

W28 Welding procedure qualification tests of steels for hull construction and marine structures

(June 2005)
(Rev.1 Nov 2006)
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(Rev.3 Complete Revision Sep 2025)

1 Scope

- 1.1 This document gives requirements for qualification tests of welding procedures intended for the use of weldable steels as specified in UR W7, UR W8, UR W11 and UR W16 for hull construction and marine structures.
- 1.2 This document excludes the qualification of welding procedures for constructing containment systems in ships carrying liquified gases in bulk and those ships using gases or other low flashpoint fuels.
- 1.3 For the qualification of welding procedures intended for the use of YP47 steels, UR W31 has specific requirements, and includes references to this UR. Range of approval is included in section 5.2.2 of this Unified Requirement.
- 1.4 This document is not applicable to T, K, Y joints (tubular type connections), for which a specific national or international standard acceptable to the Classification Society may be applied.
- 1.5 All new welding procedure qualification tests are to be carried out in accordance with this document from 01 January 2027. The list of implementation dates are recorded in the notes section. Welding procedures qualified in accordance with national or international welding procedure qualification standards may also be accepted at the discretion of the Classification Society provided that the qualification requirements for examination, testing and range of approval are considered to meet the technical requirements of this UR – see also 1.6.
- 1.6 Welding procedures qualified in accordance with national or international welding procedure qualification standards may result in a difference in the examination, testing, and range of approval. For the acceptance of such qualifications, then Annex A shall be followed.
- 1.7 This document does not invalidate welding procedure specification and welding procedure qualification records made and accepted by the Classification Society in accordance with previous revisions of this UR.

Note:

1. This UR is to be uniformly implemented by IACS Societies on ships contracted for construction from 1 January 2007 as well as the manufacturing of which is commenced on or after 1 January 2007.
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.

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3. Rev.2 of this Unified Requirement is to be uniformly implemented by IACS Societies on ships constructed on or after 1 January 2013.
 4. Rev.3 of this Unified Requirement is to be uniformly implemented by IACS Societies on ships constructed on or after 1 January 2027.
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- 1.8 Where the manufacturer or the shipyard selects plates with high heat input grade notation, then Annex E is applicable, in addition to all other requirements within this UR. (Annex E is initially introduced into Rev.3 of this UR).
- 1.9 Although the term “plates” is used throughout this UR, the requirements of this UR are also applicable to other steel product forms such as wide flats, sections, and bars.

2 General

- 2.1 Welding procedure qualification tests are intended to verify that a manufacturer or a shipyard is adequately qualified to perform welding operations using a particular procedure.
- 2.2 In general welding procedure tests are to reflect fabrication conditions in respect to welding equipment, inside or outside fabrication, weld preparation, preheating and any post-weld heat treatment. It is to be the manufacturer or shipyard’s responsibility to establish and document whether a procedure is suitable for the particular application. Steel mill recommendations are to be considered by the manufacturer or the shipyard when applying high heat input welding to plates without an approved high heat input grade notation. For welding procedure qualification tests using plates with approved high heat input grade notation, refer also to Annex E.

Guidance note: The manufacturer or the shipyard is to be aware that the use of plates which do not have an approved high heat input grade notation have not undergone a weldability test for a specified high heat input.

- 2.3 For the welding procedure approval, the welding procedure qualification test is to be carried out with satisfactory results. Welding procedure specifications are to refer to the test results achieved during welding procedure qualification testing.
- 2.4 A welding procedures test according to this UR prepared by a manufacturer or a shipyard is valid for welding in workshops or sites when the manufacturer or the shipyard who performed the tests retains complete responsibility for all the welding carried out to it.

3 Welding procedure specification**3.1 Preliminary welding procedure specification and welding procedure specification**

- 3.1.1 A preliminary welding procedure specification (pWPS) is to be prepared by the shipyard or manufacturer which intends to perform the welding procedure qualification test. The pWPS can be modified and amended during procedure tests as deemed necessary however it is to define all relevant variables required by this UR.

- 3.1.2 The shipyard or manufacturer is to submit to the Society a pWPS for review prior to the tests. In case that the test pieces welded according to the pWPS show unacceptable results the pWPS is to be revised by the shipyard or manufacturer. The new revised pWPS is to be qualified in accordance with this UR..
- 3.1.3 On satisfactory qualification of the pWPS, the Society may approve it as a WPS for production welding. The WPS approval range is to be based on the welding procedure qualification record (WPQR) and is to comply with section 5 of this UR.

