



Qualification of NDE Procedure and NDE Personnel Specification

03.01.15-Qualification_of_NDE_Procedures_and_NDE_Personnel-
Specification



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Document History

Version No.	Date	Author	Approver	Description of Amendment
1.0	04-03-22	Manas Behera	Mahmood Al Amri	First Issue



1.0 Purpose

The purpose of this specification is to establish the minimum technical requirements for the detection of flaws on materials and welds by NDE, that are needed for the design and fabrication of equipment and piping. The Contractors' NDE work shall meet the requirements of this specification.

This specification designates the requirements for non-destructive examination (NDE) methods and techniques that are accepted by the Company. Deviations from this specification require Company approval.

2.0 Scope

This document is approved by the <Concerned N-2/ Process owners> and applies to Company Group of companies.

This specification provides the additional requirements for NDE procedures, procedure qualification and NDE personnel qualification for welded joints and base materials. The extent of testing shall be defined in Company specifications for each item/component.

This specification provides additional requirements to ASME BPVC Section V.

Examination of butt welds shall be according to ISO 17635 table 3. Methods in parentheses require Company consent and approval, except for phased array ultrasonic testing (PAUT) per reference of paragraph 6.6 of this specification.

This document aims to outline the Business Processes Steps, Roles and Responsibilities, handover points required to complete the process, Interfaces, and Systems. In addition to the Reports, Forms, Requirements, and Data inputs.

3.0 Confidentiality and Distribution

- This document is the property of Company Group of Companies. Unless otherwise authorized by the Company, the distribution and use of this specification is limited to Company authorities and the Contractors' nominated by the Company. Unauthorized sharing is strictly prohibited, and Company shall not bear any responsibility further.
- This document should be part of the ITT/Contract and thus becomes a contract requirement for the Contractor / Vendor to comply with as applicable.
- This document shall be revised only by the document custodian that is Company Projects, CoE team.



4.0 Abbreviations

Abbreviation	Meaning
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASTM	American Society for Testing and Materials
AVL	Approve Vendor List
BPVC	Boiler and Pressure Vessel Code
CS	Carbon Steel
DN	Diameter Nominal
HAZ	Heat Affected Zone
ISO	International Standards Organization
NDE	Non-Destructive Examination
NPS	Nominal Pipe Size
PO	Purchase Order
PQR	Procedure Qualification Record
PWHT	Post Weld Heat Treatment
SS	Stainless Steel
WPS	Welding Procedure Specification
ToFD	Time of Flight Diffraction
PAUT	Phased Array Ultrasonic Testing
PCS	Probe Centre Separation
FSH	Full Screen Height



Abbreviation	Meaning
DAC	Distance Amplitude Correction

5.0 References

For this specification, reference is made to the following codes, standards and Company specifications. Unless specifically designated by date, the latest edition of each publication shall be used together with any amendments.

The Clause numbering in this document (mainly in Annex A), follows that of ASME BPVC Section V. Clauses of ASME BPVC Section V that are neither amended nor supplemented by this specification shall apply in their entirety.

The Codes, Standards and Specifications listed in this clause form an integral part of this specification. The metric system of units (Bar, as pressure unit) shall be used for the design and for information on all relevant documents.

5.1.1 Codes and standards

Code / Standard	Description
ASME BPVC Sec VIII, Div 1	Rules for Construction of Pressure Vessels
ASME BPVC Sec VIII, Div 2	Alternative Rules for Construction of Pressure Vessels
ASME BPVC Sec V	Non-destructive Examination
ASNT SNT-TC-1A	Examination Personnel Qualification and Certification
ISO 17635	Non-destructive testing of welds – General rules for metallic materials
ISO 9712	Non-Destructive Testing - Qualification and Certification of Personnel
ISO 13588	Non-destructive testing of welds – Ultrasonic testing – Use of automated phased array technology
ISO 10863	Non-destructive testing of welds - Ultrasonic testing - Use of time-of-flight diffraction technique (TOFD)
ISO 22825	Non-destructive testing of welds - Ultrasonic testing - Testing of welds in austenitic steels and nickel-based alloys



Code / Standard	Description
ASTM E2339-15	Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)
ASTM E2445	Standard practice for performance evaluation and long-term stability of computed radiography systems
ASTM E2700	Contact UT of welds using phased arrays

5.1.2 Definitions

Definitions supporting this document shall be consulted from ASME V Glossary of terms Article 1 Mandatory Appendix I.

6.0 NDE Procedure Qualification requirements

Amendments and supplements to ASME V BPVC have been included in Appendix A, as it was necessary to incorporate special Company Plants Facilities requirements.

6.1 Visual Examination

After completion of welding all welds shall be visually inspected following ISO 17637 and additional requirements specified in Annex A of this specification.

6.2 Magnetic particle testing

Magnetic Particle Examination shall be performed either by AC Electromagnet or Permanent Magnet with the application of fluorescent or non-fluorescent particles on the test surface. This Magnetic Particle Examination specification shall be applied for detecting discontinuities, which are on the surfaces of ferromagnetic materials (including but not limited to wrought/cast products and welds).

Typical types of discontinuities that can be detected by this method are cracks, laps, seams, cold shuts, and laminations, etc.

Magnetic Particle Examination shall be conducted in accordance with the ASME BPVC Section V and Appendix A of this specification.

