of this procedure shall be applied in conjunction with the specific technique sheets. Where required by the client, additional job specific technique sheets shall be compiled to address any applicable parameters that may differ from this procedure. These Job Specific Techniques shall be issued prior to commencement of work.

The requirements for compiling these techniques are detailed in Section 7.8 of this procedure.

# 3 DEFINITIONS AND ABBREVIATIONS

For the purpose of this procedure definitions given in BS EN 16018 shall apply.

| | |
|---|---|
| PAUT: | Phased Array Ultrasonic Testing |
| TSA: | Thermal Sprayed Aluminium |
| HAZ: | Heat Affected Zone |
| SDH: | Side Drilled Holes |
| TCG: | Time Corrected Gain |
| ACG: | Angle Corrected Gain |
| FSH: | Full Screen height |
| A-SCAN: | RF Waveform presentation |
| B-SCAN: | Cross sectional profile through one vertical slice of the test piece |
| C-SCAN: | Two-dimensional presentation of data displayed as a top or planar View |
| S-SCAN: | Sectorial Scan – Two-dimensional cross-sectional view derived from a series of A-scans. Sound beam sweeps through a series of angles to generate an approximately cone shaped cross-sectional image |
| L-SCAN: | Linear Scan – Single beam will scan across the length of the Probe at a fixed angle |

# 4 REFERENCE AND STANDARD DOCUMENTS

Other standards not listed, but which may be required, as part of a customer's requirements shall be detailed on the technique sheet without further amendment to the text of the main procedure.

- BS EN ISO 9712 - Qualification and certification of NDT Personnel, General principles
- BS EN ISO 13588 Testing - Ultrasonic testing - Use of automated phased array technology.
- ISO/DIS 20601 - Non-destructive testing of welds - Ultrasonic testing - Use of automated phased array technology for steel components with small wall thickness
- ISO 17635, Non-destructive testing of welds - General rules for metallic materials
- EN 16392-1, Non-destructive testing - Characterization and verification of ultrasonic phased array systems - Part 1: Instruments

- EN 16392-2, Non-destructive testing - Characterization and verification of ultrasonic phased array systems - Part 2: Probes
- EN 16392-3, Non-destructive testing - Characterization and verification of ultrasonic phased array systems - Part 3: Complete systems
- BS EN ISO 17640 - Non-destructive testing of welds – Ultrasonic testing – Techniques, testing levels, and assessment
- BS EN ISO 2400 - Non-destructive testing – Ultrasonic examination Specification for calibration Block 1
- BS EN ISO 7963 - Calibration Block 2 for ultrasonic examination of welds

The latest revision of the above standards shall be used. Other standards which may be required, as part of client's requirements shall be detailed on a technique sheet without further amendment to the text of the main procedure.

# 5 RESPONSIBILITIES

Personnel working to this procedure shall have knowledge of the product and material to be measured and unless otherwise specified by the client, they shall be qualified in Phased array ultrasonic testing, to the required category in accordance with the following: -

- ISO 9712 (PCN PAUT Level 2)

***Technicians shall have successfully passed the competency assessment on the reference sample as detailed in appendix 5 prior to mobilization.***

Operators shall be capable of reading the letter sizes equivalent to those defined as Jaeger 1 at a distance of 30cm and shall be tested for colour blindness particularly in the colours or shades to be used in subsequent testing. This shall be carried out annually and a record of the tests shall be maintained on file.

# 6 SAFETY

All operations shall be performed in accordance with Sparrows systems and clients Health and Safety requirements. In addition, the on-site safe systems of work requirements in accordance with the Health and Safety at Work Act 1974 shall be strictly observed.

All traces of couplant shall be removed immediately after testing where specifically required by Oilfield Testing Services, or whenever failure to do so could result in a hazard or inconvenience to the operator or any other person.

