W34 Advanced non-destructive testing of materials and welds

(Dec2019) (Rev.1 July 2026)

1. General

1.1 This document gives minimum requirements on the methods and quality levels that are to be adopted for the advanced non-destructive testing (ANDT) of materials and welds during new building of ships. The advanced methods intended for use under this UR are listed in Section 2.

1.2 The ANDT is to be performed by the shipbuilder internal NDT services, ~~,~~ manufacturer internal NDT services ~~-~~ or external NDT service suppliers ~~its subcontractors~~ in accordance with these requirements. The Classification Society's surveyor may require witnessing testing.

1.3 It is the shipbuilder's or manufacturer's responsibility to ensure that testing specifications and procedures are adhered to during the construction, and the report is to be made available to the Classification Society on the findings made by the ANDT.

1.4 The extent and method of testing, and the number of checkpoints are normally agreed between the shipyard and the Classification Society.

1.5 Terms and definitions

The following terms and definitions apply for this document.

ANDT	Advanced non-destructive testing
RT-D	Digital Radiography (also see section 7.1.6)
RT-S	Radioscopic testing with digital image acquisition(dynamic≥12bit)
RT-CR	Testing with computed radiography using storage phosphor imaging plates
PAUT	Phased Array Ultrasonic Testing
TOFD	Time of Flight Diffraction
AUT	~~Automated Ultrasonic Examinations. A technique of ultrasonic examination performed with equipment and search units that are mechanically mounted and guided, remotely operated, and motor controlled (driven) without adjustments by the technician. The equipment used to perform the examinations is capable of recording the ultrasonic response data, including the scanning positions, by means of integral encoding devices such that imaging of the acquired data can be performed.~~ Automated Ultrasonic Testing. A technique by which an object is tested by ultrasound using probes operating under mechanical control and where ultrasonic data is collected automatically.
SAUT	Semi-Automated Ultrasonic Examinations. A technique of ultrasonic examination performed with equipment and search units that are mechanically mounted and guided, manually assisted (driven), and which may be manually adjusted by the technician. The equipment used to perform the examinations is capable of recording the ultrasonic

	response data, including the scanning positions, by means of integral encoding devices such that imaging of the acquired data can be performed
Transverse butt weld (direction):	These are the welds that run perpendicular to the keel and are either vertical or horizontal across the width of the ship's structure.
Longitudinal seam weld (direction):	These are the welds that run parallel to the keel and are either vertical or horizontal across the length of the ship's structure.

Notes:

1. This UR is to be uniformly implemented by IACS Societies to ships contracted for construction on or after 1 July 2021.

2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contract for construction", refer to IACS Procedural Requirement (PR) No. 29.

3. Rev.1 of this Unified Requirement is to be uniformly implemented by IACS Societies to ships contracted for construction on or after 1 January 2028.

2. Applicability

2.1 Materials

2.1.1 This document applies to the following materials, ~~and~~ manufactured products, and IACS applications:

- ~~Material and welding for gas tankers~~ Material and welding for ships carrying liquefied gases in bulk and ships using gases or other low-flashpoint fuels in accordance with UR W1
- Normal and higher strength hull structural steels in accordance with UR W11
- High strength steels for welded structures in accordance with UR W16
- Hull and machinery steel forgings in accordance with UR W7
- Hull and machinery steel castings in accordance with UR W8
- Requirements for Use of Extremely Thick Steel Plates in Container Ships in accordance with UR S33
- Cast Copper Alloy propellers in accordance with UR W24
- Aluminium alloys for hull construction in accordance with UR W25
- Cast Steel Propellers in accordance with UR W27
- YP47 Steels and Brittle Crack Arrest Steels in accordance with UR W31
- Guidelines for non-destructive testing of hull ~~Hull~~ and machinery steel forgings in accordance with REC 68
- Guidelines for non-destructive testing of marine ~~Marine~~ steel castings in accordance with REC 69
- High manganese austenitic steels as referred to within the Guidelines on Approval of High Manganese Austenitic Steel for Cryogenic Service, in accordance with Rec 169

2.2 Welding processes

2.2.1 This document applies to welding processes specified in Table 1. ANDT of a welding process unspecified in Table 1 is to be to the satisfaction of the Classification Society.