6.2.1 Acceptance criteria

Acceptance criteria for magnetic particles shall follow T-780 of ASME BPVC V and ASME BPVC VIII Div 1 Appendix 6 or EN 13445 and ISO 23278 (when reference by design code).

6.3 Penetrant testing

Penetrant Examination shall be performed either by the Non-fluorescent or fluorescent color contrast penetrant method. This Penetrant Examination specification shall be applied for detecting discontinuities, which are on the surfaces of nonporous materials and other materials (including but not limited to wrought/cast products and welds).

Typical types of discontinuities that can be detected by this method are cracks, laps, seams, cold shuts, and laminations etc.

Penetrant Examination shall be conducted in accordance with the ASME BPVC Section V, and Appendix A.



6.3.1 Acceptance criteria

Acceptance criteria for penetrant testing shall follow T-680 of ASME BPVC V and ASME BPVC VIII Div 1 Appendix 8 or ISO 13445 and EN 23278 (when reference by design code).

6.4 Radiographic testing

Radiographic Examination can be conducted for full penetration butt welds in pipelines, piping, pressure vessels, structures etc. made of CS, SS and Low alloy steel using either X-Ray or Gamma Ray as radiation source whenever such type of examination is deemed necessary by applicable codes. X-Ray shall prevail over Gamma Ray whenever is possible.

Typical types of discontinuities that can be detected by this method are cracks, incomplete fusion, incomplete penetration, misalignment, overlap, porosity, root-concavity, undercut, burn-through, excessive/ inadequate reinforcement, inclusions, etc.

Radiographic Examination shall be conducted in accordance with the ASME BPVC Section V, and Appendix A.

6.4.1 Thickness for Radiographic Testing

Wall Thickness examination is recommended up to 40 mm, but permitted until 90mm when UT is not feasible, as specified in Table 3 of ISO 17635.

6.4.2 Acceptance criteria

Acceptance criteria for radiographic testing of vessels and tanks shall follow T-280 of ASME BPVC V and ASME BPVC VIII Div 1 or as referenced per design code. For piping acceptance criteria shall follow Table 341.3.2 from ASME B31.3. For Pipeline acceptance criteria shall follow API 1104 paragraph 9.3.

6.5 Ultrasonic testing

This section details the minimum requirements for conducting Ultrasonic Examination of base material and fusion welded joints, associated heat affected zone and base metal in pipelines, pressure vessels, process piping, storage tanks and structural steels etc. made of CS, SS and Low alloy steel from 6mm to 150 mm wall thickness (or as per code) and minimum outside diameter 100mm. In case UT is performed in lieu of RT, then advanced/recordable UT shall be performed as specified in ASME VIII BPVC Division 2 paragraph 7.5.5 and following section 6.6 of this specification. SS examination shall follow requirements of ISO 22825.

Typical types of discontinuities that can be detected by this method are cracks, incomplete fusion, incomplete penetration, misalignment, overlap, porosity, root-concavity, undercut, burn-through, excessive/ inadequate reinforcement, laminations, inclusions, etc.

Ultrasonic Examination shall be conducted in accordance with the ASME BPVC Section V, and Appendix A.

6.5.1 Acceptance criteria

Acceptance criteria for ultrasonic testing examination of welds shall follow T-480 of ASME BPVC V and ASME BPVC VIII Div 1 also ASME B31.3 or as referenced per design code. Base material examination shall follow acceptance criteria per design code requirements.

6.6 Advanced UT techniques (ToFD and PAUT)

This specification covers the examination of following materials: carbon steel, ferritic alloy steels up to and including 9Cr-Mo type within the thickness ranges specified in 6.6.1.



If ultrasonic examination is performed in lieu of RT of piping, the technique shall be either automated UT(AUT) recorded (ToFD) or recorded (PAUT) in compliance with this procedure.

If ultrasonic examination of pressure vessels is performed, the technique shall be either recorded and encoded ToFD or recorded and encoded PAUT in compliance with this procedure.

Minimum requirements for ToFD and PAUT shall comply with ASME BPVC V Article 4 and additions of Annex A of this specification.

For each separate type of weld joint a PAUT and/or ToFD scan plan Contractor shall submit a scan plan to Company for approval.

Blind test qualification may be required when specified by the Company. Blind test blocks and blind test qualifications shall follow Annex B requirements.

6.6.1 Thickness

ToFD may be used for weld thicknesses (of pipe or plate) of 9 mm and higher.

PAUT may be used for weld thicknesses (of pipe or plate) of 6 mm. Weld thicknesses (of pipe or plate) from 6mm up to 9mm may be examined by PAUT only, providing a demonstration for correct sizing of defects. See Annex A for specific requirements on PAUT demonstration.

Wall thickness of 25mm or higher should be examined by ToFD when there is accessibility from both (left & right) sides of the weld. If Contractor/Vendor preference is to use PAUT method and longer time for scanning, data collection and interpretation must be accommodated. Proven experience for thickness in production scope is required for the vendor and PAUT Company. PAUT over 25mm needs Company approval. Applicable references shall be provided.

Both sides scanning shall be performed for PAUT wherever possible in any thickness.

Skewed scanning for the detection of transfer flaws shall be performed for weld joints in thickness above 25 mm (except for P-no. 1 Group No. 1 steels).

Corner welds and welds accessible from a single side of the weld only, shall be examined by PAUT. Scan plans for one sided access configurations shall be developed following ASTM E2700. Recommendations from ASTM E2700 for corner welds and T welds shall be followed. Note: TOFD is typically possible on 1 to 4 or shallower tapered surfaces in case of thickness transition on butt welds. Scanning from inside shall also be considered.