# 7 PROCEDURE

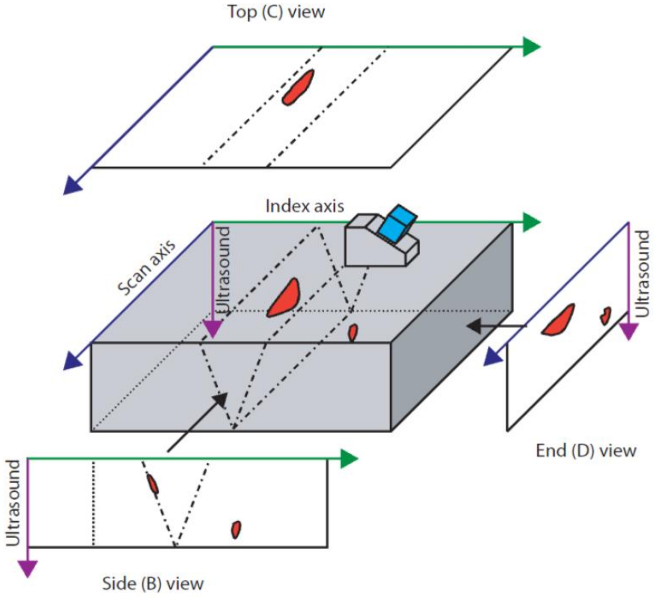
## 7.1 PROCEDURE VALIDATION

This procedure has been successfully validated using the scanning patterns as detailed within technique Sheet No. INS02tsPA0025U and validation report TSA-PAUT-VAL-001.

## 7.2 EQUIPMENT AND CONSUMABLES

**Phased Array Instruments**

Phased Array instruments shall be capable of digitizing and saving the complete unprocessed RF waveforms for the generation of Linear and Sectorial scans as well as the standard D-Scan, C-Scan, B-Scan and A-Scan displays.




Instruments shall be capable of generating frequencies over the range of at least 1 MHz to 15 MHz and equipped with stepped gain controls in units of 1.0 dB or less. The instrument must also be capable of amplitude control over its useful range. Time corrected gain (TCG) will be used in lieu of Distance Amplitude Correction curve (DAC curve).

The Omni scan OMNI MX or MX2 Phased Array Equipment (16:128) shall be used during the procedure demonstration and same type instrument and analysis software shall be used during actual job. This procedure is a combination of Tomoview and/or Omni-PC software. This system meets the following requirements:

- Combination of ultrasonic equipment and scanning mechanisms capable of acquiring and digitizing signals.
- 64 active independent channels for transmission and reception.
- Pulse output 45V or 90V per element.
- Pulse width adjustable from 30ns to 1000ns ± 10% with a resolution of 2.5ns.
- Number of focal laws= 256.
- Frequency bandwidth: 0.25MHz to 32MHz (-3dB).
- A-scan acquisition rate: 6000 A-scans/sec. Maximum pulsing rate: 1 channel at 12 kHz.
- DAC Range: up to 40 dB.
- Receiver gain range 0 –100 dB, in 0.1 dB steps.
- Data storage: CompactFlash card, USB storage device.
- Data file size: 160 MB.
- The equipment (Omniscan MX/MX2) shall have a valid calibration certificate during the period of examination.

Data analysis will be carried out utilising the Olympus ‘Tomoview’ analysis or Omni-PC software. This is software run on a separate laptop computer which makes use of weld overlays to assist is the interpretation and location of any indications.

**Transducers**

Phased Array probes can be 16, 32 or 64 element linear array design with nominal frequencies from 2.0 – 10 MHz, depending on material thickness.

- Transducers shall be of linear array type 64 elements with maximum virtual probe aperture (VPA) of 16 elements multiplied by the pitch of the probe. A lower VPA may be used depending on the pipe diameters and associated dimensions.
- Type of Probe: linear phased array.
- Manufacture: RDTech
- Model: 5L 64 –A12 or 2L 64-A12
- Serial No: 5L 64 –A12, 2L 64-A12
- Effective steering angles: 400 to 750
- Nominal frequency: 5MHz., 2.25 MHz

Wedges assist with generating the proper energy mode and angle within the component. Wedges should be prepared with couplant ports to facilitate continuous couplant feeds.

- Manufactured out of Lucite or Rexolite and angled at 55° for angle probes and flat wedge for normal scans. Whenever required, the wedge shall be shaped to match the curvature of the piping to ensure best coupling to the base material. Wedges shall be used on pipes and tubes up to pipe sizes of NPS 20”. For pipe diameters more than 20” e. g. 24” & 30”, shaped wedges may be used if warranted.