4 Qualification of welding procedure

4.1 General

- 4.1.1 Preparation and welding of test pieces are to be carried out in accordance with the pWPS and under the general condition of production welding which it represents.
- 4.1.2 Welding of the test assemblies and testing of test specimens are to be witnessed by the Surveyor.
- 4.1.3 If tack welds and/or start and stop points are a condition of the welding process they are to be fused into the joint and are to be included in the test assemblies.
- 4.14 Where most of the welding connections are a fillet weld type, a fillet weld qualification in addition to the butt weld qualification test is to be performed to confirm that acceptable weld quality is achieved.
- 4.1.5 High heat input is defined as:
- heat input greater than 50kJ/cm (for all strength levels);
- For QT condition, heat input greater than 35 kJ/cm for strength levels 420 N/mm² and above.
- 4.1.6 For steel strength levels 890 and 960 N/mm², the weld metal strength and/or toughness may be lower than that specified for the base metal provided that the application has design approval for the undermatching weld metal, and the consumables are a lower grade approved in accordance with UR W23. In such cases, the weld metal strength and/or toughness is to be not less than that specified in the approved design.

4.2 Butt weld

4.2.1 Assembly of test pieces

The test assembly is to be of a size sufficient to ensure a reasonable heat distribution and according to Fig. 1 with the minimum dimensions:

- Manual or semi-automatic welding:

Width = 2a, a = 3 x t, min 150 mm

Length b = 6 x t, min 350 mm

- Automatic welding:

Width = 2a, a = 4 x t, min 200 mm

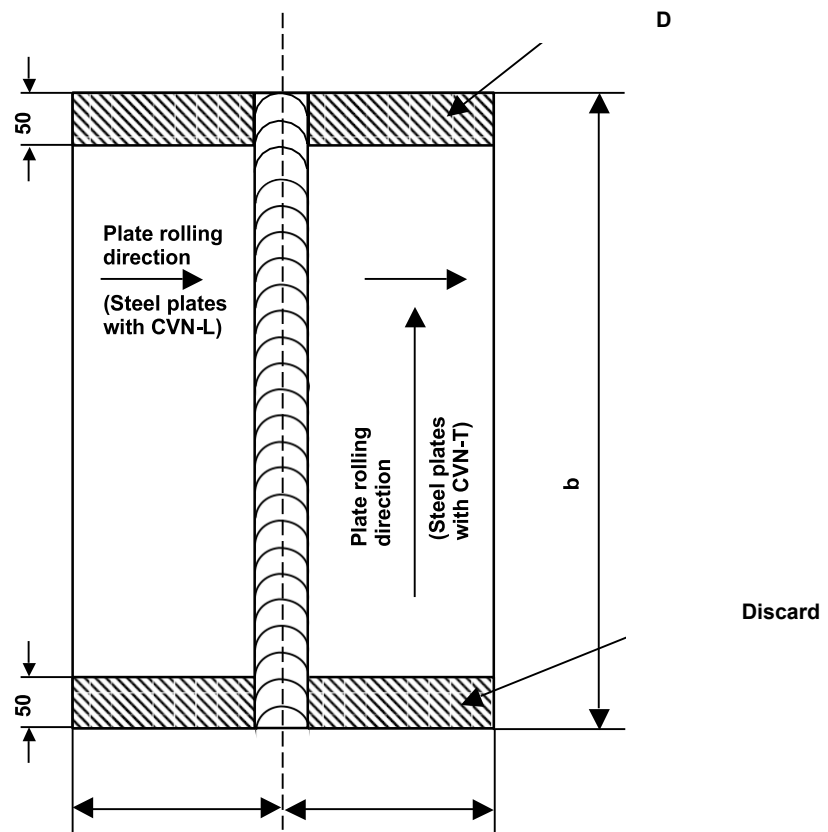
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(cont)Length $b \geq 1000$ mm

Fig. 1 Test assembly for butt weld

For hull structural steel plates impact tested in the longitudinal direction (CVN-L) in UR W11, the butt weld of the test piece is perpendicular to the rolling direction of the two plates.

For high strength steel plates impact tested in the transverse direction (CVN-T) in UR W16, the butt weld of the test piece is parallel to the rolling direction of the two plates.

4.2.2 Examination and tests

- | | |
|--------------------------------------|--|
| - Visual testing | 100% |
| - Surface crack detection | 100% |
| | (dye penetrant testing or magnetic particle testing) |
| - Radiographic or ultrasonic testing | 100% |
| - Transverse tensile test | two specimens as per 4.2.2.2 |
| - Longitudinal tensile test | required as per 4.2.2.3 |
| - Transverse bend test | four specimens as per 4.2.2.4 |
| - Charpy V-notch impact test | required as per 4.2.2.5 |
| - Macro examination | one specimen as per 4.2.2.6 |
| - Hardness test | required as per 4.2.2.7 |

