W33 Non-destructive testing of ship hull steel welds

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(Rev.1
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1 General

1.1 This document gives minimum requirements on the methods and quality levels that are to be adopted for the non-destructive testing (NDT) of ship hull structure steel welds during new building ("hull structure" as defined in UR Z23).

1.2 The quality levels given in this document refer to production quality and not to fitness-for-purpose of the welds examined.

1.3 The NDT is normally to be performed by the Shipbuilder or its subcontractors in accordance with these requirements. The Classification Surveyor may require witnessing of the testing.

1.4 It is the Shipbuilder's responsibility to assure that testing specifications and procedures are adhered to during the construction and the reports are made available to the Classification Society on the findings made by the NDT.

1.5 The extent of testing and the number of checkpoints are to be agreed between the Shipbuilder and the Classification Society. For criticality of structure reference is to be made to IACS UR S6 Tables of Structural Member Categories and IACS CSR for Bulk Carriers and Oil Tankers

1.6 This UR covers conventional NDT methods. Advanced non-destructive testing (ANDT) methods such as phased array ultrasonic testing (PAUT), time of flight diffraction (TOFD), digital radiography (RT-D), radioscopic testing (RT-S), and computed radiography (RT-CR) are covered by UR W34.

Note:

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 July 2021.

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1.7 Terms and definitions

The following terms and definitions apply for this document.

NDT Non-Destructive Testing - the development and application of technical methods to examine materials or components in ways that do not impair their future usefulness and serviceability, in order to measure geometrical characteristics and to detect, locate, measure and evaluate flaws. NDT is also known as non-destructive examination (NDE), non-destructive inspection (NDI) and non-destructive evaluation (NDE).

RT Radiographic Testing

UT Ultrasonic Testing

MT Magnetic Particle Testing

PT Dye or Liquid Penetrant Testing

PWHT Post Weld Heat Treatment

VT Visual Testing

2 Application

2.1 Base Metals

2.1.1 This document applies to fusion welds made in normal and higher strength hull structural steels in accordance with UR W11, and UR W31, high strength steels for welded structures in accordance with UR W16 and connections welds with hull steel forgings in accordance with UR W7 and hull steel castings in accordance with UR W8. Base metal other than the above may be applied by each Classification Society

2.2 Welding processes

2.2.1 This document applies to fusion welds made using manual metal arc welding (shielded metal arc welding, 111), gas-shielded metal arc welding (gas metal arc welding, including flux cored arc welding, 13x), gas-shielded arc welding with non-consumable tungsten electrode (gas tungsten arc welding, 14x), submerged arc welding (12x), electro-slag welding (72x) and electro-gas welding processes (73). Terms and numbers according to ISO 4063:2009 ("x" indicates that relevant subgroups are included). This document may also be applied to welding processes other than the above at the discretion of each Classification Society.

2.3 Weld joints

2.3.1 This document applies to butt welds with full penetration, tee, corner and cruciform joints with or without full penetration, and fillet welds.

2.4 Timing of NDT

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

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2.4.2 For high strength steels for welded structure with specified minimum yield stress in the range of 420 N/mm² to 690 N/mm², NDT shall not be carried out before 48 hours after completion of welding. For steel with specified minimum yield greater than 690 N/mm² NDT shall not be carried out before 72 hours after completion of welding. Regardless of yield strength consideration is to be given to requiring a delayed inspection where evidence of delayed cracking has been observed in production welds.

At the discretion of the surveyor, a longer interval and/or additional random inspection at a later period may be required, (for example in case of high thickness welds).

At the discretion of the surveyor, the 72 hour interval may be reduced to 48 hours for ~~radiographic testing (~~RT~~)~~ or ~~ultrasonic testing (~~UT~~)~~ inspection, provided there is no indication of delayed cracking, and a complete visual and random ~~magnetic particle (~~MT~~)~~ or ~~penetrant testing (~~PT~~)~~ inspection to the satisfaction of the surveyor is conducted 72 hours after welds have been completed and cooled to ambient temperature.

Where ~~post weld heat treatment (~~PWHT~~)~~ is carried out the requirement for testing after a delay period may be relaxed, at the discretion of the surveyor.