- Typical wedge specification: see table below:

| Part No. | Probe type | Nominal refracted angle in steel | Sweep (angle) | Probe orientation | External dimensions | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | W | W* | H |
| SA12 0L | A12 | 0° LW | NA | NA | 66 | 30 | - | 20 |
| SA12 N55S IHC | A12 | 55° SW | 30 –70 | Normal | 69 | - | 40 | 43 |

**Couplant**

For encoded scanning, generally couplant is water of sufficient pressure directed into the probes with couplant ports. Other acceptable couplants include Ultragel grades, gels, pastes and other commercially prepared formulas. The same couplant used for the calibration, validation shall be used for the production welding.

All forms of couplants should be free of air bubbles and exhibit appropriate wetting characteristics.

**Reference and Calibration Blocks**

Calibration blocks shall be fabricated from the same or similar material and should conform to both range and sensitivity settings of the item under test.

IIW Type 2 Calibration Block to be used for distance calibration, verifying angle (focal Laws) and theoretical wedge index point, assessing sensitivity, and sweep linearity and element checks.

**ISO Basic Calibration Blocks**: The basic calibration block configuration and reflectors shall be as shown in BS EN ISO 2400 and BS EN ISO 7963.

**Material**: The material from which the block is fabricated shall be from material of the same material specification, product form, and heat treatment condition, as the material to which the search unit is applied during the examination shall be used for.

**Quality**: The quality of the calibration block shall be checked by straight beam search unit prior to fabrication to ensure absence of any objectionable laminar type discontinuities that may otherwise interfere with calibration procedures. Areas that contain indications exceeding the remaining back wall reflection shall be excluded from the beam paths required to reach the various calibration reflectors.

**Heat Treatment**: The calibration block shall receive at least the minimum tempering treatment required by the material specification for the type and grade.

**Surface Finish**: The finish on the surfaces of the block shall be representative of the surface finishes of the component.

**Temperature**: The temperature of the reference block must be within +/- 15 deg. C. of the component being tested and in the range 0 °C to 50 °C.

## 7.3 SURFACE CONDITION

All scanning surfaces shall be free from scale, spatter, rust, scars or any other foreign material, which is likely to interfere with the subsequent test. Scanning surfaces may be assumed to be satisfactory if the surface roughness, Ra, is not greater than 6,3µm for machined surfaces, or not greater than 12,5µm for shot-blasted surfaces.

Welds shall be tested with a TSA coating of 200 microns or below as qualified in validation report TSA-PAUT-VAL-001.

The contour or waviness of the test surface shall not result in a gap greater than 0.5mm between the probe shoe and the surface. Adequate probe contact for curved surfaces is considered satisfactory when it meets the following;

ISO 17640 Clause 6.3.4 the equation is $g = a^2/D$ or $D \geq 2\ a^2$

where; ‘D’ is the diameter of the component (in mm)
‘a’ is the diameter of the probe in the direction of examination (in mm)

A probe that cannot meet the above requirement shall be adapted by contouring the probe shoe to suit the test surface. In addition, adjustments shall be made to compensate for any changes in sensitivity and/or range settings.

## 7.4 RANGE AND SENSITIVITY SETTINGS

**Sensitivity and Range Corrections**

Range and sensitivity settings shall be established in accordance with BS EN ISO 13588 prior to each examination and re-confirmed at the following stages as detailed below;

- At least every 4hrs during testing.
- Any change in equipment
- Any change in the test parameters
- Where changes in the equivalent settings are suspected
- At the end of each inspection

Signal-to-noise ratio should be optimized with a minimum of 12 dB for the reference signals, when using A-scans, or with a minimum of 6 dB when using images.

Sensitivity and range changes – If deviations from the initial settings are found during these checks the corrections given in Table 3 of BS EN ISO 13588 shall be carried out.

**Table 3 — Sensitivity and range corrections**

| Sensitivity | |
|---|---|
| Deviations ≤4 dB | No action required; data may be corrected by software |
| Deviations >4dB | The complete chain of measurement shall be checked. If no defective components are identified, settings shall be corrected and all tests carried out since the last valid check shall be repeated |
| NOTE 1 The required signal-to-noise ratio has to be achieved. | NOTE 2 The deviation 4 dB applies for pulse echo testing. For TOFD testing 6 dB deviation is allowed. |
| **Range** | |
| Deviations ≤0,5 mm or 2 % of depth-range, whichever is greater | No action required |
| Deviations >0,5 mm or 2 % of depth-range, whichever is greater | Settings shall be corrected and all tests carried out since the last valid check shall be repeated |

**Primary Reference Level**

For PAUT examinations the primary reference response shall be established at 80% amplitude (± 5%) from the appropriate reflectors.

