Ultrasonic Testing Procedure

Butt weld, 60° single-V, 2 × 10 mm structural steel — training sample for the UT-Trainer

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Prepared	Reviewed / approved	Effective
Level 2	Level 3	

Note: This is a training sample. It shows the structure and content of a typical written procedure and does not replace the applicable standards or client and code requirements. Limits taken from standards must be checked against the current standard before use.

1 Purpose and scope

This procedure specifies the manual ultrasonic testing (pulse echo, contact technique, angle beam probes) of the butt weld of two 10 mm structural steel plates with a 60° single-V preparation. The weld metal and the heat-affected zone are tested for longitudinal imperfections (lack of fusion, root defects, slag, porosity). In the UT-Trainer this is the specimen “V-Weld”.

2 Standards and reference documents

- ISO 17640 — Ultrasonic testing of welds: techniques, testing levels and assessment
- ISO 11666 — Ultrasonic testing of welds: acceptance levels
- ISO 23279 — Characterization of indications in welds
- ISO 16810 / ISO 16811 — General principles, sensitivity and range setting
- ISO 2400 (calibration block No. 1) and ISO 7963 (calibration block No. 2, “V2”)
- ISO 9712 — Qualification and certification of personnel
- UFD 900 instrument manual

3 Personnel

- Testing is carried out by personnel certified to UT Level 1 working to this procedure.
- Calibration, evaluation and reporting are the responsibility of personnel certified to UT Level 2.
- The procedure itself is written by Level 2 and approved by Level 3.

4 Equipment and probes

Item	Requirement
Flaw detector	UFD 900 (or UT-Trainer), A-scan, gain in steps ≤ 2 dB, reject off
Main probe	Angle probe 70°, 4 MHz, crystal 8 × 9 mm — common for 8 to 15 mm wall thickness
Second angle	Angle probe 60°, 4 MHz, 8 × 9 mm — meets the 30° fusion face at right angles (side-wall fusion)
Couplant	Oil, gel or paste — the same for calibration and testing
Calibration block	V2 (ISO 7963) for range, probe delay, index point and angle
Reference block	Plate of the same thickness (10 mm) and material with a Ø 3 mm side-drilled hole at 5 mm depth (in the UT-Trainer: right plate, 45 mm beside the weld)

5 Scanning surfaces and examination volume

- Scanning surface: top of the plates on both sides of the weld, free of spatter, scale and loose rust.
- Examination volume: weld metal plus at least 10 mm of parent metal (HAZ) on each side.
- The weld cap stays in place; testing uses the half and the full skip from both plates.

6 Range calibration

1. Angle probe on the V2: peak the echo from the R25 radius, CAL PROBE with the R25 echo and the following echo → sound velocity (steel, shear wave ≈ 3250 m/s) and probe delay.
2. Read the index point (X-value) at the centre mark of the V2; determine the probe angle on the Ø5 hole.
3. RANGE 80 mm sound path: the first, second and third leg are then on the screen (see table 1).

7 Sensitivity: DAC over half and full skip

The reference reflector is the Ø 3 mm side-drilled hole. As indications may lie in the first leg (before the half skip) and in the second leg (between half and full skip), the DAC curve must cover the whole range of sound paths used. The hole at mid-thickness is hit once in every leg:

1. DAC/AVG key, then BUILD DAC: start the DAC recording.
2. First leg (direct): choose the probe distance with the highest hole echo, Gate A over it, ↑ saves — the instrument sets this first echo to 80 % screen height.
3. Second leg (after one bounce off the bottom surface) and third leg (after the full skip): peak the echo each time, Gate A over it, ↑.
4. Finish with Enter. The GL curve joins the three echo peaks; it drops with the sound path.
5. Determine the transfer correction (difference in coupling and attenuation between reference block and test object) and enter it as TRANSFER.

In the UT-Trainer (70°, 10 mm) the hole echoes appear at probe distance a ≈ 57 / 85 / 111 mm (sound path ≈ 12 / 41 / 70 mm). Exercise 8 in the Exercises tab guides you through exactly this recording.

8 Test sensitivity and levels

Item	Requirement
Reference level H0	DAC curve of the Ø 3 mm side-drilled hole (+ transfer correction)
Scanning sensitivity	H0 + 6 dB (search allowance, SCAN)
Evaluation level	H0 − 14 dB (acceptance level 2 to ISO 11666) — indications above it are investigated
Recording level	Acceptance level − 4 dB — indications above it are entered in the report
Acceptance level (8 ≤ t < 15 mm)	Length ≤ t: H0 − 4 dB; length > t: H0 − 10 dB
Signal-to-noise	Noise at least 12 dB below the evaluation level

The values in rows 4 to 6 reflect ISO 11666, technique 1 (Ø 3 mm side-drilled hole), acceptance level 2 to the best of the author's knowledge and must be confirmed against the current standard before use. Project requirements take precedence.