2.5 Applicable methods for testing of weld joints

2.5.1 The methods mentioned in this document for detection of surface imperfections are ~~visual testing (~~VT~~)~~, PT and MT. The methods mentioned for detection of internal imperfections are UT and RT.

2.5.2 Applicable methods for testing of the different types of weld joints are given in Table 1.

Table 1: Applicable methods for testing of weld joints

WELD JOINT	PARENT MATERIAL THICKNESS	APPLICABLE TEST METHODS
Butt welds with full penetration	thickness < 8mm[1]	VT, PT, MT, RT
	thickness ≥ 8mm	VT, PT, MT, UT, RT
Tee joints, corner joints and cruciform joints with full penetration	thickness < 8mm[1]	VT, PT, MT, RT[3]
	thickness ≥ 8mm	VT, PT, MT, UT, RT[3]
Tee joints, corner joints and cruciform joints without full penetration and fillet welds	All	VT, PT, MT, UT[2], RT[3]

Notes:

1) In cases of thickness below 8mm the Classification Society may consider application of an appropriate advanced UT method.
2) UT may be used to check the extent of penetration in tee, corner and cruciform joints. This requirement is to be agreed with the Classification Society.
3) RT may be applied however there will be limitations

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3 Qualification of personnel involved in NDT

3.1 The Shipbuilder 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 9712:2012.

Personnel qualification to an employer based qualification scheme as e.g. SNT-TC-1A, 2016 or ANSI/ASNT CP-189, 2016 may be accepted if the Shipbuilder or its subcontractors written practice is reviewed and found acceptable by the Society. The Shipbuilder 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 9712:2012.

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 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 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 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 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 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, welding, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.

4 Surface condition

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

Preparation and cleaning of welds for subsequent NDT are to be in accordance with the accepted NDT procedures, and are to be to the satisfaction of the surveyor. Surface conditions that prevent proper interpretation may be cause for rejection of the weld area of interest.

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5 General plan of testing: NDT method selection

5.1 The extent of testing and the associated quality levels are to be planned by the Shipbuilder according to the ship design, ship type and welding processes used. For new construction survey reference is to be made to the NDT requirements of IACS UR Z23 and the applicable parts of the UR Z23 enclosures Table 1 and Appendices.

5.2 For each construction, the Shipbuilder shall submit a plan for approval by the Classification Society, specifying the areas to be examined and the extent of testing and the quality levels, with reference to the NDT procedures to be used. Particular attention is to be paid to inspecting welds in highly stressed areas and welds in primary and special structure indicated in IACS UR S6. The NDT procedure(s) shall meet the requirement stated in section 6 of this UR and the specific requirements of the Classification Society. The plan shall only be released to the personnel in charge of the NDT and its supervision.

In selecting checkpoints, emphasis shall be given to the following inspection locations:

Welds in high stressed areas
Fatigue sensitive areas
Other important structural elements
Welds which are inaccessible or very difficult to inspect in service
Field erected welds
Suspected problem areas

Block construction welds performed in the yards, or at subcontracted yards/facilities, are to be considered in selecting checkpoints.

For other marine and offshore structures the extent is to be agreed by the Classification Society.

If an unacceptable level of indications are found the NDT extent is to be increased.

5.3 The identification system shall identify the exact locations of the lengths of weld examined.

5.4 All welds over their full length are to be subject to VT by personnel designated by the Shipbuilder, who may be exempted from the qualification requirements defined in section 3 of the UR.

5.5 As far as practicable, PT or MT shall be used when investigating the outer surface of welds, checking the intermediate weld passes and back-gouged joints prior to subsequent passes deposition. MT shall be performed in ferromagnetic materials welds unless otherwise agreed with the Classification Society. Surface inspection of important tee or corner joints, using an approved MT or PT method, shall be conducted to the satisfaction of the surveyor.

5.6 Welded connections of large cast or forged components (e.g. stern frame, stern boss, rudder parts, shaft brackets...) are to be tested over their full length using MT (MT is the preferred method) or PT, (PT is to be applied for non-ferrous metals) and at agreed locations using RT or UT.