As defined in BS EN ISO 13588, an electronic TCG shall be used to equalize the reference reflector responses over the entire thickness range plus a minimum of 1T where 'T' is thickness, as required to achieve full-volumetric coverage from one side of the weld.

Any differences between the TCG reference block and the material under test shall be corrected as detailed below.

**Attenuation and Transfer Loss**

Allowances shall be made for differences in attenuation or transfer loss between the parent material and the test block used to plot the TCG.

- Differences of < 2 dB no correction is required.
- Differences > 2dB < 12dB shall be compensated for
- Differences > 12 dB shall require further preparation of the surfaces or alternative NDT techniques.

The noise level during the weld examination (excluding spurious surface indications) shall be 12 dB below the relevant evaluation level.

## 7.5 EQUIPMENT CALIBRATION

**Instrument Linearity Evaluation**

Ultrasonic instrument linearity shall be verified at the beginning and end of each series of examinations, which is not to exceed 3 months.

**Screen-Height Linearity**

Position a search unit on a calibration block to obtain indications from the two calibration reflectors. Alternatively, a straight-beam search unit may be used on any calibration block that will provide amplitude differences with sufficient signal separation to prevent the overlapping of the two signals.

Adjust the search unit position to give a 2:1 ratio between the two indications, with the larger indication set at 80% of full-screen height (FSH) and the smaller indication at 40% of FSH. Without moving the search unit set the larger indication to 100% of FSH; record the amplitude of the smaller indication, estimated to the nearest 1% of FSH.

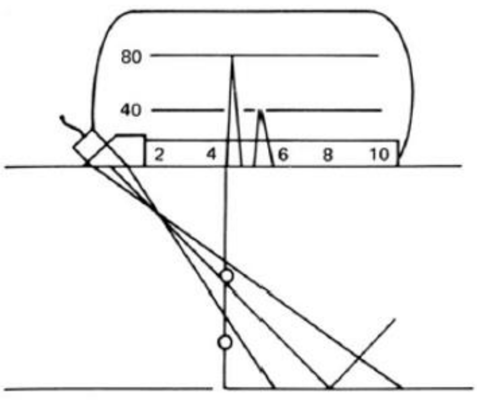
Successively set the larger indication from 100% to 20% of FSH in 10% increments (or 2 dB steps if a fine control is not available); observe and record the smaller indication estimated to the nearest 1% of FSH at each setting. The reading must be 50% of the larger amplitude within ±3% of FSH.

**Amplitude-Control Linearity**

Position a search unit on a calibration block to obtain maximum amplitude from a calibration reflector.

As a minimum, the amplitude control linearity shall be performed to document linearity at both ends of the gain range being used with the equipment.

Without moving the search unit, set the indication to the required percentage of FSH and increase or decrease the dB as specified on the Ultrasonic Instrument Linearity Verification (Form 1). The estimated signal shall be recorded to the nearest 1% of FSH.




**Element check**

Use the parallel surface of the calibration block to set up a 0° linear scan at 1 element steps and use multiplexing across the probe elements. The amplitude of each of the elements shall be recorded. The amplitude variation between two adjacent elements shall not exceed ±3 dB (20% FSH). A minimum of 90% of the active elements must be within this tolerance, otherwise the probe must be placed within quarantine and an alternative used. The presence of two adjacent inactive elements is not acceptable.

**Focal-Law Verification**

The transmission and reception of ultrasonic waves of a given angle of incidence is a function of time delays calculated by focal laws using the information provided to the phased array system. Verification that the input information is correct and that the phased array system is working properly must be checked.

Select the Angle-beam cursor and adjust its position so that it displays A-scan information for the 45° angle of refraction or the minimum angle that will be used in the sectorial scan.

Using the 100mm radius on the IIW block, peak the signal shown on the A-scan display. Note: Although the sectorial scan may indicate higher amplitude responses from other angles, only use the A-scan response associated with the 45° angle of propagation.

Indicate the beam exit point on the transducer wedge. This beam exit location is only valid for the 45° angle of propagation.

Using the primary angle of beam refraction exit location, measure the actual angle of propagation by peaking the response in the A-scan display using the plexiglass insert on the IIW block. Record the actual angle of propagation as indicated on the IIW block using the beam exit point location.