If 100% RT or 100% volumetric examination is specified on the datasheet/requisition, then nozzle to shell weld seams (joint category D, joint type 7) shall be examined by PAUT, and included in the scan plan. If accessible from the inside surface of the nozzle, manual straight beam examination shall supplement PAUT examination (as recommended per ASTM E2700).

Pipe diameters lower than NPS 2 (DN 50) shall be radiographed.

At Company's discretion, welds in complex geometries such as corner joints or double curved surfaces are subject to computer simulation and a mockup demonstration.

Wherever PAUT or ToFD is mentioned, it shall be understood to mean ToFD/PAUT AND all code or specification required supplemental techniques like near/far side angle beam UT scanning for ToFD, straight beam UT scanning of zones adjacent to the weld, transverse UT angle beam flaw scanning, etc.

6.6.2 Acceptance criteria

All Contractor PAUT/TOFD procedures shall be qualified in accordance with this specification and ASME Sect. V, Article 4. Also, approval from the Company is required prior to start of work.



For thin wall examination between 3.2mm to 8mm ISO 20601 shall be followed, and acceptance criteria shall comply with ISO 4761.

PAUT as replacement of UT for equipment requires that examination follows ASME V Article 4 mandatory appendix IV or V. Evaluation shall be in accordance with conventional criteria based on type, indication length and amplitude (ASME V, Article 4 paragraph T-482).

If PAUT/TOFD is performed in lieu of RT for equipment (in reference to UW-12 for PAUT in lieu of RT), then examination shall follow ASME V Article 4 mandatory appendix IV or V. Additional requirements for procedure qualification shall be prepared according to ASME V Article 4 Mandatory appendix IX. Evaluation shall be in accordance with 7.5.5 of ASME VIII Division 2.

If PAUT/ToFD is proposed for piping, examination shall follow ASME V Article 4 mandatory appendix IV or V. Evaluation shall be in accordance with conventional criteria based on type, indication length and amplitude (reference to 344.6.2 of ASME B31.3 for the thickness less than 25mm, appendix R shall be used for thickness greater than or equal to 25mm). In case of fracture mechanics-based acceptance criteria, qualification by demonstration of sizing shall be performed in accordance with Mandatory appendix IX.

PAUT/TOFD for high pressure piping (K341.4.2 & K344.6.3 (d) ASME B31.3) requires examination following ASME V Article 4 mandatory appendix III or V. Evaluation shall be in accordance with alternative criteria from B31 code case 181.

7.0 Personnel Qualification

The NDE personnel who approves the test results shall be Level III as minimum, qualified in accordance with the requirements specified in ASNT SNT-TC-1A or ISO 9712. Other qualifications are subject to approval by Contractor/Company. Supervisors responsible for overseeing and controlling NDE activities shall be Level III qualified. Level I NDE personnel/operators can perform NDE work, with exception of not be allowing to interpreting the test results, under full supervision of level II or level III personnel.

Personnel Qualification Requirements when Computed Radiography (CR), Digital Radiography (DR), Phased Array Ultrasonic Technology (PAUT) and Ultrasonic Time of Flight Diffraction (TOFD) is used, shall meet the requirements of ASME Section V, Article 1, Mandatory Appendix II.

Personnel who perform visual inspection shall be qualified in accordance with ISO 9712 as specified in ISO 17637 section 3.

7.1 Additional requirements for ToFD and PAUT

Personnel Qualification Requirements for Phased Array Ultrasonic Technology (PAUT) and Ultrasonic Time of Flight Diffraction (TOFD) shall meet the requirements of ASME Section V Article 1 Mandatory appendix II.

PAUT Operators shall be qualified UT Level II in accordance with ASNT SNT-TC-1A at a minimum. Other equivalent internationally recognized qualifications (such as what is referenced in ISO 13588) are acceptable with prior Company approval. In addition, PAUT operators shall be qualified by successfully passing a PAUT specific qualification exam administered by a Company approved third party testing facility.

Personnel performing and evaluating PAUT/ToFD examinations shall be qualified and certified in accordance with 7.3 of ASME VIII Division 2. Only PAUT/ToFD level III can approve a PAUT/ToFD procedure respectively.

Qualified PAUT Operators may be assisted by a UT Level I that has met the minimum requirements of ASNT SNT-TC-1A and has a minimum of 8 hours of documented training on the PA instrument/scanner being used. The scanner technician shall complete a demonstration of proficiency prior to performing any onsite field exams. This demonstration shall include but not be limited to the calibration of encoders, accurate positioning of search units and equipment pre-scan check out.



Personnel performing scanning/data collection and data evaluation of PAUT and ToFD shall be PAUT/ToFD level II or III (respectively).

All PAUT operators responsible for analysis of phased array data shall be capable of characterizing and classifying all indications.

The PAUT/ToFD operator/technician shall be qualified to use the procedure when their performance demonstration test is determined to be successful.



Annex A Amendments and supplements to ASME V BPVC

ARTICLE 1 – GENERAL REQUIREMENTS

T-120 General

Replace the existing file to the requirements of chapter 7 of this specification.

T-150 PROCEDURE

Replace paragraph (a) with the following

All NDE performed under this specification shall be done to an approved written procedure. The Procedure shall be reviewed and endorsed by the NDE Contractor's Level III personnel before submission to the Company for approval.