Table 1 Applicable welding process

Welding process		ISO 4063: ~~2009~~ 2023
Manual welding	Shield Metal Arc Welding(SMAW)	111
Resistance welding	Flash welding(FW)	24
Semi-automatic welding	(1) Metal Inert Gas welding(MIG) (2) Metal Active Gas welding(MAG) (3) Flux Cored Arc Welding(FCAW)	131 135, 138 136
TIG welding	Gas Tungsten Arc Welding(GTAW)	141
Automatic welding	(1) Submerged Arc Welding(SAW) (2) Electro-gas Welding(EGW) (3) Electro-slag Welding(ESW)	12 73 72

2.3 Weld joints

2.3.1 This document applies to butt welds with full penetration. Variations of joint design, for example, tee, corner and cruciform joints (with or without full penetration) can be tested using PAUT. The constraints of joint design with respect to testing are to be recognized, documented, and agreed with the Society before application.

2.4 Timing of ANDT

2.4.1 ANDT are to be conducted after welds have cooled to ambient temperature and after post weld heat treatment where applicable.

2.4.2 Timing of ANDT for welds ~~on ship hull welds on steels with specified minimum yield stress in the range of 420 N/mm^2 to 690 N/mm^2~~ shall be in accordance with 2.4.2 of UR W33 (Non-destructive testing of ship hull steel welds)~~.~~

2.5 Testing methods

2.5.1 The methods mentioned in this document for detection of imperfections are PAUT (only automated / semi-automated PAUT), TOFD, RT-D.

2.5.2 Applicable methods for testing of the different types of materials and weld joints are given in Table2.

Table2 Applicable methods for testing of materials and weld joints

MATERIALS AND WELD JOINTS	PARENT MATERIAL THICKNESS	APPLICABLE METHODS
Ferritic butt welds with full penetration	thickness<6mm	RT-D, PAUT[1)2)]
	6 mm ≤ thickness ≤ 40 mm	PAUT, TOFD, RT-D
	thickness>40mm	PAUT, TOFD, RT-D[2)3)]
Ferritic tee joints and corner joints with full penetration	thickness≥6mm	PAUT, RT-D[2)3)]
Ferritic cruciform joints with full penetration	thickness≥6mm	PAUT[2)3)]
1.5% to 3.5%nickel steel butt welds with full penetration	thickness<6mm	RT-D
	6 mm ≤ thickness ≤ 40 mm	RT-D, PAUT, TOFD
	thickness>40mm	PAUT, TOFD, RT-D[2)3)]
1.5% to 3.5%nickel steel tee joints, corner joints with full penetration	thickness≥6mm	PAUT, RT-D[2)3)]
Austenitic stainless steel, duplex stainless steel, high manganese austenitic steel and 5% to 9%nickel steel butt welds with full penetration[1]	thickness<6mm	RT-D
	6 mm ≤ thickness ≤ 40 mm	RT-D, PAUT[2),3),4)]
	thickness>40mm	PAUT[2)3)4)], RT-D[2)3)]
Austenitic stainless steel, duplex stainless steel, high manganese austenitic steel and 5% to 9%nickel steel tee joints, corner joints with full penetration[1]	thickness≥6mm	PAUT[2) 3),4)],RT-D[2)3)]
Aluminium tee joints and corner joints with full penetration	thickness≥6mm	PAUT[2)3)], RT-D[2)3)]
Aluminium cruciform joints with full penetration	thickness≥6mm	PAUT[2)3)]
Aluminium butt welds with full penetration	thickness<6mm	RT-D
	6 mm ≤ thickness ≤ 40 mm	RT-D, TOFD, PAUT
	thickness>40mm	TOFD, PAUT, RT-D[2)3)]
Cast Copper Alloy	All	PAUT, RT-D[2)3)]
Steel forgings	All	PAUT, RT-D[2)3)]
Steel castings	All	PAUT, RT-D[2)3)]
Base materials/Rolled steels, Wrought Aluminium Alloys	thickness<6mm	RT-D
	6 mm ≤ thickness ≤ 40 mm	PAUT, TOFD, RT-D
	thickness>40mm	PAUT, TOFD, RT-D[2)3)]

Notes:

1) PAUT may be applied to the welded joints of pipe and simple geometry in plate of thickness range from 3.2mm to less than 6mm in accordance with ISO 4761:2022 and ISO 20601:2018. This may involve AUT and/or SAUT techniques.