If the measured angle of propagation is 45° ±2°, then critical focal-law parameters are correct.

If the measured angle of propagation is outside the allowable tolerance (45° ±2°), then all transducer and setup parameters must be reviewed for accuracy. If these parameters are correct, then check the shear-wave velocity value used for the material. If this is correct, then small adjustments must be made to the transducer-wedge velocity entry. If the measured angle is too high, then the wedge velocity must be increased slightly, and repeated. Similarly, if the measured angle is too low, then the wedge-velocity parameter must be lowered and repeated until the measured angle is within tolerance.

**Time-Base Verification**

Position the angle cursor and adjust its position so that it displays A-scan information for the 45° angle of refraction.

Place the transducer so that reflections from both the 2- and 4-in. radius reflectors on the IIW block are peaked and observed simultaneously on the A-scan display.

Use the A-scan cursors to measure the distance between the 2- and 4-in. signals. This result shall be 2 in. ±0.1 in.

If the measured separation between the signals is too large (greater than 2.1 in.), decrease the shear- velocity parameter under the part setup menu. Similarly, if the measured distance is too short (less than 1.9 in.), increase the velocity value. Repeat adjustment until an acceptable value is achieved.

With the transducer remaining in the peaked position, measure the metal path of the 4 -in. radius reflector using a cursor in the A-scan display.

The value should measure to be 4 in. ±0.1 in. If this measurement is less than 3.9 in., increase the value of the Delay parameter until the measurement is correct. If this value is greater than 4.1 in., decrease the delay parameter until the measurement is correct. The requirements for focal law verification, time base verification and sensitivity adjustments are listed below.  Instrument linearity verification and ultrasonic beam spread is not required.

As an alternative, other calibration blocks may be used to perform the time-base or wedge-delay calibration.

**Velocity Calibration**

Velocity calibration is achieved by using the two radius of the calibration block. The index point of the wedge shall be set to 50mm or 100mm (depending upon the calibration block used) from the curved surface of the calibration block, and two reflections shall be obtained to allow the velocity calibration.

**Wedge Delay**

Wedge delay calibration shall be performed using the 3mm Ø SDH, which is approximately one-half the thickness of the component to be examined, or within the zone of material to be examined.

**Sensitivity Calibration**

Sensitivity calibration using the relevant 3mm Ø SDH of the calibration block, as specified in the technique sheet shall be used for the linear and sectorial group calibrations. Select a calibration reflector, which is approximately one-half the thickness of the component to be examined, or within the zone of material to be examined.

Peak up this signal from the calibration reflector and scan the phased array probe backwards through all the different angles or focal laws.

Scan forward over the calibration reflector through all the refracted angles or focal laws. The OmniScan system will calculate the required gain needed at each focal law to adjust the amount needed.

**TCG Calibration**

TCG calibration for each of the groups using the calibration block with three SDH's of a specific diameter, as per the technique sheet, positioned at ¼T, ½T & ¾T. The TCG level shall be set to 80% FSH (with ±5%). The inspection sensitivity shall be set as TCG gain + 6dB.

## 7.6 WELD EXAMINATION

Prior to commencing the examination, the technician and client shall identify the welds to be examined, review the weld design, dimensions and determine the applicability of the specific scan plan.

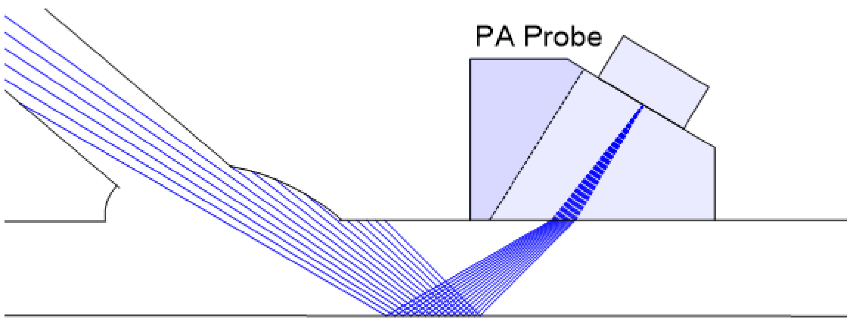
All Phased Array examinations shall be performed in "full RF A-Scan" data collection mode and stored for post processing, evaluation and archival.