A procedure demonstration shall be performed to the satisfaction of the Company. Personnel demonstration shall be conducted to verify the ability of the examiner to apply the examination procedure. The examination procedure shall comply with the applicable requirements of this Section for the examination method.

All Procedure Demonstration shall be witnessed by the Company and NDT contractor Level III.

Company may engage a third-party agency to carry out inspection on its behalf. Where an inspection agency has witnessed the testing, the agency shall also issue a Certificate of Conformance, which states that the testing practices were following ASME V and this specification.

Unless specified otherwise by the Company, all NDE of welds shall be carried out with the weld at ambient temperature.

T-180 EVALUATION

Replace existing text with the following to the requirements of chapter 6.2.1, 6.3.1, 6.4.2, 6.5.1 & 6.6.2 of this specification.

Article 2 - RADIOGRAPHIC EXAMINATION

T-221 PROCEDURE REQUIREMENT

T-221.1 Compliance without a Written Radiographic Procedure.

Replace existing text with the following Radiographic procedure shall be state all the essential and non-essential variables but not limited to the following information:

- a) Material type and thickness range
- b) Isotope or max voltage used
- c) Source to object distance
- d) Distance from source side of the object to film distance
- e) Source size
- f) Film brand and designation
- g) Screens used
- h) Source size
- i) Film brand and designation
- j) Screens used

T-224 SYSTEM OF IDENTIFICATION



Replace the existing text with the following

A system shall be used to produce permanent identification on each radiograph traceable to the contract/PO.

Each weld shall have a unique identification reference marked in such a manner to permit the case of identification of individual welds and areas of defects within the weld.

The above identification shall preferably appear as Lead images.

The Identification markers shall be placed in such a way they shall not obscure the area of interest.

The information shall include:

- Contract number/PO
- Component
- Weld or weld seam number or identification
- Nominal diameter of the pipe
- Wall thickness or pipe schedule
- Date

T-225 MONITORING DENSITY LIMITATION OF RADIOGRAPHS

Add the following

Measurement of film density shall be made by a densitometer having a range of 0 – 4. The densitometer instrument shall be calibrated to manufacturer's recommendations. The calibration records shall be available for review by the Contractor/Company.

T-231 FILMS

Replace by the following

Film type shall be selected in accordance with ISO 17636 Table 3 Class B (unless otherwise specified).

T-232 INTENSIFYING SCREENS

Replace by the following

Intensifying screens shall be selected in compliance with ISO 17636 table 3 and following Class B (unless otherwise specified).

Lead intensifying screens shall be utilized and shall be of good quality to prevent screen marks on film and be of 0.125 mm thick placed at both the front and back of the film inside the cassette

T-233 IMAGE QUALITY INDICATOR (IQI) DESIGN

Add the following

Wire type penetrometers shall be used to determine radiographic sensitivity.

T-261 SOURCE SIZE

Add the following

Maximum source size that will be utilized shall be less than or equal to the 3X3mm.

Source size shall be selected in accordance with paragraph 7.2 of ISO 17636, including table 2 and as per Class B (unless otherwise specified).

T-272.2 GAMMA RADIATION.

Add the following:



Where examination using Gamma radiation is permitted, the source shall be SE-75 or Iridium 192. The maximum strength shall be 15 curies in accordance with the limitation in the ORPIC HSE Manual.

Sources of higher strength shall not be used on site without written approval from the Company.

T-277.2 Number of IQIs.

Add the Following

Minimum two IQI / penetrameters shall be placed, one at the center and one at extreme end of the film for the film length greater than or equal to 120mm.

T-281 QUALITY OF RADIOGRAPHS

Add the following

The image of a wire is acceptable if a continuous length of at least 10 mm is clearly visible in a section of uniform optical density.

T-283 IQI SENSITIVITY

Add the following:

Radiographic Sensitivity shall be equal to or better than that specified in the applicable code.

For the DWDI technique, the diameter of wires employed shall be based on the nominal single wall thickness of the specimen.

For the DWSI technique, the diameter of wire shall be based on the nominal single wall thickness of the specimen.

For weldments, the thickness of external weld reinforcement and internal weld protrusion shall be included in the sensitivity calculation.

T-286 EVALUATION BY MANUFACTURER

Add the following:

Radiographs shall be interpreted, and the report endorsed by a qualified radiographic interpreter and then submitted to the Company for approval.

T-291 RADIOGRAPHIC TECHNIQUE DOCUMENTATION DETAILS

Include the requirements of section 8 of ISO 17636 and add the following:

- Weld identification number
- Client
- Report no.
- Radiographer's identity
- Welder's number(s)
- Acceptance & procedure Code / specification
- Radiographic procedure number
- Whether original weld or repair
- Heat treatment condition
- Sensitivity achieved
- Geometric unsharpness
- Location and type of any flaws discovered
- test location



Add new clause for Digital Radiography requirements:

COMPUTED RADIOGRAPHY USING PHOSPHOR IMAGING PLATES (CR)

Type of image plates

Only high definition CR systems may be used with a detector basic spatial resolution of the Image Plate (IP) of $SR_b \leq 80\mu\text{m}$ maximum. SR_b measured in accordance with Annex C of EN ISO 17636-2 (i.e. a system able to detect duplex wire pair 11 per ISO 19235-5 or ASTM E2002).

For penetrating thicknesses of 8mm and lower CR systems should have a basic spatial resolution of $SR_b \leq 50\mu\text{m}$ (i.e. a system able to detect duplex wire pair 13 per ISO 19235-5 or ASTM E2002).