2) Only applicable with limitations, need special qualification subject to acceptance by Classification Society.

3) ~~1)~~ The ultrasonic testing of anisotropic material using advanced methods will require specific procedures and techniques. Additionally, the use of complementary techniques and equipment may also be required, e.g. using angle compression waves, and/or creep wave probes for detecting defects close to the surface.

4) Where applicable, PAUT is to be conducted under the direct longitudinal wave technique, with the array probe positioned on both sides and both surfaces to reduce any detrimental effects of noise echo, attenuation, acoustic anisotropy and mode conversion.

3. Qualification of personnel involved in ANDT

3.1 Refer to UR W35 for requirements for supervisors, operators, and qualification of personnel involved in NDT.

~~3.1 The Shipbuilder, manufacturer or its subcontractors is responsible for the qualification and preferably 3rd party certification of its supervisors and operators to a recognised certification scheme based on ISO 9712:~~

~~Personnel qualification to an employer based qualification scheme as e.g. SNT-TC-1A, or ANSI/ASNT CP-189, may be accepted if the Shipbuilder, manufacturer or its subcontractors written practice is reviewed and found acceptable by the Society. The Shipbuilder, manufacturer or its subcontractors written practice shall as a minimum, except for the impartiality requirements of a certification body and/or authorised body, comply with ISO 9712:.~~

~~The supervisors' and operators' certificates and competence shall comprise all industrial sectors and techniques being applied by the Shipbuilder or its subcontractors.~~
~~Level 3 personnel shall be certified by an accredited certification body.~~

~~3.2 The Shipbuilder, manufacturer or its subcontractors shall have a supervisor or supervisors, responsible for the appropriate execution of NDT operations and for the professional standard of the operators and their equipment, including the professional administration of the working procedures. The Shipbuilder, manufacturer or its subcontractors shall employ, on a full-time basis, at least one supervisor independently certified to Level 3 in the method(s) concerned as per the requirements of item 3.1. It is not permissible to appoint Level 3 personnel; they must be certified by an accredited certification body. It is recognised that a Shipbuilder, manufacturer or its subcontractors may not directly employ a Level 3 in all the stated methods practiced. In such cases, it is permissible to employ an external, independently certified, Level 3 in those methods not held by the full-time Level 3(s) of the Shipbuilder, manufacturer or its subcontractors.~~

~~The supervisor shall be directly involved in review and acceptance of NDT Procedures, NDT reports, calibration of NDT equipment and tools. The supervisor shall on behalf of the Shipbuilder, manufacturer or its subcontractors re-evaluate the qualification of the operators~~

~~annually.~~

~~3.3 The operator carrying out the NDT and interpreting indications, shall as a minimum, be qualified and certified to Level 2 in the NDT method(s) concerned and as described in item 3.1.~~

~~However, operators only undertaking the gathering of data using any NDT method and not performing data interpretation or data analysis may be qualified and certified as appropriate, at level 1.~~

~~The operator shall have adequate knowledge of materials, weld, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.~~

4. Technique and procedure qualification

4.1 General

The shipbuilder or manufacturer ~~has to~~ shall submit to the Classification Society the following documentation for review:

---The technical documentation of the ANDT.

---The operating methodology and procedure of the ANDT according to section 7.

---Result of software simulation, when applicable.

4.2 Software simulation

Software simulation may be required by the Classification Society, when applicable for PAUT or TOFD techniques. The simulation may include initial test set-up, scan plan, volume coverage, result image of artificial flaw etc.. In some circumstances, artificial defect modelling/simulation may be needed or required by the project.

4.3 Procedure qualification test

The procedure qualification for ANDT system shall include the following steps:

- Review of available performance data for the inspection system (detection abilities and defect sizing accuracy).
- Identification and evaluation of significant parameters and their variability.
- Planning and execution of a repeatability and reliability test programme[1] which including onsite demonstration.
- Documentation of results from the repeatability and reliability test programs.