**Scanning Normal to the Weld**

The probe(s) or transducer(s) is directed 90° to the weld centreline and moved so that the Phased Array beam passes through all the inspection volume. This is accomplished by an electronic raster or sectorial scan.

For Phased Array exams and when possible, the weld should be scanned from both sides of the weld.

**Scan No 1 – Example beam plot of sectorial scan**



**Scanning Speed and Overlap**

Data collection shall be adequate to ensure 100% coverage with a minimum of 25% overlap however, typically the smallest possible indexing is used; i.e. 2mm which far exceeds code requirements of 10%

A maximum of 5% of the total number of lines collected in one single scan may be missed but no adjacent lines shall be missed.

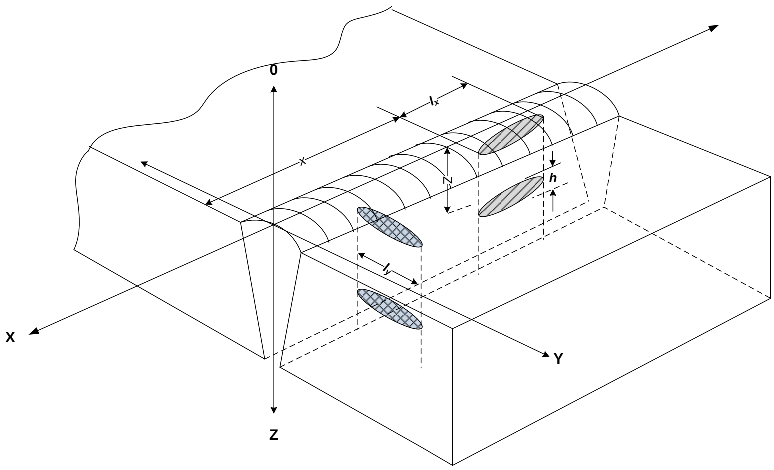
**Access Restrictions**

Any area which can't be fully inspected by PAUT must be inspected with manual conventional Ultrasonics, as per Sparrows conventional UT procedure. Any restrictions will be included in the final PAUT report.

## 7.7 LOCATION AND SIZING OF IMPERFECTIONS

Imperfections can be located either longitudinally or circumferentially with the aid of a calibrated encoder. This shall determine the location of the imperfection by positioning the indication at a given point on the C-scan (or top view scan). Since the angles of the Phased Array probe are known, it is possible to accurately volumetrically position and size defects using the S-and B-scan scan images.

Flaw sizing, is normally performed by measuring the vertical extent (in the case of cracks) or the cross-sectional distance (in the case of volumetric /planar flaws) at the 20 dB levels, once the flaw has been isolated and the image normalized. The depth and or extent of anomaly is determined using two Cartesian cursors to measure a tip-diffracted signal or corner trap signal from one end of the flaw and its separation or distance (Delta) from the tip-diffracted signal produced by the opposite end of the flaw. The length of a flaw is determined using the 6dB drop technique.




Unless otherwise specified by the client, the method employed shall be appropriate to the size, type and orientation of the reflector.

Unless otherwise specified by the client, the following shall be used;

As per BS EN ISO 13588 estimates of indication height shall be made using the -6dB drop as determined from the S-scan or B-scan. This is suitable for large planar flaws with extents greater than the beam. For flaws with dimensions smaller than the beam a correction for beam divergence may be used to improve sizing estimates.

The through wall extent (TWE) of any indications may be cross-checked / assessed by manual ultrasonics in compliance with Sparrows UT procedure.

**Assessment and Recording**

Data shall be recorded in an unprocessed form. A complete data set with no gating, filtering or thresh holding for response from examination volume (weld plus heat affected zone) shall be recorded in the data record.

Geometric indications: generally, certain metallurgical discontinuities and geometric conditions may produce indications that are not relevant. Classification of an indication as geometric shall be through the following steps:

Indications that are determined to originate from surface configuration such as weld reinforcement or root protrusion, may be classified as geometric indications and these indications need not be characterized or sized in accordance with the flaw sizing criteria stated in this procedure.

The maximum indication amplitude and location of indication shall be recorded. As a minimum the indication amplitude with respect to TCG, location with respect to weld centre line and pipe circumference and length shall be recorded.