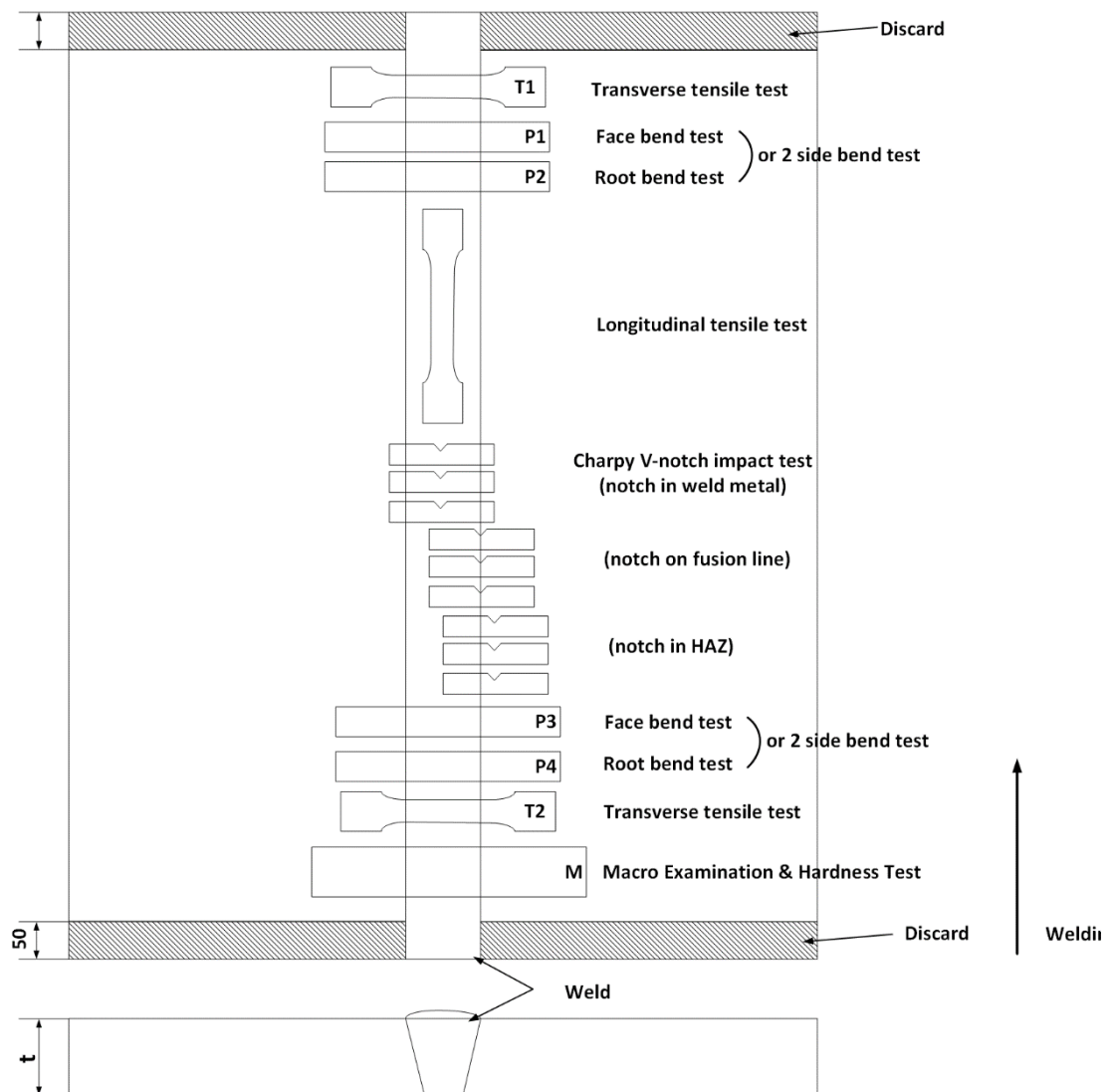
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Fig 2. Test Sampling

4.2.2.1 Non-destructive testing

Test assemblies are to be examined by visual and by non-destructive testing prior to the cutting of test specimen. In case that post-weld heat treatment is required or specified, non-destructive testing is to be performed after heat treatment. For steels according to UR W16 with a specified minimum yield strength of:

420 N/mm² – 690 N/mm² the non-destructive testing is to be delayed for a minimum of 48 hours;

890 N/mm² – 960 N/mm² the non-destructive testing is to be delayed for a minimum of 72 hours;

unless post-weld heat treatment has been carried out.

NDT procedures are to be agreed with the Society.

Imperfections detected by visual or non-destructive testing are to be assessed in accordance with ISO 5817:2023, Level B, except for undercut, excess weld metal, incorrect weld toe and excess of penetration for which Level C applies.

4.2.2.2 Transverse tensile test

The testing is to be carried out in accordance with UR W2.4. The tensile strength recorded for each specimen is not to be less than the minimum required for the base metal.