Note: 1) The data from the repeatability and reliability test program is to be analysed with respect to comparative qualification block test report and onsite demonstration. The qualification block shall be in accordance with ASME V Article 14 MANDATORY APPENDIX II UT PERFORMANCE DEMONSTRATION CRITERIA or agreed by the Classification Society, and at least the intermediate level qualification blocks shall be used. The high-level qualification blocks shall be used when sizing error distributions and an accurate Probability of Detection (POD) need to be evaluated. The procedure qualification may be performed by demonstrating on reference blocks(s). The demonstration process onsite shall be witnessed

by the Classification Society's surveyor.

4.4 Procedure approval

The testing procedure is to be evaluated based upon the qualification results, if satisfactory the procedure can be considered approved.

4.5 Onsite review

For the test welds, supplementary NDT shall be performed on an agreed proportion of welds to be cross checked with other methods. Alternatively, other documented reference techniques may be applied to compare with ANDT results.

Data analyses shall be performed in accordance with the above activities. Probability of Detection (PoD) and sizing accuracy shall be established when applicable.

When the result of inspection review does not conform to the approved procedure, the inspection shall be suspended immediately. Additional procedure review qualification and demonstration shall be undertaken to account for any nonconformity.

When a significant nonconformity is found, the Classification Society has the right to reject the results of such activities.

5. Surface condition

5.1 Area to be examined shall be free from scale, loose rust, weld spatter, oil, grease, dirt or paint that might affect the sensitivity of the testing method.

5.2 Where there is a requirement to carry out PAUT or TOFD through paint, the suitability and sensitivity of the test shall be confirmed through an appropriate transfer correction method defined in the procedure. In all cases, if transfer losses exceed 12 dB, the reason shall be considered and further preparation of the scanning surfaces shall be carried out, if applicable. If testing is done through paint, then the procedure shall be qualified on a painted surface.

5.3 The requirement for acceptable test surface finish is to ensure accurate and reliable detection of defects. For the testing of welds, where the test surface is irregular or has other features likely to interfere with the interpretation of NDT results, the weld is to be ground or machined.

6. General plan of testing. ~~: NDT method selection~~

6.1 The extent of testing shall be planned by the shipbuilder or manufacturer according to the ship design, ship or equipment type and welding processes used. Particular attention shall be paid to highly stressed areas. The extent of testing shall be in accordance with UR or REC applicable with material of weld examined.

7. Testing requirements

7.1 General

7.1.1 The shipbuilder internal NDT services, manufacturer internal NDT services or external NDT service suppliers ~~shipyard or manufacturer~~ is to ensure that personnel carrying out NDT or interpreting the results of NDT are qualified to the appropriate level as detailed in section 3.

7.1.2 Procedures

(1) All NDT are to be carried out to a procedure that is representative of the item under inspection.

(2) Procedures are to identify the component to be examined, the NDT method, equipment to be used and the full extent of the examinations including any test restrictions.

(3) Procedures are to include the requirement for components to be positively identified and for a datum system or marking system to be applied to ensure repeatability of inspections.

(4) Procedures are to include the method and requirements for equipment calibrations and functional checks, together with specific technique sheets / scan plans, for the component under test.

(5) Procedures are to be approved by personnel qualified to Level III in the appropriate technique in accordance with a recognised standard.

(6) Procedures are to be reviewed by the Classification Society ~~Society's Surveyor~~.

7.1.3 The methods considered within the application of this UR are defined in section 2.5.1

7.1.4 PAUT techniques shall conform as a minimum to section 7.2 of this UR. Depending on the complexity of the item under test and the access to surfaces, there may be a requirement for additional scans and/or complementary NDT techniques to ensure that full coverage of the item is achieved.

7.1.4.1 PAUT of welds shall include a linear scan of the fusion face, together with other scans as defined in the specific test technique. Refer to linear scan requirements in section 7.2.2.4

7.1.5 TOFD techniques shall conform as a minimum to section 7.3 of this UR. Depending on the complexity of the item under test and the access to surfaces, there may be a requirement for additional scans and/or complementary NDT techniques to ensure that full coverage of the item is achieved.