Any indications exceeding 20% FSH of the TCG shall be assessed in terms of the location, length and height.

**Flaw height**

Using the Omniscan in the “S” scan image, position the angle curser on the flaw image such that a maximized signal from the flaw image is displayed in the A scan view. Move the angle cursor towards top or bottom such that the cursor is touching the flaw edge and the A-scan indication is dropped by 20 dB. Place a curser so that it intersects with the angle cursor at that point. Repeat the same procedure for the other edge (either top or bottom) of the flaw image. The measured vertical distance between the two Cartesian cursers as displayed in the measurement information bar is the actual flaw height or thickness.

**Measure flaw length**

Use either the “A” scan 6db drop off method, or the “B” scan image. In the “B” scan image, position one vertical curser at one end of the flaw and a second vertical curser at the opposite end of the flaw. The measured distance between the two vertical cursers as displayed in the measurement information bar is the actual flaw length. For flaw sizing using the Tomoview or Omni-PC latest software, consult the current procedure as contained in the latest manual version.

If necessary, employ alternate NDE methods for verification.

Note: It is recommended that maximum amplitude be used for the length assessment slag inclusion defects as the multi facet nature the 6dB drop method might undersize the defect.

- Planar
- Volumetric
- Surface breaking
- Subsurface
- Geometry

**NOTE:** The aforementioned methods are used only when no client requirement has been specified.

## 7.8 TECHNIQUES

Sparrows shall apply this procedure in conjunction with the appropriate specific technique sheet detailed in Appendix 2, which are based on the requirements of BS EN ISO 13588.

Where required, by the client, additional 'job specific' technique sheets shall be compiled and issued to address any differing parameters that may be applicable. These technique sheets shall overrule Appendix 1 and must be read in conjunction with this procedure.

Technique sheets shall be compiled and/or approved by personnel qualified to at least Level 2 in the appropriate method, sector & category.

The numbering system to be used for specific techniques is detailed in Appendix 2 of this procedure.

The technique shall supply the following information: -

- Description
- Joint type
- Thickness range
- Reference number (See Appendix 1 for numbering system to be used)
- Probe and Shoe type
- Element number, size and pitch
- Probe frequency
- Scan type (Sectorial or Linear)
- Beam type
- Index offset
- Start element
- Active elements
- Angle minimum and maximum
- Angle step
- Focal laws
- Test temperature
- Reference sensitivity
- Scanning sensitivity

**NOTE:** The 'record and reject levels' form part of the standard on which the techniques are based, and these must be referred to.

# 8 ACCEPTANCE CRITERIA

The specific acceptance shall be supplied by the client prior to the commencement on testing and shall be referenced within appendix 1.0 - Client / Contract Specific References. ***All indications shall be cross checked by manual UT using a 2 MHz shear wave probe.***

**Storage**

Copies of reviewed and approved Inspection / test reports shall be retained within the Project file for a period of one year, thereafter stored in archive for a period of five years. In addition, all raw data to be backed up and stored electronically on a daily basis. The weld scanning data shall be presented to the client.

All raw PAUT data shall be submitted to the client on either a USB drive or external hard drive, complete with a copy of 'Olympus Tomoviewer' software which will permit basic analysis.

All PAUT data shall be in a recordable form which will have been captured either by a calibrated wheel encoder or recorded in time, which is a feature of the Omniscan software.

## 9 APPENDICES

Appendix 1 - Client / Contract Specific references
Appendix 2 - Index of Technique Sheets
Appendix 3 - Acceptance Criteria
Appendix 4 - Phased Array Report Format
Appendix 5 - Reference Blocks

## APPENDIX 1 - CLIENT / JOB SPECIFIC REQUIREMENTS

This section is included to allow details of specific Client requirements to be placed in this document.

| **Project Specific References** | |
|---|---|
| Client | |
| Project | |
| Scope of work | Phased Array Ultrasonic Testing as per client instruction |
| Project reference | |
| Procedure in accordance with international standard | BS EN ISO 13588 and ISO/DIS 20601 |
| Client specification | |
| Extent of inspection | As per above Specifications |
| Acceptance criteria | As per above Specifications |
| Specific technical requirements | ***All indications shall be cross checked by manual UT using a 2 MHz shear wave probe.*** |
| Additional project requirements | As per above Specifications |

