AUT QUANTIFICATION METHODOLOGY

METHODOLOGY 3

Methodology for Practical Trials and Destructive Validation

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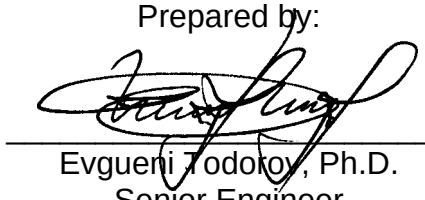

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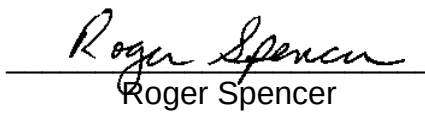

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MATERIALS JOINING TECHNOLOGY

Methodology for Practical Trials and Destructive Validation

1.0 Scope

1.1 This methodology describes important steps and responsibilities for preparing, conducting, and assessing the automated ultrasonic testing (AUT) practical quantification trials. It also describes the steps to validate the AUT measurements through destructive testing as part of the quantification process.

1.2 Practical trials described in this methodology shall be conducted after review of the TJ by the administrator(1) using specimens designed and fabricated to meet the quantification objectives.(2)

1.3 The quantification administrator is responsible for conducting the quantification process through TJ and practical trials. Under certain circumstances, the AUT procedure and equipment may be quantified through TJ and open trials; however, the complete AUT system (procedure, equipment, and AUT operators) will be quantified through TJ and blind trials. The balance between the TJ and practical trials depends on many factors.(1)

1.4 The administrator is responsible to assure that practical trial activities are monitored by suitably qualified and experienced personnel.

2.0 General Requirements to AUT Procedure and Operators during Practical Trials

2.1 The detectability and false positive frequency will be affected by the flaw decision recording (and/or reporting) threshold level used during the trials. If performance of various AUT vendors is compared, the administrator shall ensure that comparisons are accomplished at equivalent threshold levels to allow a fair and valid comparison.

2.2 A low echo-amplitude decision threshold, slightly above the noise level, should be used. However, very low thresholds will increase the probability of false positives (PFP). Several scans with different thresholds might be used to optimize the ratio of detectability to false positive.

2.3 The weld circumference shall have markers to verify the scanner position and accuracy. The circumferential positioning reference point (e.g., start or “0” degree) shall be marked on the specimens in a manner that does not interfere with the scanning and signal interpretation.

2.4 The quantification process may be part of a larger AUT qualification program in which repeatability demonstrations may be required by the Contracting Party. These repeatability demonstrations typically include scans to evaluate: scanner band placement, reverse scanning, temperature effects, deviations in calibration responses, etc. It is recommended that repeatability demonstrations be performed prior to quantification scans to help detect system anomalies that could impact quantification results.

2.6 The AUT vendor shall ensure that the required AUT operators, specified by the Contracting Party, are included in the quantification practical trials.

3.0 Procedure to Conduct Practical Trials

Open and blind trials should be separated. There are different requirements for both types. Open and blind trials generate different estimates for POD and sizing.

3.1 Preparation for practical trials

3.1.1 The TJ and any other required documentation shall be reviewed and approved by the administrator prior to conducting practical trials.

3.1.2 The administrator shall coordinate access to the specimens to assure that scanning can be performed in a timely manner. Likewise, the administrator shall insure that the AUT operators have access to electricity and a water supply as needed.

3.1.2 The administrator shall verify that AUT equipment and personnel are correct.

3.1.3 The administrator will give a short briefing to AUT operators regarding how the trials are to be performed and to answer any questions. A short instruction list will be provided to assure that all AUT operators have the same information.

3.2 Practical Trials

3.2.1 The administrator shall monitor the practical trials to assure that AUT setups and scans are performed in accordance with the approved AUT procedure. Any observed departures from the procedure or difficulties experienced by the AUT operators will be recorded and evaluated for their effect on the outcome of the practical trials.

3.2.2 The administrator shall secure all manufacturing drawings and details of flaw locations and sizes. No defect information shall be available to the AUT operators during the quantification process.

3.2.3 AUT operators shall setup and scan each weld per the approved AUT procedure. Each specimen should be scanned in the same general angular position as what is expected during construction (vertical, horizontal, etc.). The administrator may establish a suitable time limit that will be imposed on all participants during the trials. The time used to complete the practical trials will be recorded as part of the quantification.

3.2.4 No markings may be made on the specimens that could provide knowledge of flaw locations to other operators.

3.2.5 Practical trial specimens should only be available to AUT operators during the quantification process and only when the administrator's representative is present.

3.2.6 Scan files shall be clearly identifiable as to the specimen identification and AUT operator.

3.2.7 After completion of the scans, the AUT operator shall provide the administrator with a high-resolution hard copy or electronic copy of the scan results, as well as, scan data files and viewer program. The AUT operator shall provide interpretation of the AUT data in table format similar to that shown in Appendix 1 within three business days. Other reporting formats may be used if approved by the administrator.