9 Scanning

- From both plates, beam across the weld, with 70° and 60°.
- Move the probe in a raster between half-skip and full-skip distance (table 1), swivelling ± 10° to 15°.
- Overlap of adjacent passes at least 10 % of the crystal width, scanning speed max. 150 mm/s.
- Transverse imperfections (if required): probe on the ground weld or at an angle to the weld in both directions.

Table 1 (T = 10 mm)	**70°**	**60°**
Skip distance, half skip T·tan β	27.5 mm	17.3 mm
Skip distance, full skip 2·T·tan β	54.9 mm	34.6 mm
Sound path, half skip T / cos β	29.2 mm	20.0 mm
Sound path, full skip 2·T / cos β	58.5 mm	40.0 mm

10 Evaluation of indications

1. Peak every indication above the evaluation level (optimise distance and swivel) and read the echo height in dB relative to the DAC (measuring line: rating against the reference curve).

2. Locate it: sound path s, surface distance p = s·sin β, depth in the first leg t = s·cos β, in the second leg t = 2T − s·cos β.

3. Size the length with the 6 dB drop method: move the probe along the weld until the echo drops to half its height — on both sides; the distance between the two probe centre positions is the indication length.

4. Characterise (planar / volumetric) with both angles and from both sides (ISO 23279): lack of side-wall fusion gives a clearly higher echo when the beam meets it squarely (60°), slag and pores hardly react to angle and side.

5. Compare with the acceptance levels (section 8) and enter the result.

11 Calibration checks

- Check range and sensitivity before starting, at least every 4 hours, after any change of instrument, probe or cable and at the end.
- Sensitivity deviation > 4 dB or range deviation > 2 % of the range: recalibrate and retest all welds tested since the last valid check.

12 Report

Results are entered in the test report to annex A. The report contains at least: test object and weld, procedure and testing level, instrument and probes, calibration and sensitivity (DAC points, transfer correction, search allowance), scan plan and areas not tested, all recordable indications with position, length, echo height and assessment, overall result, name, level and signature.

Sources and practical examples

- Pallakki NDT, Ultrasonic Examination Procedure PNEC/UT/01 (ASME V): www.pallakkindt.com/images/service/UTprcedure.pdf
- BINDT, PCN Appendix C1 (ISO 17640, sample instruction and data sheet): www.bindt.org/downloads/PCNGENC1.pdf
- TWI, Manual ultrasonic inspection of thin metal welds: www.bindt.org/downloads/NDT2012_1A2.pdf

Annex A — Ultrasonic test report for a butt weld

Report No.		Date	
Client		Component / drawing	
Weld No.		Material / thickness	Structural steel / 10 mm
Weld type	60° single-V, welded from one side	Procedure	UT-VN-01 Rev. 0
Standards / level	ISO 17640 testing level B / ISO 11666 acceptance level 2	Surface condition	

Instrument	Type	Serial No.	Couplant
UFD 900			

Probe	Angle	Frequency	Crystal	Probe delay (µs)	X-value (mm)	Measured angle
1	70°	4 MHz	8 × 9 mm			
2	60°	4 MHz	8 × 9 mm			

Calibration	70°	60°
Calibration block / range	V2 / 80 mm	V2 / 80 mm
Reference reflector	SDH Ø 3 mm, 5 mm deep	SDH Ø 3 mm, 5 mm deep
DAC point 1 (1st leg): sound path / gain		
DAC point 2 (2nd leg): sound path / gain		
DAC point 3 (3rd leg): sound path / gain		
Transfer correction (dB)		
Scanning sensitivity (dB)	H0 + 6 dB =	H0 + 6 dB =
Evaluation / recording level	H0 − 14 dB / H0 − 8 dB (l ≤ t)	H0 − 14 dB / H0 − 8 dB (l ≤ t)

Scan plan (sketch): scanning sides, directions, half/full skip, areas not tested:

No.	Probe / side	Position y from – to (mm)	Length (mm)	Sound path s (mm)	Surface dist. p (mm)	Depth t (mm)	Echo vs DAC (dB)	Type (planar / volumetric)	Assessment
Ex.	*70° / right*	*170 – 178*	*8*	*31.5*	*29.6*	*≈ 9.2 (2nd leg)*	*−6*	*volumetric*	*acceptable (l ≤ t, below H0 − 4 dB)*

Overall result: ☐ acceptable ☐ not acceptable ☐ further testing required

Operator (name, level, cert. No.)	Evaluation (name, level)	Date / signature	Acceptance / client