AUT QUANTIFICATION METHODOLOGY

METHODOLOGY 1

Methodology for Contents and Review of Technical Justification (TJ)

Issued by:
Edison Welding Institute

Revision: 5

Revision Date: February 18, 2011

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Methodology for Contents and Review of TJ

1.0 Scope

1.1 This methodology describes the review of documentation related to the quantification process. This methodology addresses documentation included as part of the Technical Justification (TJ) such as automated ultrasonic testing (AUT) procedure, AUT operator training and certification documentation, and AUT equipment documentation. This methodology is part of the guidelines for quantification of AUT of girth welds.(1)

1.2 The TJ documentation will be provided to the Quantification Administrator by the AUT vendor or Contracting Party.

1.3 The actual scope and content of required documentation shall be set by agreement between the Contracting Party, Quantification Administrator, and AUT vendor based on specific requirements of the pipeline project.

2.0 Contents of the TJ

2.1 At a minimum the TJ shall consist of the following:

- Introduction including a description of the inspection and quantification objectives
- AUT procedure
- Personnel certification and training information.

2.2 If the use of previous quantifications or experimental results is to be considered as a means of reducing or eliminating practical trials, the TJ shall contain relevant documentation and evidence to support this approach. In this case the TJ may contain additional documentation such as:

- Summary of input information
- Overview of AUT procedure used in previous quantification
- List of AUT essential parameters affected
- Predictions by modeling
- Experimental evidence from previous qualification/quantification activities.

2.3 In general, the TJ shall provide data and information necessary to show that there are no changes in essential variables that would significantly affect the use of previous quantification results for a current project. The TJ should provide a detailed overview of previous quantifications to be considered.

2.4 It should be noted that the items that are required in a TJ will depend on the complexity and criticality of the AUT procedure and may contain any or all of the following major sections:

2.4.1 Introduction

2.4.1.1 The introduction shall address the following:

- Girth weld joints covered by the TJ
- The purpose and scope of TJ

- Brief description of TJ major components or sections.

2.4.1.2 The inspection and quantification objectives should be described in the documentation. Following are objectives that could be applicable:

- Detection capability expressed typically in POD for certain flaw types and sizes (e.g., $\mathbf{a}_{90/95}$) and confidence in detection capability estimates
- False calls (e.g., PFP) or false positive frequency
- Flaw height, length, and depth sizing accuracy
- Location accuracy along the pipe circumference and axis
- Flaw characterization – for example, capability to discriminate between lack of fusion (LOF), cracks, and pores.

2.4.2 AUT procedure

AUT procedures shall be submitted and reviewed to determine that the AUT examination will be performed in a controlled manner that is in agreement with applicable codes, standards, or other contractual documents. Appendix 1 is provided as a list of typical essential parameters that should be addressed in the AUT procedure. The AUT vendor may be required to provide evidence on how each of the essential parameters are controlled or monitored if not clear from the AUT procedure. An AUT procedure will generally need to address the following items:

- Scope and applicability of the procedure
- Description of pipe and girth weld
    - Pipe diameter
    - Wall thickness
    - Material
    - Surface condition
    - Test temperature
    - Weld bevel design
- List of documents referenced in the procedure
- Description of equipment and materials to be used
- Calibration requirements for equipment
- Description of periodic equipment checks
- Description of AUT software and revision
- Description of output screen
- Definition of acronyms used in the procedure
- Personnel training and certification requirements
- Description of calibration samples
    - Identification of calibration samples
    - Reflector target descriptions
    - Position reference targets
    - Allowable tolerances
- Description of probe placement
- Description of scanner
    - Type and model
    - Positioning of scanner
    - Scan speed
    - Scan index increments
- Description of calibration setup

    - Description of each UT channel
    - Gate positioning and thresholds
    - Reference reflector
    - Description of probe or active element group [number of elements for phased array (PA)]
    - Beam angles
    - Wave mode
    - Exit point offset from weld centerline
    - Signal amplitude
    - Allowable tolerances for dynamic calibration scan
    - Allowable adjustments of gain, focal laws, offset, etc.
    - Overtrace (overlap) requirements
    - Calibration intervals
    - Method for couplant monitoring
- Data interpretation
    - Sizing methodologies
    - Thresholds for defect reporting
    - Inspection acceptance criteria
- Inspection of rework areas
- Data storage
- Data backup intervals
- Reporting.

2.4.3 Personnel training and certification

2.4.3.1 Previous quantification data indicate that among the three major components of the AUT process – system, procedure and personnel, the personnel is the single most critical component that affects the AUT process performance to the greatest extent. Documentation shall be provided showing that personnel performing the AUT girth weld inspection, or participating in the quantification process, comply with the following requirements:

2.4.3.1.1 AUT operators who are involved in inspection data interpretation and girth weld disposition shall be certified to at least Level 2 in the ultrasonic method according to a recognized certification standard meeting the requirements of CP-189 ANSI/ASNT or CGSB48.9712 or EN473 or ISO9712 or equivalent.

2.4.3.1.2 Operators shall also have received additional training and experience with the equipment specified in the AUT procedure.

2.4.4 Summary of relevant input information

2.4.4.1 The summary of relevant input information should describe the previous quantification under consideration such as: description of girth weld, description of flaws detected and sized, and performance data in terms of detection capabilities and sizing accuracy. It is recognized that all input parameters listed in the summary may not be available or pertinent. However, the more information that can be provided, the better will be the decision regarding acceptability of the TJ.