## APPENDIX 2 – INDEX OF TECHNIQUE SHEETS

### 1.0 Technique Numbering

Technique numbering is generated as detailed in the example below;

Example: INS02tsPA0025U

### 2.0 Index of Techniques

The techniques that form Appendix 2 of this procedure are listed below;

| Technique No. | Application |
|---|---|
| INS02tsPA0025U | TSA Coated Welds - ***Example*** |

# Technique No. INS02tsPA0025U

| | | | |
|---|---|---|---|
| Description | Thermal Sprayed Aluminium Welds | | |
| System | Various | | |
| Material type | Carbon Steel | Dimensions | Material thickness ≥ 5.0mm |

| | | | | | | |
|---|---|---|---|---|---|---|
| Equipment | Olympus Omniscan SX2 or equivalent | Note | This technique is applicable to the equipment & probe/shoe specified only. | | | |
| Probe – **Scan ref 1** | 2L8-DGS1 | Elements | 8 | Pitch | 1.0mm | |

**Equipment Parameters**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Tx/Rx | Filter | None | Scan factor | 1.1 | Cal block | EN ISO No. 1 |
| Frequency | 2.0 MHz | Rectifier | FW | TCG | 3.0mm SDH | Ref block | Appendix 5 |
| Energy | 80 v | Video filter | On | Index Point | Auto | Ref sensitivity | 80% FSH |
| Pulse width | 100 ns | Averaging | 1 | Sum gain | Auto | Scan sensitivity | +6 dB (min) |
| PRF | 15 | Reject | 0 % | Focus depth | 20mm | | |

| | | | |
|---|---|---|---|
| Test temp | 5 - 30° C | Couplant | Water or Ultragel |

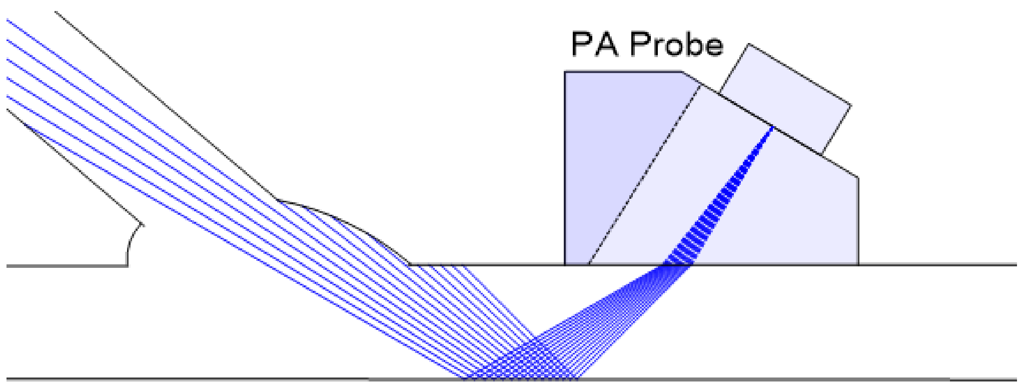
**Test techniques**

| Scan Ref | Scan type | Beam type | Index offset | Start element | Active elements | Angle - Min | Angle - Max | Angle - Step | Focal laws |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Sectorial | Shear Wave | As per Scan ref 1 | 1 | 8 | 45° | 60° | 1° | 16 |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |

**Notes**

| | |
|---|---|
| 1 | A minimum overlap of adjacent scans of 10mm should be made |
| 2 | All Phased Array scans to shall be performed in the “full RF A-Scan” mode |
| 3 | Test parameters detailed may be modified as necessary to optimise system performance. |
| 4 | **All indications shall be cross checked by manual UT using a 2 MHz shear wave probe.** |
| 5 | |

**Scan ref 1**




**Surface Requirements**

| | | | |
|---|---|---|---|
| Cleaning required | All surface contamination to be removed | Surface finish | Smooth |

**Technique Approval**

| | | |
|---|---|---|
| **Approved by**<br>D. Kinsella.<br>IEng. FIAQP. MBINDT | **Qualification**<br>BS EN ISO 9712 Level 3 UT, PA, TOFD | **Date**<br>25th March 2019 |

## APPENDIX 3 – ACCEPTANCE CRITERIA (TO BE INSERTED HERE)

## APPENDIX 4 – PAUT REPORT FORMAT (TO BE INSERTED HERE)

## APPENDIX 5 – REFERENCE SAMPLE