5.7 As given in Table 1, UT or RT or a combination of UT and RT may be used for testing of butt welds with full penetration of 8mm or greater. Methods to be used shall be agreed with the Classification Society. The method used shall be suited for the detection of particular types and orientations of discontinuities. RT and UT are used for detection of internal discontinuities, and in essence they supplement and complement each other. RT is generally

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most effective in detecting volumetric discontinuities (e.g. porosity and slag) whilst UT is more effective for detecting planar discontinuities (e.g. laminations, lack of fusion and cracks). Although one method may not be directly relatable to the other, either one would indicate conditions of inadequate control of the welding process.

5.8 In general start/stop points in welds made using automatic (mechanized) welding processes are to be examined using RT or UT, except for internal members where the extent of testing is to be agreed with the attending surveyor.

5.9 Where the surveyor becomes aware that an NDT location has been repaired without a record of the original defect, the shipyard is to carry out additional examinations on adjacent areas to the repaired area to the satisfaction of the attending surveyor. Reference is to be made to UR Z23.

5.10 Welds in thick steels (>50mm) used in container carrier, deck and hatch coaming areas are to be inspected in accordance with the additional requirements in IACS UR S33

6 Testing

6.1 General

6.1.1 The testing method, equipment and conditions shall comply with recognized National or International standards, or other documents to the satisfaction of the Classification Society.

6.1.2 Sufficient details shall be given in a written procedure for each NDT technique submitted to the Classification Society for acceptance.

6.1.3 The testing volume shall be the zone which include the weld and parent material for at least 10mm each side of the weld, or the width of the heat affected zone (HAZ), whichever is greater. In all cases inspection shall cover the whole testing volume.

6.1.4 Provision is to be made for the surveyor to verify the inspection, reports and records (e.g. radiographs) on request.

6.2 Visual testing (VT)

6.2.1 The personnel in charge of VT is to confirm that the surface condition is acceptable prior to carrying out the inspection. VT shall be carried out in accordance with standards agreed between the Shipbuilder and the Classification Society.

6.3 Liquid penetrant testing (PT)

6.3.1 PT shall be carried out in accordance to ISO 3452-1:2013 or a recognized accepted standard and the specific requirement of each Classification Society.

6.3.2 The extent of PT shall be in accordance to the plans agreed with the attending surveyor and to the satisfaction of the surveyor.

6.3.3 The surface to be examined shall be clean and free from scale, oil, grease, dirt or paint so there are not contaminants and entrapped material that may impede penetration of the inspection media.

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6.3.4 The temperature of parts examined shall be typically between 5°C and 50°C, outside this temperature range special low/high temperature penetrant and reference comparator blocks shall be
used.

6.4 Magnetic particle testing (MT)

6.4.1 MT shall be carried out in accordance to ISO 17638:2016 or a recognized accepted standard and the specific requirement of each Classification Society.

6.4.2 The extent of MT shall be in accordance to the plans agreed with the attending surveyor and to the satisfaction of the surveyor.

6.4.3 The surface to be examined shall be free from scale, weld spatter, oil, grease, dirt or paint and shall be clean and dry. In general, the inside and outside of the welds to be inspected need to be sufficiently free from irregularities that may mask or interfere with interpretation.

6.5 Radiographic testing (RT)

6.5.1 RT shall be carried out in accordance to ISO 17636-1:2013 or an accepted recognized standard and any specific requirement of Classification Society

6.5.2 The minimum inspected weld length for each checkpoint is to be specified in the approved NDT plan (see 5.2) and shall follow the requirements of each Classification Society. For hull welds the minimum length inspected by RT is typically 300mm.

The extent of RT shall be in accordance to the approved plans and to the satisfaction of the surveyor.

Consideration may be given for reduction of inspection frequency for automated welds where quality assurance techniques indicate consistent satisfactory quality.
The number of checkpoints is to be increased if the proportion of non-conforming indications is abnormally high.

6.5.3 The inside and outside surfaces of the welds to be radiographed are to be sufficiently free from irregularities that may mask or interfere with interpretation. Surface conditions that prevent proper interpretation of radiographs may be cause for rejection of the weld area of interest.