Note: For thicker applications the higher definition system of $SR_b \leq 50\mu\text{m}$ is not advantageous and should not be used.

Examination

The rays absorbing phosphor layer of an IP is much thicker than a silver layer of a film. The thickness of the layer causes more scattering and demands that working with lead screens shall be mandatory. Metal front sheets shall be applied; the type and thickness shall be selected in accordance with Table 3 of ISO 17636-2.

Requirements for weld joint identification, location markers, IQI's, etc. for CR and DR images shall be the same as required for RT with analogue film.

Each digital RT image shall have the required markers and the IQI visible.

Scanning

Scanning of the image plate (IP) shall be performed on a resolution that is just higher (i.e. lower in μm) than the IP system its standard spatial resolution SR_b (i.e. $70\mu\text{m}$ for $SR_b = 80\mu\text{m}$, $35\mu\text{m}$ for $SR_b = 40\mu\text{m}$).

There shall be a backup scanner available (on call in a day), this because the availability of the scanner is critical to the overall execution of the computed radiography.

Periodic Equipment Evaluation

The image plate (IP) is subject to wear. After a certain amount of radiographs and minimum weekly, the film shall be checked in accordance with ASTM E 2445 paragraph 9.6.4, 9.6.5 and 9.6.6, results to be included and administrated into an IPs quality logbook. The check should be performed by the CR equipment vendor or designated authorized person.

Handling

Image plates must be kept in their protective black sleeves and only be taken out upon scanning and returned into its black sleeve immediately after. The sleeves shall only be opened in a room that is dark with only some indirect (sun) light. This is required because light exposure deteriorates the image and influences the test result.

Image plates shall be handled with care, using soft gloves.

Image plates are temperature sensitive and the time between radiographic exposure and scanning must be minimized. A maximum interval of 4 hours shall be maintained.

The scanner itself is a kind of laboratory equipment and shall be placed in a conditioned room and free from dust and debris.

Image Quality

Each computed radio graphed shall be evaluated for its minimum gray values in accordance with Annex D.1 of ISO 17636-2.



For image quality, the minimum SNR measured shall be above those required in accordance with Table D.1 of ISO 17636-2, corresponding to the required SNRN values per Table 3: Class B of ISO 17636-2.

Measuring of the gray scale should be performed in the heat affected zone and be plotted and reported for each radiographic image.

DIRECT RADIOGRAPHY (DR) DIGITAL DETECTOR ARRAY SYSTEM (DDA)

DDA shall only be used in a fixed setting inside the workshop.

DDA shall only be used for radiography of straight butt welds in pipes $\leq$ DN100 and Schedule $\leq$ 80 (i.e. $\leq$ 9.6mm wall thickness).

The external weld surface shall be ground flush with the pipe.

The detector system its basic spatial resolution shall be $SR_b \leq 160\mu\text{m}$ maximum, measured in accordance with Annex C of EN ISO 17636-2 (i.e. a system able to detect duplex wire pair 8 per ISO 19235-5 or ASTM E2002).

Monitor Viewing Conditions

Monitoring viewing conditions shall be in accordance with ISO 17636-2 paragraph 7.10.

Operator Training

Making digital radiographs requires a different operating procedure than that of radiography with film. Operators need additional training instructions. Additional training is required by an expert in digital radiography, preferably by the digital radiography equipment vendor. Supplier shall have applicable training certificates available for Contractor/Company review. The certification shall be additional to the NDE Operator his/her level in analogue RT.

Data Protocol

Supplier shall establish a clear data file numbering protocol. This is required considering the huge volume of radiographs and tracking of each image to it's; equipment number or line number, ISO number, weld number and shot number.

A system of storing and sharing the image folder with all film information must be established. Digital Image folders of PCs and laptops shall have a daily upload of the images data into a redundant data control system.

Contractor/Company shall be provided local access to the applicable viewer program required to evaluate the digital images.

In relation to data acquisition and NDE imaging features, NDE image/signal data should be displayed on a system conforming to ASTM DICONDE format and follow ASTM E2339-15 standard practice. Other format/image options require Company approval.

The native data files of all images shall be issued to Company, together with the final manufacturing data books or piping system test package records, including the applicable CR viewer software or internet link to the applicable free downloadable software.

Supplier shall maintain the redundant back up storage of the digital images for the same period as required for the (hard copy) manufacturing data books.

Article 4 – ULTRASONIC EXAMINATION METHOD FOR WELDS

T-421 WRITTEN PROCEDURE REQUIREMENTS

Replace first sentence of existing text with the following

Procedures shall be qualified in accordance with Section T-150 and Annex A additions of this specification.



T-431 INSTRUMENT REQUIREMENTS

Add the following

The specific ultrasonic unit (make and model), probe type and calibration blocks to be used shall be specified in the procedure for Company approval. Calibration blocks should be IIW-V1, IIW-V2 or step wedge type unless Company specified the type of calibration blocks.

T-462 GENERAL CALIBRATION REQUIREMENTS

T-462.6 TEMPERATURE

Add the following

The maximum surface temperature when using conventional probes and couplants shall not exceed 50 °C.

T-467 CALIBRATION CONFIRMATION

T-467.3.2 SENSITIVITY SETTINGS.

Add the following

The scanning sensitivity shall be set on the parent material in an area free from imperfections such that the second back wall echo is displayed at full screen height.