7.1.6 RT-D techniques shall conform as a minimum to section 7.4 of this UR. For the purpose of this UR, RT-D comprises of two main RT methods; RT-S and RT-CR. Other methods may be included (e.g. radioscopy systems), however, then must conform to this UR as applicable, and any specific requirements shall demonstrate equivalence to these requirements.

7.1.6.1 In all RT-D methods, in addition to specific requirements, detector output quality control methods shall be described within the procedure.

7.1.6.2 The procedure shall define the level of magnification, post-processing tools, image/data security and storage, for final evaluation and reporting.

7.2 Phased array ultrasonic testing

PAUT shall be carried out according to procedures based on ISO 13588:2019, ISO 18563-1:~~2015~~ 2022, ISO 18563-2:~~2017~~ 2024, ISO 18563-3:~~2015~~ 2024 and ISO 19285:2017, and for thin wall <6mm, ISO 20601:2018 and ISO 4761:2022, or recognized standards and the specific requirements of the Classification Society.

7.2.1 Information required prior to testing

A procedure shall be written and include the following information as in minimum shown in table 3. When an essential variable in Table 3 is to change from the specified value, or range of values, the written procedure shall require requalification. When a nonessential variable is to change from the specified value, or range of values, requalification of the written procedure is not required. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.

Table 3 Requirements of a PAUT Procedure

Requirement	Essential Variable	Nonessential Variable
Material types or weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)	X	…
The surfaces from which the examination shall be performed	X	…
Technique(s) (straight beam, angle beam, contact, and/or immersion)	X	…
Angle(s) and mode(s) of wave propagation in the material	X	…
Search unit type, frequency, element size and number, pitch and gap dimensions, and shape	X	…
Focal range (identify plane, depth, or sound path)	X	…
Virtual aperture size (i.e., number of elements, effective height[1], and element width)	X	…
Focal laws for E-scan and S-scan (i.e., range of element numbers used, angular range used, element or angle increment change)	X	…
Special search units, wedges, shoes, or saddles, when used	X	…
Ultrasonic instrument(s)	X	…
Calibration [calibration block(s) and technique(s)]	X	…
Directions and extent of scanning	X	…
Scanning (manual vs. automatic)	X	…
Method for sizing indications and discriminating geometric from flaw indications	X	…
Computer enhanced data acquisition, when used	X	…
Scan overlap (decrease only)	X	…
Personnel performance requirements, when required	X	…
testing levels, acceptance levels and/or recording levels	X	…
Personnel qualification requirements	…	X
Surface condition (examination surface, calibration block)	…	X
Couplant (brand name or type)	…	X
Post-examination cleaning technique	…	X
Automatic alarm and/or recording equipment, when applicable	…	X
Records, including minimum calibration data to be recorded (e.g., instrument settings)	…	X
Environmental and safety issues	…	X

Note: 1) Effective height is the distance from the outside edge of the first to last element used in the focal law.

7.2.2 Testing

7.2.2.1 Testing levels

The testing levels specified in the testing procedure shall be in accordance with recognized standards accepted by the Classification Society. Four testing levels are specified in ISO 13588:2019, each corresponding to a different probability of detection of imperfections.

7.2.2.2 Weld Examinations

The weld examinations shall in accordance with ISO 13588:2019 and the additional special requirements of this UR.

The array probe position shall be selected to obtain an appropriate echo height, considering the flaw location, flaw characteristics, and weld joint shape and profile.

7.2.2.3 Material Examinations

Material examinations shall conform to section 2.1 as a minimum.

7.2.2.4 Volume to be inspected

The purpose of the testing shall be defined by the testing procedure. Based on this, the volume to be inspected shall be determined.
A scan plan shall be provided. The scan plan shall show the beam coverage, the weld thickness and the weld geometry.
If the evaluation of the indications is based on amplitude only, it is a requirement that an 'E' scan (or linear scan) shall be utilized to scan the fusion faces of welds, so that the sound beam is perpendicular to the fusion face ± 5º. This requirement may be omitted if an 'S' (or sectorial) scan can be demonstrated to verify that discontinuities at the fusion face can be detected and sized, using the stated procedure (note, this demonstration shall utilize reference blocks containing suitable reflectors in location of fusion zone).