6.6 Ultrasonic testing (UT)

6.6.1 UT shall be carried out according to procedure based on ISO 17640:2018 (testing procedure), ISO 23279:2017 (characterization) and ISO 11666:2018 (acceptance levels) or accepted standards and the specific requirements of the Classification Society.

6.6.2 The minimum inspected weld length for each checkpoint is to be specified in the approved NDT plan (see 5.2) and shall follow the requirements of each Classification Society.

The extent of UT shall be in accordance to the approved plans and to the satisfaction of the surveyor.

A checkpoint shall consist of the entire weld length or a length agreed with the Classification Society.

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7 Acceptance Levels (criteria)

7.1 General

7.1.1 This section details the acceptance levels (criteria) followed for the assessment of the NDT results. Techniques include but are not limited to: VT, MT, PT, RT and UT.

7.1.2 As far as necessary, testing techniques shall be combined to facilitate the assessment of indications against the acceptance criteria.

7.1.3 The assessment of indications not covered by this document shall be made in accordance with a standard agreed with the Classification Society. Alternative acceptance criteria can be agreed with the Classification Society, provided equivalency is established.

The general accepted methods for testing of welds are provided in Table 2 and Table 3 for surface and embedded discontinuities respectively. Refer to ISO 17635:2016.

Table 2. Method for detection of surface discontinuities (All type of welds including fillet welds)

Materials	***Testing Methods***
Ferritic Steel	VT
	VT, MT
	VT, PT

Table 3. NDT for detection of embedded discontinuities (for butt and T joints with full penetration)

Materials and type of joint	***Nominal thickness (t) of the parent material to be welded (mm)***		
	t < 8	***8 ≤ t ≤ 40***	***t > 40***
Ferritic butt-joints	RT or UT[1]	RT or UT	UT or RT[2]
Ferritic T-joints	UT[1] or RT[2]	UT or RT[2]	UT or RT[2]

Notes:

1) Below 8mm the Classification Society may consider application of an appropriate advanced UT method.
2) RT may be applied however there will be limitations.

7.2 Quality Levels.

Testing requirements follows the designation of a particular quality level of imperfections in fusion-welded joints in accordance with ISO 5817:2014. Three quality levels (B, C and D) are specified.

In general Quality level C is to be applied for hull structure.

Quality level B corresponds to the highest requirement on the finished weld, and may be applied on critical welds.

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This standard applies to steel materials with thickness above 0.5 mm. ISO 5817:2014 Table 1 provides the requirements on the limits of imperfections for each quality level. ISO 5817:2014 Annex A also provides examples for the determination of percentage of imperfections (number of pores in surface percent).

All levels (B,C and D) refer to production quality and not to the fitness for purpose (ability of product, process or service to serve a defined purpose under specific conditions). The correlation between the quality levels defined in ISO 5817:2014, testing levels/ techniques and acceptance levels (for each NDT technique) will serve to define the purpose under specific conditions. The acceptance level required for examination shall be agreed with the Classification Society. This will determine the quality level required in accordance with the non-destructive technique selected. Refer to tables 4 to 9.

7.3 Testing Levels.

7.3.1 The testing coverage and thus the probability of detection increases from testing level A to testing level C. The testing level shall be agreed with the Classification Society. Testing level D is intended for special applications, this can only be used when defined by specification. ISO 17640:2018 Annex A tables A.1 to A.7 provide guidance on the selection of testing levels for all type of joints in relation to the thickness of parent material and inspection requirements.

7.3.2 The testing technique used for the assessment of indications shall also be specified.

7.4 Acceptance Levels.

7.4.1 The acceptance levels are specified for each testing technique used for performing the inspection. The criteria applied is to comply with each standard identified in tables 4 to 9 (or any recognized acceptable standard agreed with the Classification Society).