2.4.4.1.1 The girth weld description from a previous quantification should contain the following as applicable:

- Geometry of girth weld:
  - Pipe-to-pipe joints where diameter, thickness, and material may or may not vary through the joint
  - Other joints as applicable (e.g., tie-in configurations)
- Pipe diameter
- Thickness range
- Surface condition
- Weld crown configuration
- Weld root configuration
- Wall thickness range of straight pipe
- Weld mismatch (misalignment)
- Type of material
- Macrostructure of base material
- Macrostructure of weld
- Access restrictions
- Constraints set by weather or manufacturing process cycle.

2.4.4.1.2 The flaw description should contain the following as applicable:

- Flaw types
- Description of how flaws were introduced into quantification samples
- Flaw dimensions
  - Flaw heights
  - Flaw lengths
  - Flaw depth
- Position of flaws along the axis of the pipe with respect to the weld center line (upstream or downstream)
- Orientation of flaws with respect to the pipe axis (tilt and skew)
- Flaw surface roughness and/or branching
- Presence of unusual stresses that could affect flaw detection and sizing.

2.4.4.1.3 Predictions by modeling

Ultrasonic inspection modeling calculations may be used for the following purposes:

- Show which relevant flaws are the most difficult to detect
- Show that the most difficult flaws still generate responses above the recording level and to demonstrate the margin of detection for the probes which detect them
- Determine how changes in essential parameters may affect flaw detection and sizing accuracy established in previous quantifications
- Show that diffracted tip signals can be observed at the chosen sensitivity levels, thereby permitting flaw size measurement using methods that rely on the observation of such signals [e.g., time-of-flight diffraction (TOFD)].

The Administrator may require the AUT vendor to provide evidence in accordance with industry practices supporting AUT vendor modeling results and claims.

2.4.5 Experimental evidence

2.4.5.1 Experimental evidence submitted in the TJ may consist of the following:

- Results from practical trials associated with previous quantification efforts
- Results from round robin field probability of detection (POD) trials
- Results from experimental studies performed in the laboratory or in-field, using either fully representative or simplified test specimens
- Field experience results.

2.4.5.2 It is important that results used from pre-existing studies, field experience, other quantification exercises or previously conducted POD studies be relevant to the submitted AUT procedure. This will involve providing sufficient details for the experimental work to demonstrate that the girth weld, flaws, inspection procedure, equipment and other inspection conditions are sufficiently similar to those in the present case.

3.0 Quantification Administrator's Report

3.1 Following review of all submitted documents, the Quantification Administrator shall issue a report providing results of the documentation review. This report will be part of the project quantification file.

3.2 The report shall contain at least the following:

- Introduction
- Results of AUT procedure review
- Results of AUT operator training and certification records
- Results of TJ documentation review
- Statement in view of AUT objectives being or not being met and recommended steps to meet the objectives
- Conclusions and recommendations.

4.0 Administrator Quality Assurance

The Quantification Administrator shall ensure the personnel involved in the document review process are cognizant of the purpose, objective, and implementation of the quantification process. In addition, the Administrator's personnel involved in the review shall possess sufficient training in AUT. The report shall be reviewed and approved by a certified Level 3 specialist in the ultrasonic testing method.

5.0 References

(1) Guidance for Quantification of Automated Ultrasonic Testing Systems for Examination of Pipeline Girth Welds, Edison Welding Institute (EWI).

Appendix 1 – List of Typical Essential Parameters

Group	Essential Controls/Verifications	Typical Tolerances
Instrument	Horizontal and vertical instrument linearity	No more than 5% deviation from ideal
Probe	Probe exit point	±1 mm of designed exit point
	Beam angle	±1.5 degree of designed angle
	Pulse duration at -20 dB	2.5 µs maximum
	Beam skew angle parallel to probe length axis	±1.5 degree of intended angle
	Wedge wear pin extension	0.2 to 0.5 mm
	Beam dimension in through wall axis at zone metal path	Zone height ±0.5 mm
	Transducer identification	Serial number or other unique identification readily traceable to manufacturers documentation
Calibration Block	Target reflectors	
	Hole diameter	±0.1 mm
	Flatness of FBH	±0.1 mm
	All pertinent angles	±1 degree
	Notch depth	±0.1 mm
	Notch length	±0.5 mm
	Hole depths	±0.2 mm
	Central position of all targets	±0.1 mm
	Acoustic velocity differences between calibration block and pipe stemming from pipe production	Variations shall not result in refracted angle changes greater than 1.5 degree
Scanner	Scanner position accuracy	±10 mm over full circumference
Procedure	Zone height (zonal only)	3 mm maximum
	Signal-to-noise ratio in area of interest	10 to 1 minimum
Data Collection	Distance between recordable output	2 mm maximum

Group	Essential Controls/Verifications	Typical Tolerances
Process Control	Temperature variations between calibration block and pipe	±10°C
	Accuracy of probe offsets from weld centerline (includes total inaccuracies caused by weld shrinkage and band placement)	±1 mm
	Calibration block wear groove depth	0.5 mm maximum
	Loss of elements (PA only)	No more than 25% of active aperture elements
	Wedge wear	No wearface scoring or chipping greater than 0.5 mm in depth; or general overall wear causing a vertical height change of the wedge greater than 0.5 mm from original when measured at all four corners

Note: The essential parameters and tolerances shown in Appendix 1 are typical for AUT of girth welds. Additional essential parameters and tolerances may be specified by the governing documents or by agreement between the interested parties for the specific application.