7.2.2.5 Reference blocks

Depending on the testing level, a reference block shall be used to determine the adequacy of the testing (e.g. coverage, sensitivity setting). The design and manufacture of reference blocks shall be in accordance with ISO 13588:2019 or recognized equivalent standards and the specific requirements of the Classification Society.

7.2.2.6 Indication assessment

Indications detected when applying testing procedure shall be evaluated either by length and height or by length and maximum amplitude. Indication assessment shall be in accordance with ISO 19285:2017 or recognized standards and the specific requirements of the Classification Society. The sizing techniques include reference levels, Time Corrected Gain (TCG), Distance Gain Size (DGS) and 6 dB drop. 6 dB drop method shall only be used for measuring the indications larger than the beam width.

7.3 Time of flight diffraction

TOFD shall be carried out according to procedure based on ISO 10863:~~2011~~ 2020, and ISO 15626:2018 or recognized standards and the specific requirements of the Classification Society.

7.3.1 Information required prior to testing

A procedure shall be written and include the following information as shown in table 4. When an essential variable in Table 4 is to change from the specified value, or range of values, the written procedure shall require requalification. When a nonessential variable is to change from the specified value, or range of values, requalification of the written procedure is not required. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.

Table 4 Requirements of a TOFD Procedure

Requirement	Essential Variable	Nonessential Variable
Weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)	X	…
The surfaces from which the examination shall be performed	X	…
Angle(s) of wave propagation in the material	X	…
Search unit type(s), frequency(ies), and element size(s)/shape(s)	X	…
Special search units, wedges, shoes, or saddles, when used	X	…
Ultrasonic instrument(s) and software(s)	X	…
Calibration [calibration block(s) and technique(s)]	X	…
Directions and extent of scanning	X	…
Scanning (manual vs. automatic)	X	…
Data sampling spacing (increase only)	X	…
Method for sizing indications and discriminating geometric from flaw indications	X	…
Computer enhanced data acquisition, when used	X	…
Scan overlap (decrease only)	X	…
Personnel performance requirements, when required	X	…
testing levels, acceptance levels and/or recording levels	X	…
Personnel qualification requirements	…	X
Surface condition (examination surface, calibration block)	…	X
Couplant (brand name or type)	…	X
Post-examination cleaning technique	…	X
Automatic alarm and/or recording equipment, when applicable	…	X
Records, including minimum calibration data to be recorded (e.g., instrument settings)	…	X
environmental and safety issues	…	X

7.3.2 Testing

7.3.2.1 Testing levels

The testing levels specified in the testing procedure shall be in accordance with recognized standards accepted by the Classification Society. Four testing levels are specified in ISO

10863:~~2011~~ 2020, each corresponding to a different probability of detection of imperfections.

7.3.2.2 Volume to be inspected

The purpose of the testing shall be defined by the testing procedure. Based on this, the volume to be inspected shall be determined.
A scan plan shall be provided. The scan plan shall show the locations of the probes, beam coverage, the weld thickness and the weld geometry.

7.3.2.3 Due to the nature of the TOFD method, there is a possibility that the scan plan may reveal weld volume zones that will not receive full TOFD coverage (commonly known as dead zones, either in the lateral wave, back wall, or both). If the scan plan reveals that these dead zones are not adequately inspected, then further TOFD scans and/or complementary NDT methods shall be applied to ensure full inspection coverage.

7.4 Digital radiography

Digital radiography shall be performed per procedure(s) based on ISO 17636-2:~~2013~~ 2022 and standards referenced therein, or recognized standards and additional specific requirements of the Classification Society.
Any variation to applying the standard (e.g. IQI placement) shall be agreed with Classification Society.

A procedure shall be written and include the following information as shown in table 5.