7.4.2 Probability of detection (POD) indicates the probability that a testing technique will detect a given flaw.

7.5 Visual testing (VT)

7.5.1 The acceptance levels and required quality levels for VT are provided in IACS Rec 47 and Table 4 below.

Table 4. Visual testing

Quality Levels (ISO 5817:2014 applies)[a]	***Testing Techniques/ levels (ISO 17637:2016 applies)[a]***	***Acceptance levels[b]***
B	Level not specified	B
C		C
D		D
[a] Or any recognized standard agreed with Classification Society and demonstrated to be acceptable [b] The acceptance levels for VT are the same to the quality levels requirements of ISO 5817:2014		

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7.6 Penetrant testing (PT)

7.6.1 The acceptance levels and required quality levels for PT are provided in Table 5 below:

Table 5. Penetrant Testing

Quality Levels (ISO 5817:2014 applies)[a]	*Testing Techniques/ levels (ISO 3452-1:2013 applies)*[a]	*Acceptance levels (ISO 23277:2015 applies)*[a]
B	Level not specified	2X
C		2X
D		3X
[a] Or any recognized standard agreed with Classification Society and demonstrated to be acceptable		

7.7 Magnetic Particle testing (MT)

7.7.1 The acceptance levels and required quality levels for MT is provided in Table 6 below:

Table 6. Magnetic Particle Testing

Quality Levels (ISO 5817:2014 applies)[a]	*Testing Techniques/ levels (ISO 17638:2016 applies)*[a]	*Acceptance levels (ISO 23278:2015 applies)*[a]
B	Level not specified	2X
C		2X
D		3X
[a] Or any recognized standard agreed with Classification Society and demonstrated to be acceptable		

7.8 Radiographic testing (RT)

7.8.1 The acceptance levels and required quality levels for RT are provided in Table 7 below. Reference radiographs for the assessment of weld imperfections shall be provided in accordance to ISO 5817:2014 or acceptable recognized standard agreed with the Classification Society.

Table 7. Radiographic Testing

Quality Levels (ISO 5817:2014 applies)[a]	*Testing Techniques/ levels (ISO 17636-1:2013 applies)*[a]	*Acceptance levels (ISO 10675-1:2016 applies)*[a]
B	B (class)	1
C	B[b] (class)	2
D	At least A (class)	3
[a] Or any recognized standard agreed with Classification Society and demonstrated to be acceptable [b] For circumferential weld testing, the minimum number of exposures may correspond to the requirements of ISO 17636-1:2013, class A		

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7.9 Ultrasonic testing (UT)

7.9.1 The acceptance levels and required quality levels for UT are provided in Tables 8 and 9 below:

Table 8. Ultrasonic Testing

Quality Levels (ISO 5817:2014 applies) [a, b]	*Testing Techniques/Levels (ISO 17640:2018 applies)* [a, b]	*Acceptance Levels (ISO 11666:2018 applies)* [a, b]
B	at least B	2
C	at least A	3
D	at least A	3[c]

[a] Or any recognized standard agreed with Classification Society and demonstrated to be acceptable
[b] When characterization of indications is required, ISO 23279:2017 is to be applied
[c] UT is not recommended but can be defined in a specification with same requirement as Quality Level C

Table 9. Recommended Testing and Quality Levels (ISO 17640)

Testing Level[a,b,c] (ISO 17640:2018 applies)	*Quality Level (ISO 5817:2014 applies)*
A	C, D
B	B
C	By agreement
D	Special application

[a] POD increases from testing level A to C as testing coverage increases
[b] Testing Level D for special application shall be agreed with Classification Society
[c] Specific requirements for testing levels A to C, are provided for various types of joints in ISO 17460:2018 Annex A

7.9.2 UT Acceptance Levels apply to the examination of full penetration ferritic steel welds, with thickness from 8 mm to 100mm. The nominal frequency of probes used shall be between 2MHz and 5MHz. Examination procedures for other type of welds, material, thicknesses above 100 mm and examination conditions shall be submitted to the consideration of the Classification Society.

7.9.3 The acceptance levels for UT of welds are to be defined in accordance to ISO 11666:2018 requirements or any recognized acceptable standard agreed with the Classification Society. The standard specifies acceptance level 2 and 3 for full penetration welded joints in ferritic steels, corresponding to quality levels B and C (Refer to table 8).

