



OPERATING PROCEDURE

Procedure No.

SES 26-702

Title

ULTRASONIC INSPECTION, STEEL, GENERAL

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1.0 PURPOSE

To provide a detailed procedure for the inspection of parts subjected to the Ultrasonic (UT) Inspection.

2.0 APPLICABILITY

The requirements of this procedure are directive in nature to all personnel involved in:

2.1 Defining design requirements for Ultrasonic Inspection.

2.2 The performance of UT inspection for the purpose of final product acceptance.

3.0 REFERENCE DOCUMENTS

3.1 SARA SAE Quality Assurance Manual

3.2 SDP-27-007, "Control of Inspection, Measuring & Test Equipment"

3.3 SDP-27-009, "Control of Nonconforming Products".

3.4 American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code.

3.4.1 Section V, Article 5, "Ultrasonic Examination Methods for Materials and Fabrication"

3.4.2 Section V, Article 23, SA-435/SA-435M, "Standard Specification For Straight-Beam Ultrasonic Examination Of Steel Plates"

3.4.3 Section VIII, Division 1, Appendix 7, "Examination of Steel Castings"

3.4.4 Specification SA 609, "Standard Specification for Longitudinal Beam Ultrasonic Inspection of Carbon and Low Alloy Steel Castings"

American Petroleum Institute Specifications (API)

3.5.1 Specification 6A, "Specification for Wellheads and Christmas Tree Equipment"

3.5.2 Specification 16A, "Specification for Drill Through Equipment"





3.5.3 Specification 8A, "Specification for Drilling and Production Hoisting Equipment"

3.5.4 Specification 8C, "Specification for Drilling and Production Hoisting Equipment (PSL-1 and PSL-2)"

(R) 3.5.5 Specification 16D, "Control Systems for Drilling Well control Equipment"

(R) 3.5.6 Specification 16C, "Specification for Choke and Kill Systems"

3.6 American Society for Testing and Materials (ASTM)

3.6.1 A-388, "Ultrasonic Inspection of Heavy Steel Forgings"

3.6.2 E-213, "Standard Procedure For Ultrasonic Examination Of Metal Pipe And Tubing"

3.6.3 E-317, "Evaluation Performance Characteristics of Pulse Echo Ultrasonic Testing Systems"

3.6.4 E-428, "Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Testing"

(R) 3.7 American Society for Nondestructive Testing (ASNT)

(R) 3.7.1 Recommended Practice SNT-TC-1A

4.0 GENERAL

UT Inspection is an approved volumetric nondestructive method for detecting discontinuities in castings, forgings and welds. The intent of this procedure is to provide the required controls for the use of UT Inspection.

5.0 RESPONSIBILITY

5.1 Design Engineering is responsible for including this procedure as a design requirement when UT Inspection is specified on product drawings. This requirement is effective with the original release of this procedure.

(R) – Indicates revised item



Note: The requirements of this procedure are not intended to supersede any UT Inspection requirements imposed by the various SARA SAE Material Specifications. Such UT Inspections shall be accomplished as required by the Material Specification.

- 5.2** Manufacturing Engineering is responsible for including this procedure as a requirement on Process Routings in accordance with design requirements.
- 5.3** Quality Control is responsible for performing UT Inspection for final product acceptance. The inspections shall be performed in accordance with this procedure.
- 5.4** The NDT Level III is responsible for approving UT Inspection Procedures, UT Inspection Work Instructions and UT Inspection Scan Sheets.

6.0 METHODS

6.1 General

- 6.1.1** UT Inspection is performed where specified by the applicable Engineering drawing, Quality Assurance Plan, or Nonconformance Report disposition.
- 6.1.2** SARA SAE personnel performing UT Inspection for final product acceptance shall be NDT Level II.
- 6.1.3** When in-process or final acceptance NDT is subcontracted, the requirements of this procedure shall be followed:
- 6.1.3.1** Technicians' qualifications shall be approved by the subcontractor's Level III and provided to the SARA SAE file in the Quality Records Department.
- 6.1.3.2** Technicians performing and/or interpreting UT inspections for final product acceptance shall be NDT Level II - UT minimum.
- 6.1.3.3** This SOP, applicable UT Inspection Work Instructions, and Inspection Scan Sheet shall be furnished to, and be used by, the subcontractor in the performance of the UT Inspection.





6.1.3.4 All subcontract UT inspection shall be accompanied by a report of Nondestructive Testing listing acceptance criteria and status.

6.1.4 Product Form. Configuration is the Engineering or process drawing. Surfaces may be in the as-cast, welded, rolled, or forged condition except where surface irregularities could mask indications or defects.

6.1.5 Equipment and Supplies

6.1.5.1 Frequency. UT Inspection shall be conducted with a pulse echo instrument capable of generating frequencies over the range of at least 1 MHz to 5 MHz.

6.1.5.2 UT equipment calibration shall be accomplished in accordance with the requirements of SOP 8.009, "Gage Control, Maintenance and Calibration Procedure."

6.1.5.3 UT equipment function and inspection calibration shall be performed as required by the applicable UT Inspection Work Instruction and UT Inspection Scan Sheet.

6.1.5.4 Search Units. Search units may be either single or dual element. Contoured contact wedges may be used to aid ultrasonic coupling. Calibration shall be done with the contact wedges used during examination.