Table 5 Requirements of a Digital radiography Procedure

Requirement
Material types or weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)
Digitizing System Description:
Manufacturer and model no. of digitizing system
Physical size of the usable area of the image monitor
Film size capacity of the scanning device
Spot size(s) of the film scanning system
Image display pixel size as defined by the vertical/horizontal resolution limit of the monitor
Illuminance of the video display
Data storage medium
Digitizing Technique:
Digitizer spot size (in microns) to be used
Loss-less data compression technique, if used
Method of image capture verification
Image processing operations
Time period for system verification
Spatial resolution used:
Contrast sensitivity (density range obtained)
Dynamic range used
Spatial linearity of the system
Material type and thickness range
Source type or maximum X-ray voltage used
Detector type
Detector calibration
Minimum source-to-object distance

Distance between the test object and the detector
Source size
Test object scan plan (if applicable)
Image Quality Measurement Tools
Image Quality Indicator (IQI)
Wire Image Quality Indicator
Duplex Image Quality Indicator
Image Identification Indicator
Testing levels, acceptance levels and/or recording levels
Personnel qualification requirements
Surface condition
Records, including minimum calibration data to be recorded
Environmental and Safety issues

7.4.1 Testing levels

Regarding choice of testing level per ISO 17636-2: ~~2013~~ 2022 this is referred to in section 8.4.

8. Acceptance Levels

8.1 General

8.1.1 This section details the acceptance levels followed for the assessment of the NDT results. Methods include but are not limited to: Phased array ultrasonic testing (PAUT), Time of flight diffraction (TOFD), Digital radiography (RT-D).

8.1.2 It may be necessary to combine testing methods to facilitate the assessment of indications against the acceptance criteria.

8.1.3 Acceptance criteria for each material and weld joint shall be in accordance with each UR and Recommendation in section 2.1.1.

8.2 Phased array ultrasonic testing

8.2.1 Weld Examinations

The relationship between acceptance levels, testing levels and quality levels is given in Table 6.
Quality levels and acceptance levels for PAUT of welds shall be in accordance with ISO 19285:2017 or recognized standard agreed with the Classification Society.

Table 6 Acceptance levels for PAUT thickness ≥ 6mm

Quality levels according to ISO 5817:~~2014~~ 2023	Testing level according to ISO 13588:2019	Acceptance levels according to ISO 19285:2017
C, D	A	3
B	B	2
By agreement	C	1
Special application	D	By agreement

Table 6a Acceptance levels for PAUT thickness 3.2 ≤ t < 6mm

Quality levels according to ISO 5817: 2023	Testing level according to ISO 20601:2018	Acceptance levels according to ISO 4761:2022
B (stringent)	C	1
C (intermediate)	C	2
D (moderate)	C	3
Special application	D	By agreement

8.2.2 Material Examinations

Quality levels and acceptance levels for PAUT of material testing shall be in accordance to recognized standard agreed with the Classification Society.
The acceptance levels for material examinations shall conform as a minimum to the appropriate IACS Resolutions, including UR and Recommendations.

8.3 Time of flight diffraction

The relationship between acceptance levels, testing levels and quality levels is given in Table 7.
Quality levels and acceptance levels for TOFD of welds shall be in accordance to ISO 15626:2018 or recognized standard agreed with the Classification Society.

Table 7 Acceptance levels for TOFD

Quality levels according to ISO 5817: ~~2014~~ 2023	Testing level according to ISO 10863: ~~2011~~ 2020	Acceptance level according to ISO 15626:2018
B (Stringent)	C	1
C (Intermediate)	At least B	2
D (Moderate)	At least A	3

8.4 Digital radiography

The relationship between acceptance levels, testing levels and quality levels is given in Table 8.
Quality levels and acceptance levels for Digital Radiography of welds shall be in accordance with ISO 10675-1: 2021 and ISO 10675-2: 2021 or standard agreed with the Classification Society.

Table 8 Acceptance levels for Digital radiography

Quality levels according to ISO 5817: ~~2014~~ 2023 or ISO 10042:2018	Testing techniques/level(class) according to ISO 17636-2:: ~~2013~~2022	Acceptance level according to ISO 10675-1: ~~2016~~ 2021 & ISO 10675-2: ~~2017~~ 2021
B (Stringent)	B (class)	1
C (Intermediate)	B* (class)	2
D (Moderate)	A (class)	3
*For circumferential weld testing, the minimum number of exposures may correspond to the requirements of ISO 17636-2: ~~2013~~ 2022, class A		

Guidance notes:

(i) An interpretation (or evaluation) length of 100mm (as described in ISO 10675: 2021, parts 1 and 2) shall be applied throughout the radiograph (or digital image), and not just applied to randomly selected locations. The full radiographic (diagnostic) length shall be evaluated – this may consist of a series of multiple 100mm lengths. For porosity, the 100mm length containing the most severe distribution within the radiograph is to be selected as the interpretation area(s)

(ii) For the Interpretation of radiographs (or digital images) at crossover locations, then each transverse butt or longitudinal seam (single line) weld is to be assessed separately, and the lengths not to be aggregated when interpreting indications based on area.