In the absence of a back wall echo due to non-parallel surfaces, the scanning sensitivity shall be set as above using a separate parallel-sided plate with the same thickness and attenuation characteristics.

T-470 EXAMINATION

Add the following

Scanning shall conform with Annex A of ISO 17640, including the requirements specified for Testing (Level B to be followed unless otherwise specified).

Weld seams with limited access (such as tapering, drilling of holes for nozzles, installation of attachments and pads) shall be inspected before carrying out such activities before PWHT. After PWHT these areas may be exempted and recorded on reports as inaccessible.

T-480 EVALUATION

Add the following

To determine the echo dynamic pattern, the indication shall be investigated by probe movement in two mutually perpendicular directions. Angle probe scans shall be made in a direction towards or away from the reflector, and at right angles to this direction. Normal probe scans shall be made along the length of the weld and across its width.

T-493 REPORT

Add the following

Key points monitored shall be identified on relevant isometric drawings for piping systems and on schematic diagrams for static equipment.

Detailed sketches of any corrosion or other defects noted shall be recorded and attached with the ultrasonic inspection report.

Signed and scanned reports saved in order and shall be submitted to the company at the end of the project/ contract.

T-492 EXAMINATION RECORDS

Add the following:

- Ultrasonic procedure number



- Date of examination
- Examination personnel Identity, level and signature.
- Calibration sheet identity
- Weld identification and location
- Welding process
- NDE specification.
- Surface condition.
- Acceptance criteria.
- Wall thickness and length of weld examined.
- Heat treatment condition.
- Original or repair weld.
- Map or record of discontinuities assessed.

Add new clause for ToFD:

Add the following to Mandatory Appendix III:

EXAMINATION CONSIDERATIONS

Before weld examination it is mandatory to perform a lamination check on base material.

Nozzles interference on the PCS must be considered in the scan plan. Alternatively, PAUT is preferred, or supplementary UT technique must be included in scan plan.

HAZ volume coverage considering 10 mm shall be part of the volume to be examined. The exact value of HAZ can be considered alternatively plus additional 6mm of base metal to be included as part of the volume to be examined (on this case HAZ measurements shall be documented and attached to TOFD procedure).

To ensure a 100 % coverage on the weld to be examined, all weld caps of adjacent welds that interfere with the smooth transition of the probes, shall be ground flush, to an evenness and smoothness that guarantees adequate coupling and data collection in an area of 200mm on either side of the weld, or 3 times the thickness (whichever is less).

For butt welds Table 2 of ISO 10863 shall be followed for determining the number of TOFD setups in the scan plan depending on wall thickness.

Examination for process piping shall maximize coverage of T welds extending examination volume by 38mm on each intersecting weld in compliance with 341.4.1b of ASME B31.3.

Minimum overlap between adjacent scans must be 25mm.

Angle beam examination shall be performed for detection of reflectors transverse to the weld.

Add new clause for PAUT:

Add the following to Mandatory Appendix V:

Before weld examination it is mandatory to perform a lamination check on base material.

Weld axis reference point shall be marked before examination; this step shall be part of PAUT scan plan, by indication on a sketch where scanning direction must be indicated and also probes position (PCS).

Nozzles interference on the PCS must be considered in the scan plan. Percentage without both sides access to be estimated and indicated in the scan plan.



PAUT examination shall be performed by an automated or semi-automated full encoded and recorded scan of a weld seam from both sides with proven scan plan illustrating full cover coverage of the weld seam, root, cap and HAZ areas. When access is only possible from one side, scan plan and demonstration shall follow IX-435.8, irrespective of if acceptance criteria are workmanship or fracture mechanics based.

HAZ volume coverage considering 25 mm shall be part of the volume to be examined for thickness up to 100mm (for higher thickness up to 200mm 50mm shall be considered). The exact value of HAZ can be considered alternatively plus additional 6mm of base metal (in this case HAZ measurements shall be documented and attached to PAUT procedure).

To ensure a 100 % coverage on the weld to be examined, all weld caps of adjacent welds that interfere with the smooth transition of the probes, shall be ground flush, to an evenness and smoothness that guarantees adequate coupling and data collection in an area of 200mm on either side of the weld, or 3 times the thickness (whichever is less).

Examination for process piping shall maximize coverage of T welds extending examination volume by 38mm on each intersecting weld in compliance with 341.4.1b of ASME B31.3.

Angle beam examination shall be performed for detection of reflectors transverse to the weld.

PAUT & ToFD procedure validation/qualification

A scanner or demonstration block shall be fabricated in compliance with the requirements of ASME BPVC Section V Article 4, Appendix IX. Thickness shall be within 25% of the material thickness to be examined, and artificial flaws shall follow IX-435.5 and IX-435.6 requirements. Curvature requirements shall be in compliance with IX-435.1.

In case of multiple examination zones, a minimum of one flaw per zone shall be detected, categorized and sized successfully (in full compliance with IX-482).

If surface flaws are not possible to be detected, categorized and sized by PAUT or TOFD technique, then one subsurface flaw per zone shall be considered to validate main examination method.

Subsurface flaws shall be totally embedded and not left open to any side of the block to permit length sizing for a useful evaluation of the method.

Only when IX-482 (a) is met, then main method can be supplemented by manual techniques for sizing and categorizing demonstration block artificial flaws.