6.1.6 UT Inspection Work Instructions/UT Inspection Scan Sheets

UT Inspection Work Instructions and UT Inspection Scan Sheets shall be developed to provide specific information and techniques for products and welds subjected to UT Inspection. The Work Instructions and Scan Sheets shall identify (a) the Calibration Block to be used for the UT Inspection, (b) the calibration method to be used, (c) part preparation requirements, and (d) the scanning method(s) to be used. The Work Instructions and Scan Sheets shall be approved by the NDT Level III.



**6.2 Procedure****6.2.1 Calibration Blocks****6.2.1.1 Design, Manufacture and Certification**

Calibration blocks shall be designed, manufactured and certified in accordance with:

- (A) ASTM E-428, "Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Testing"
- (B) ASME Specification SA-609, "Standard Specification for Longitudinal Beam Ultrasonic Inspection of Carbon and Low Alloy Steel Castings"
- (C) Special requirements not covered by the above specifications.

The design, manufacture and certification of the calibration blocks shall be approved by the NDT Level III.

6.2.1.2 Type and Quantity of Calibration Blocks

Calibration Blocks of sufficient type and quantity to meet the materials/welds to be UT Inspected shall be available for use.

The type and quantity of Calibration Blocks shall be approved by the NDT Level III

6.2.2 Evaluation**6.2.2.1 Relevant Indication.** An indication is considered relevant and must be investigated if:

- A. The indication cannot be explained by or attributed to part geometry.
- B. The screen presentation of the indication is more than 20% of the DAC.



All indications which produce a response greater than 20% of the primary reference level are investigated to the extent that the operator can evaluate the shape, identity and location of all such reflectors. In the event that the gain has been increased to aid detection of reflectors, evaluation of all such reflectors will be performed at the primary reference level (dB).

- C. A 50% loss of backwall is observed (using the straight beam backwall method).

6.2.3 Sequence Of Inspection/Areas To Be Inspected

- 6.2.3.1 UT inspection for final acceptance shall be performed after all welding, heat treatment/postweld (stress relieve) heat treatment, and machining operations are completed with the following exception:

Exception - API 6A, PSL 3 and 4 body, bonnet, stems, end and outlet connection base material volumetric examination shall be performed after heat treatment for mechanical properties (exclusive of stress relieve treatments) and prior to machining operations that limit effective interpretation of the examination.



- 6.2.3.2 Welds and base metal shall be UT inspected when required by the applicable Engineering drawing, Quality Assurance Plan, or Nonconformance Report.
- 6.2.3.3 The UT Inspection shall be performed in accordance with the applicable UT Work Instruction and UT Inspection Scan Sheet.

6.3 Acceptance Criteria

6.3.1 Pressure Containment Welds

- 6.3.1.1 Relevant indications which produce a response greater than 20% of reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all

such indications and evaluate them in terms of the acceptance standards given below.

6.3.1.2 Relevant indications characterized as cracks, lack of fusion, and of incomplete penetration are unacceptable regardless of length.

6.3.1.3 Other relevant indications are unacceptable if the indication exceeds the reference level amplitude and has lengths which exceed:

(A) 1/4 in. for t up to 3/4 in.

(B) 1/3 t for t from 3/4 in. to 2-1/4 in.

(C) 3/4 in. for t over 2-1/4 in.

where t is the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld, t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included in t .

6.3.2 Castings, Forgings and Valve Stems where DAC Calibrations are employed.

6.3.2.1 No single relevant indication exceeding the DAC curve.

6.3.2.2 No multiple relevant indications exceeding 50% of reference DAC curve. Multiple indications are defined as two or more indications (each exceeding 50% of the reference DAC curve) within 1/2 inch of each other in any direction.

6.3.2.3 API 6A, PSL 4 - Gate Valve Bodies, Bonnets, and End and Outlet connections; Casing and Tubing Hanger Mandrels

(A) Same acceptance criteria as in 6.3.2.1 and 6.3.2.2 with the following addition:

(1) No continuous cluster of indications on the same plane regardless of amplitude



found over area twice the diameter of the search unit.

6.3.2.4 Angle Beam - A forging shall be unacceptable if it contains reflectors that produce indications that exceed the reflections from the ID/OD reference notches.

6.3.3 Forging inspections where back reflections are employed as calibration reflectors for straight beam examinations.

6.3.3.1 Straight Beam - A forging shall be unacceptable when one or more reflections are present producing indications accompanied by a complete loss of back reflection, where the back reflection loss is not attributable to nor associated with the geometric configuration of the part. For this purpose, a back reflection of less than 15% full screen height shall be considered a complete loss of back reflection.

6.3.3.2 Angle Beam - A forging shall be unacceptable if it contains reflectors that produce indications that exceed the reflections from the ID/OD reference notches.

6.4 Data Reporting

6.4.1 Acceptance of the UT Inspection shall be documented by:

6.4.1.1 Completing entries on the Router NDE form, and

6.4.1.2 Entering an inspection stamp impression or signature and date on the appropriate Router operation.

6.4.2 Nonconforming parts shall be reported on an NCR in accordance with SDP-27-009, "Control of Nonconforming Products" The report shall include an exact description of the nonconformance.