9. Reporting

9.1 The test report shall include at least the following information:

a) a reference to standards of compliance;

b) information relating to the object under test:
1) identification of the object under test,
2) dimensions including wall thickness,
3) material type and product form,
4) geometrical configuration,
5) location of welded joint(s) examined,
6) reference to welding process and heat treatment,
7) surface condition and temperature,
8) stage of manufacture;

c) information relating to equipment:

Table 9 Information relating to equipment

Method	Information
All	manufacturer and type of instrument, including with identification numbers if required.
PAUT	1) manufacturer, type, frequency of phased array probes including number and size of elements, material and angle(s) of wedges with identification numbers if required, 2) details of reference block(s) with identification numbers if required, 3) type of couplant used.
TOFD	1) manufacturer, type, frequency, element size and beam angle(s) of probes with identification numbers if required, 2) details of reference block(s) with identification numbers if required, 3) type of couplant used.
RT-D	1) system of marking used, 2) radiation source, type and size of focal spot and identification of equipment used, 3) detector, screens and filters and detector basic spatial resolution.

d) information relating to test technology:

Table 10 Information relating to test technology

Method	Information
All	1) testing level and reference to a written test procedure, 2) purpose and extent of test, 3) details of datum and coordinate systems, 4) method and values used for range and sensitivity settings, 5) details of signal processing and scan increment setting, 6) access limitations and deviations from standards, if any.
PAUT	1) increment (E-scans) or angular increment (S-scans), 2) element pitch and gap dimensions, 3) focus (calibration should be the same as scanning), 4) virtual aperture size, i.e. number of elements and element width, 5) element numbers used for focal laws, 6) documentation on permitted wedge angular range from manufacturer, 7) documented calibration, TCG and angle gain compensation, 8) scan plan.
TOFD	1) details of TOFD setups, 2) details of offset scans, if required.
RT-D	1) detector position plan, 2) tube voltage used and current or source type and activity, 3) time of exposure and source-to-detector distance, 4) type and position of image quality indicators, 5) achieved and required SNR_N for RT-S or achieved and required grey values and/or SNR_N for RT-CR, 6) for RT-S: type and parameters such as gain, frame time, frame number, pixel size, calibration procedure, 7) for RT-CR: scanner type and parameters such as pixel size, scan speed, gain, laser intensity, laser spot size, 8) image-processing parameters used, e.g. of the digital filters.

e) information relating to test results:

Table 11 Information relating to test results

Method	Information
All	1) acceptance criteria applied, 2) tabulated data recording the classification, location and size of relevant indications and results of evaluation, 3) results of examination including data on software used, 4) date of test, 5) reference to the raw data file(s), 6) date(s) of scan or exposure and test report, 7) names, signatures and certification of personnel.
PAUT	1) phased array images of at least those locations where relevant indications have been detected on hard copy, all images or data available in soft format,

	2) reference points and details of the coordinate system.
TOFD	TOFD images of at least those locations where relevant TOFD indications have been detected.

9.2 Results of NDT are to be recorded and evaluated by the shipbuilder or manufacturer on a continual basis. These records are to be available to the Surveyor.

9.3 The shipbuilder or manufacturer is to be responsible for the review, interpretation, evaluation and acceptance of the results of NDT. Reports stating compliance or otherwise with the criteria established in the inspection procedure are to be issued

9.4 In addition to the above general reporting requirements, all specified NDT methods will have particular requirements and details that shall be listed in the report. Refer to the applicable method standards for specific requirements.

9.5 The shipbuilder or manufacturer is to keep the inspection records for the appropriate period deemed by Classification Societies.

10. Unacceptable indications and repairs

All indications (discontinuities) exceeding the applicable acceptance criteria shall be classed as defects, and shall be eliminated and repaired as per applicable IACS requirements, including UR and Recommendations.

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