4.0 Procedure for Conducting Destructive Measurements

4.1 The administrator shall review reports from the AUT quantification trials to ensure the accuracy and completeness of flaw circumferential position, length, height, and depth before proceeding with destructive testing.

4.2 It is recommended that destructive verification (metallographic cross-sections) be used to verify flaw depth and height. Other fingerprinting techniques may be used for flaw length measurements.

4.3 When destructive verification is used as the means for obtaining reference measurements, locations for cross-sectioning should be selected based on the circumferential location of maximum flaw height for engineering-critical assessment (ECA) applications, or maximum signal amplitude for workmanship criteria. Locations for cross-sectioning should be laid out using either a flexible tape scale that can completely wrap around the circumference, or by use of an AUT scanner that has a demonstrated error of less than ± 2 mm for the entire pipe circumference.

4.4 Each flaw should be cross-sectioned at the AUT reported maximum flaw height location and at 2 to 3 adjacent locations on each side of the maximum flaw height at intervals of approximately 3 mm or less. When flaw length is part of the sizing accuracy determination, additional cross-sections should be made near the ends of each flaw to determine the flaw length.

4.5 Each macro should be identified as to weld number, circumferential weld location (rounded to the nearest 1.0 mm) and US side of the weld. Macro surfaces should be ground and then polished to a final surface finish of 3 micron or finer. The surface should then by lightly etched using an etchant appropriate for the material.

4.6 Photographs should be taken of the polished macro surface using magnifications of 5 to 10×. Prior to taking photographs, it is recommended that the macros be viewed at magnifications up to 100× to accurately determine the full extent of flaws. Each macro photograph should contain the following:

- Weld number
- Circumferential location
- Measurements showing the depth and height of any flaws (intentional or unintentional) having a through wall height of 0.3 mm or greater and a length of at least 6 mm
- Annotation identifying the US side of the weld
- A linear reference scale
- Depth and height measurements can be rounded to the nearest 0.1 mm.

4.7 False positive indications shall be verified through destructive sectioning at locations where AUT operators reported flaws in “no-flaw” weld sectors.

4.8 After adequate validation, additional techniques may be used (e.g., high-resolution eddy current) to determine whether a flaw is fused or transparent to the acoustic energy on a macro.

4.9 At least three additional no-flaw weld sectors shall be sectioned to validate the “no-flaw” indications where the AUT operators did not report flaws in “no-flaw” weld sectors.

4.10 Flaw locations and sizes determined after destructive validation shall be arranged in table format similar to that shown in Appendix 2.

5.0 Reporting

5.1 The quantification administrator will assemble the tabulated AUT data for each operator and the destructive measurements in preparation for the statistical analysis.[3] Summary tables with data assembled by the quantification body as shown in Appendices 1 and 2 shall be included in the documentation.

5.2 Any general conclusions or observations in the tabulated data should be documented. This would include flaws that were unusually difficult to detect, flaws with relatively large sizing errors, detection of unintentional flaws, and locations with repeated false calls.

5.3 The documentation will be part of the quantification file.

6.0 References

(1) Methodology for Contents and Review of Technical Justification (TJ), Edison Welding Institute (EWI).

(2) Methodology for Design, Fabrication, and Fingerprinting of Quantification Welds, Edison Welding Institute (EWI).

(3) Methodology for Data Analysis, Edison Welding Institute (EWI).

Appendix 1 – Sample Table for Flaw Location and Size after AUT of Girth Weld Specimens

Date:
Project No.:
Weld No.:
AUT Equipment:
AUT Procedure:
AUT Operator:
AUT Vendor:
Location of Inspection:

AUT Report

Sector No.	Flaw Type	Axial Position (US/DS)	Circumferential Position (mm)		Length (mm)	Depth (mm)	Height (mm)	Amplitude (% FSH)	Detection Channel(s)	Comments
			Start	Stop						
S1	NF									
S2	Transverse Crack	US/DS	66	66	N/A	15	4.5	65	Trans.	
S3	NF									
S4	NF									
S5	Crack	US	176	208	32	11.2	2.6	88	US-F1, TOFD	
S6	NF									
S7	LOF	DS	246	254	8	4.4	2.4	78	DS-F4	
S8	NF									
S9	NF									
…	…	…	…	…	…	…			…	…

FSH – Full screen height
NF – No flaw
US/DS – Upstream (US) or Downstream (DS)

Appendix 2 – Sample Table for Specimen NDE Fingerprinting after Destructive Validation

Date:
Project No.:
Weld No.:
Laboratory Performing Destructive Validation:
Analyst:

Location and Size of Flaws after Destructive Validation

Sector No.	Flaw Type	Axial Position (US/DS)	Circumferential Position (mm)		Length (mm)	Depth (mm)	Height (mm)	Comments
			Start	Stop				
S1								
S2								
S3								
S4								
…	…	…	…	…	…	…	…	…

US/DS – Upstream (US) or Downstream (DS)