7.9.4 Sensitivity settings and levels. The sensitivity levels are set by the following techniques:

- Technique 1: based on 3mm diameter side- drilled holes
- Technique 2: based on distance gain size (DGS) curves for flat bottom holes (disk-shaped reflectors)
- Technique 3: using a distance-amplitude-corrected (DAC) curve of a rectangular notch of 1mm depth and 1mm width
- Technique 4: using the tandem technique with reference to a 6mm diameter flat-bottom hole (disk shaped reflector)

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The evaluation levels (reference, evaluative, recording and acceptance) are specified in ISO 11666:2018 Annex A.

8 Reporting

8.1 Reports of NDT required shall be prepared by the Shipbuilder and shall be made available to the Classification Society.

8.2 Reports of NDT shall include the following generic items:

- Date of testing
- Hull number, location and length of weld inspected
- Names, qualification level and signature of personnel that have performed the testing
- Identification of the component examined
- Identification of the welds examined
- Steel grade, type of joint, thickness of parent material, welding process
- Acceptance criteria
- Testing standards used
- Testing equipment and arrangement used
- Any test limitations, viewing conditions and temperature
- Results of testing with reference to acceptance criteria, location and size of reportable indications
- Statement of acceptance / non-acceptance, evaluation date, name and signature of evaluator
- Number of repairs if specific area repaired more than twice

8.3 In addition to generic items, reports of PT shall include the following specific items:

- Type of penetrant, cleaner and developer used
- Penetration time and development time

8.4 In addition to generic items, reports of MT shall include the following specific items:

- Type of magnetization
- Magnetic field strength
- Detection media

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- Viewing conditions
- Demagnetization, if required

8.5 In addition to generic items, reports of RT shall include the following specific items:

- Type and size of radiation source (width of radiation source), X-ray voltage
- Type of film/designation and number of film in each film holder/cassette
- Number of radiographs (exposures)
- Type of intensifying screens
- Exposure technique, time of exposure and source-to-film distance as per below:
- Distance from radiation source to weld
- Distance from source side of the weld to radiographic film
- Angle of radiation beam through the weld (from normal)
- Sensitivity, type and position of IQI (source side or film side)
- Density
- Geometric un-sharpness
- Specific acceptance class criteria for RT

Examinations used for acceptance or rejection of welds shall be recorded in an acceptable medium. A written record providing following information: identification and description of welds, procedures and equipment used, location within recorded medium and results shall be included. The control of documentation unprocessed original images and digitally processes images is to be to the satisfaction of the surveyor.

8.6 In addition to generic items, reports of UT shall include the following specific items:

- Type and identification of ultrasonic equipment used (instrument maker, model, series number), probes (instrument maker, serial number), transducer type (angle, serial number and frequency) and type of couplant (brand).
- Sensitivity levels calibrated and applied for each probe
- Transfer loss correction applied Type of reference blocks
- Signal response used for defect detection
- Reflections interpreted as failing to meet acceptance criteria

The method for review and evaluation of UT reports is required for adequate quality control and is to be to the satisfaction of the surveyor.

8.7 The shipyard is to keep the inspection records specified in 8.2 to 8.6 of this document for at least for 5 years.

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9 Unacceptable indications and repairs

9.1 Unacceptable indications shall be eliminated and repaired where necessary. The repair welds are to be examined on their full length using appropriate NDT method at the discretion of the Surveyor.

9.2 When unacceptable indications are found, additional areas of the same weld length shall be examined unless it is agreed with the surveyor and fabricator that the indication is isolated without any doubt. In case of automatic welded joints, additional NDT shall be extended to all areas of the same weld length.

All radiographs exhibiting non-conforming indications are to be brought to the attention of the surveyor. Such welds are to be repaired and inspected as required by the surveyor. When non-conforming indications are observed at the end of a radiograph, additional RT is generally required to determine their extent. As an alternative, the extent of non-conforming welds may be ascertained by excavation, when approved by the surveyor.

9.3 The extent of testing can be extended at the surveyor's discretion when repeated non-acceptable discontinuities are found.

9.4 The inspection records specified in section 8 are to include the records of repaired welds.

9.5 The Shipbuilder shall take appropriate actions to monitor and improve the quality of welds to the required level. The repair rate is to be recorded by the shipyard and any necessary corrective actions are to be identified in the builder's QA system.

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