Article 5 – ULTRASONIC EXAMINATION METHODS FOR MATERIALS

Ultrasonic Examination shall be carried out to an approved written procedure. The procedure shall be reviewed and endorsed by the NDE Contractor's ASNT Level III before submission to the Company for Approval.

T-522 WRITTEN PROCEDURE REQUIREMENTS

Replace first sentence of existing text with the following

Procedures shall be qualified in accordance with Section T-150 and Annex A additions of this specification.

MUT procedure validation:

Procedure shall be validated as per the code acceptance criteria. Validation block shall be simulated the similar damages in the job and incorporated discontinuities are minimum acceptable limit.

T-530 EQUIPMENT

Add the following



See also the section T-431 of this specification

T-563 CALIBRATION CONFIRMATION

T-563.3.2 SENSITIVITY SETTINGS.

Add the following

See also the section T-467 of this specification

T-492 EXAMINATION RECORDS

Add the following

For each ultrasonic examination the following information shall be identified and recorded:

- Ultrasonic procedure number
- Date of examination
- Examination personnel Identity, level and signature.
- Calibration sheet identity
- Weld identification and location
- Welding process
- NDE specification.
- Surface condition.
- Acceptance criteria.
- Wall thickness and length of weld examined.
- Heat treatment condition.
- Original or repair weld.
- Map or record of discontinuities assessed.
- Conclusion - accept or reject according to Specification.

Article 6 - LIQUID PENETRANT EXAMINATION

T-621 PROCEDURE

T-630 EQUIPMENT

Add the following:

All penetrant material shall be aerosol applied.

The make and brand of the penetrant, developer and cleaner to be used shall be specified individually in the procedure for Company approval.

T-641 CONTROL OF CONTAMINANTS

Add the following to the end of the first paragraph:

The required certification shall be available for review by the Company.

T-651 TECHNIQUES

Delete the first paragraph up to the column and replace with the following:



Normally a color contrast (daylight visible) penetrant shall be used with the penetrant processes listed. Fluorescent penetrants shall be used only on special applications with the prior approval of the Company.

T-690 DOCUMENTATION

T-692 EXAMINATION RECORDS

Add the following:

The test report shall be prepared and contain as a minimum the following information:

- Procedure number
- Date of examination
- Examination personnel identity, level and signature.
- Weld identification
- Material
- Technique
- Type of consumable
- Acceptance criteria / standard
- Size and location of any defect found
- Acceptance or rejection with respect to acceptance standard

Article 7 - MAGNETIC PARTICLE EXAMINATION

T-720 GENERAL

Replace the first sentence of the existing text with the following:

This procedure is intended to be limited to applications where flaws break the surface of ferromagnetic materials.

It should not be assumed that magnetic particle examination is capable of detecting sub-surface discontinuities.

T-721 WRITTEN PROCEDURE REQUIREMENTS

Add the following:

Magnetic particle examination shall be carried out to an approved written procedure. The procedure shall be reviewed and endorsed by the NDE Contractor's ASNT level III before submission to the Company for approval.

T-750 TECHNIQUE

Replace the second paragraph (including listed items) with the following:

Magnetization shall be carried out by the yoke technique.

T-764 MAGNETIC FIELD ADEQUACY AND DIRECTION

Replace the first paragraph with the following:

T-764.3 Magnetic Field Direction.

When it is necessary to verify the adequacy or direction of the magnetizing field, this shall be done by means of a Burmah-Castrol Strip positioned on the surface to be examined. This indicator consists of a cracked strip of Mu-metal encased in thin copper.



T-764.2 Magnetic Field Adequacy.

When using this indicator, a suitable flux or field strength is indicated when a clearly defined line of magnetic particles form across the copper face of the indicator, when the examination medium is applied simultaneously with the magnetizing force.

T-773 METHOD OF EXAMINATION

Add the following:

Examination shall be done using the continuous magnetic flow method by the application of an AC or permanent yoke magnet unless prior approval is obtained from the Company for other methods. The magnet shall remain in position while the examination medium is applied and while excess examination medium is being removed.

T-793 EXAMINATION RECORDS

Add the following:

On top of the required per T-793, each report shall contain also the following information:

- Procedure number
- Examination personnel identity, level and signature
- Weld identification
- Method of magnetization
- Date of inspection
- Type of inspection medium
- Applied magnetic field strength
- Heat treatment condition of weld
- Whether original weld or repair (O or R)
- Flaws detected and locations
- Acceptance criteria / Specification
- Conclusions: Acceptance or rejection with respect to the specification

Article 9 – VISUAL EXAMINATION

T-991 REPORT OF EXAMINATION

Add the requirements from ISO 17637 section 5.

T-993 RECORD MAINTENANCE

Add the requirements from ISO 17637 section 5.

If a permanent visual record of an examined weld is required, photographs or accurate sketches or both should be made with any imperfections clearly indicated.



Annex B: ToFD and PAUT blind test requirements

The blind testing procedure is intended to qualify the UT TOFD/PAUT operators and the associated NDT procedure. It requires ordering, at a third-party company, test blocks with a representative weld bevel preparation and artificial defects. Approximate defect locations and size shall be defined by Company's Engineer. Test blocks will not be shared with the vendor/contractor or the inspection Company.

After receipt of the test blocks, and before the start of production, test blocks shall be scanned by the UT technicians in accordance with the reviewed and accepted procedure. Defects found shall be sized and reported to Company/Contractor for evaluation.

Company may choose to waive the blind testing qualification of a UT operator, although only if the operator has been qualified by blind testing for Company in the preceding 12 months on similar thicknesses using a similar procedure and technique.

The UT technician shall be minimum level 2 specifically qualified for ToFD or PAUT per ASNT or ISO 9712. A level 3 specifically qualified for ToFD/PAUT shall supervise the blind testing and must have the ability to verify the quality of the operator's scan in terms of equipment set-up.

The responsibility for completing the blind testing procedure resides with the Vendor, and they shall procure the test blocks. They shall also deliver the base metal for the test blocks to the test block fabricator in the agreed thicknesses and weld bevel preparations. The number and location of defects in the qualification blocks shall be defined by Company. Therefore, Contractor shall provide contact details of responsible people at the test block fabricator to the Company. Flaw number and sizes shall meet the requirements found in ASME SEC VIII Division 2, Para. 7.5.5.1 as minimum. The vessel fabricator shall be in direct contact with the test block fabricator to arrange the delivery and receipt of the test blocks.

Qualification shall be witnessed by Company/Contractor, NDT Expert and Inspector. It is the responsibility of the Vendor/Contractor to arrange a date for the blind testing (and possible re-testing) with all parties involved. It is advised that this date shall be planned well ahead of time to allow participation of experts and inspectors.

After all qualification testing has been completed, the test blocks shall be shipped to the site for storage. The shipping shall be coordinated with Company. The shipping costs are in Vendor/Contractor's scope unless otherwise specified.

Test Block Details

The test blocks shall be within 25% of the production thickness as per ASME VIII Div 2 para 7.5.5.1. They shall be of material sonically equivalent to the production material, made using the same welding process with the same weld bevel preparation. Blind test block shall have "realistic defects". The length of the test blocks shall be coordinated with Company's engineer. The blocks shall have detachable run-on and run-off plates (attached by bolts) flush with the top and bottom surfaces to facilitate scanning. The blocks shall have secure lifting lugs welded to it. These welds must be MT examined and be surface defect free.

The number of test blocks shall be maximally six (6) for any order, and maximally four (4) for any vessel. Typically, a ToFD block will be made for the shell thickness and the head thickness, and a PAUT block (for one-sided scanning at nozzles) for both thicknesses. In case of a multiple vessel order, Company's Engineer shall be consulted for the thicknesses to be purchased.

The blocks shall be fully characterized by best available NDT techniques by the test block fabricator. For reference, the blocks shall be low stress stamped for scanning direction and weld centre line, and they shall be stamped with a unique ID number, referenced in the final documentation. The sides of the plates shall be etched to bring out the weld microstructure and then protected by transparent lacquer. The final surface preparation of the weld shall be equivalent to that of the fabricated equipment/piping.



The blocks shall be shipped to the Vessel manufacturing location in a sealed box. At reception, Contractor/Company inspector shall be present to confirm intact seals and the blocks shall then be stored in a secure, locked location. At the time of qualification, Company inspector shall be present when the seal is broken.

Test Block Fabricators

Three companies that can fabricate test blocks are: ITMA (Spain), FlawTech (USA), Sonaspection (UK). Other companies may be considered, at Company's approval. A copy of this appendix shall be given to the test block fabricator for reference.

Documentation

The Vendor/Contractor shall submit a detailed schedule for the blind testing procedure, from base metal ordering to the blind testing. They shall also submit drawings of the prepared base metal plates and WPSs to the test block fabricators.

The third-party test block manufacturer shall submit final documentation of the test blocks to Company/Contractor. It shall comprise of drawings in isometric & projection views of the final, as fabricated defect locations and sizes, WPSs used for welding, and a generous number of images of the etched surfaces and the finished test blocks/ID numbers for identification of the blocks.

The NDT inspection company shall prepare for evaluation, on the testing day for acceptance/rejection evaluation, per operator, a drawing/sketch of all relevant defects found. The sketch shall clearly indicate the name of the operator, block ID number, and the scanning reference direction in relation to the markings on the block. The information shall also be tabulated providing a summary of the blind test results. It shall be clearly indicated if it is an acceptable indication/ flaw or if it is not in accordance with the NDT procedure's criteria. The data submitted shall be reviewed and signed by the level 3 of the NDT company.

The NDT inspection company's level 3 shall prepare for final submission within two weeks after the test a report including, per operator, above information originally presented, oversizing/under sizing tolerances, PDF image(s) of the scans with all flaws clearly visible/identified, scan plans used, and probe details.



Appendix 1

USER FEEDBACK PAGE

Document title					
Document number and the revision					
	User to use this Feedback Form to identify any inaccuracy, error or ambiguity to notify the Document Authority so that appropriate action can be taken. The user is requested to return this page fully completed, indicating precisely the proposed improvement and justification.				
Name:		Email:		Date :	
Page Ref:	Observation	Proposed Improvement & Justification			



DOCUMENT INFORMATION

Title	Qualification of NDE Procedure and NDE Personnel Specification
Document code	03.01.15-Qualification_of_NDE_Procedures_and_NDE_Personnel
Purpose	The purpose of this specification is to establish the minimum technical requirements for the detection of flaws on materials and welds by NDE, that are needed for the design and fabrication of equipment and piping.
Audience	OQ Project & Technology Community
Category	Governance
Subcategory	PCoE Quality Management
Effective date	Feb, 2022
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DOCUMENT APPROVALS		
Authorized Approver	Date	Signature(s)
VP, Project CoE	10/03/2022	