For steel strength levels 890 and 960 N/mm², where an undermatching consumable approved in accordance with UR W23 is used, the transverse tensile strength is to be not less than the minimum specified weld metal tensile strength required by the approved design, see 4.1.6.

When butt welds are made between plates of different grades, the tensile strength to be obtained on the welded assembly is to be in accordance with the requirements relating to the steel grade having lower strength.

4.2.2.3 Longitudinal tensile test

Longitudinal tensile test of deposited weld metal taken lengthways from the weld is required for cases where the welding consumable is not approved by the Society.

The testing is to be carried out in accordance with UR W2.4. The tensile properties recorded for each specimen are not to be less than the minimum required for the approval of the appropriate grade of consumable.

Where more than one welding process or type of consumable has been used to make the test weld, test specimens are to be taken from the area of the weld where each was used with the exception of those processes or consumables used to make the first weld run or root deposit.

For steel strength levels 890 and 960 N/mm², where an undermatching consumable approved to UR W23 is used, the longitudinal tensile strength is to be not less than the minimum specified weld metal tensile strength required by the approved design, see 4.1.6.

4.2.2.4 Bend test

Transverse bend tests for butt joints are to be in accordance with UR W2.6.

The mandrel diameter to thickness ratio (i.e. D/t) is to be that specified for the welding consumable (UR W17, UR W23) approvals + 1.

The bending angle is to be 180°. After testing, the test specimens are not to reveal any open defects in any direction greater than 3 mm. Defects appearing at the corners of a test specimen during testing are to be investigated case by case.

Two root and two face bend specimens are to be tested. For thickness 12 mm and over, four side bend specimens may alternatively be tested.

For butt joints in heterogeneous steel plates or with undermatching weld metal (where approved for strength levels 890 and 960 strength levels), face and root longitudinal bend test specimens may be used instead of the transverse bend test specimens.

4.2.2.5 Impact test

a) Normal and higher strength hull structural steels according to UR W11

The positions of specimens are to be in accordance with these requirements. Dimensions and testing are to be in accordance with the requirements of UR W2.7.

Test specimen with Charpy-V-notch are to be used. Requirements for sampling and positions are indicated in Fig. B.1 and B.2. of Annex B.

Test temperature and absorbed energy are to be in accordance with Table 1.

Table 1 Impact test requirements for butt joints ($t \leq 50$ mm) ^{(1). (2)}

Grade of Steel	Testing temperature (°C)	Value of minimum absorbed energy (J)		
		For manually or semi-automatically welded joints		For automatically welded joints
		Downhand, Horizontal, Overhead	Vertical upward, Vertical downward	
A ⁽³⁾	20	47	34	34
B ⁽³⁾ , D	0			
E	-20			
A32, A36	20			
D32, D36	0			
E32, E36	-20			
F32, F36	-40			
A40	20	39	39	
D40	0			
E40	-20			
F40	-40			

Note:

- (1) For thickness above 50 mm impact test requirements are to be agreed by the Society.
- (2) These requirements are to apply to test piece of which butt weld is perpendicular to the rolling direction of the plates.
- (3) For Grade A and B steels average absorbed energy on fusion line and in the heat-affected zone is to be minimum 27 J.

When butt welds are made between different steel grades/types, the test specimens are to be taken from the side of the joint with lower toughness of steel. Temperature and absorbed energy results are to be in accordance with the requirements for the lower toughness steel.

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Where more than one welding process or consumable has been used to make the test weld, impact test specimens are to be taken from the respective areas where each was employed. This is not to apply to the process or consumables used solely to make the first weld run or root deposit.

The testing of sub – size specimen is to be in accordance with UR W2.7.2.

b) High strength steels according to UR W16.

The impact test is to be performed as described in the above a).

V-notch specimens are located in the butt welded joint as indicated in Fig. B.1 and B.2 of Annex B and the V-notch is to be cut perpendicular to the surface of the weld.

Test temperature and absorbed energy are to be in accordance with the requirements of base metal as specified in UR W16.

For steel strength levels 890 and 960 N/mm², where an undermatching consumable approved in accordance with UR W23 is used, the test temperature and absorbed energy is to meet the requirement of the approved design, see 4.1.6.

c) Weldable C and C-Mn hull and machinery steel castings and forgings according to UR W7 and UR W8.

For base metal with specified impact values test temperature and absorbed energy are to be in accordance with the requirements of the base metal to be welded.

4.2.2.6 Macro examination

The test specimens are to be prepared and etched on one side to clearly reveal the weld metal, the fusion line and the heat-affected zone.

Macro examination is to include about 10 mm unaffected base metal.

The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal and the absence of defects such as cracks, lack of fusion etc.

4.2.2.7 Hardness test

A hardness test is required for steels with a specified minimum yield strength of $R_{eH} \geq 355$ N/mm². The Vickers method HV 10 is normally to be used. The indentations are to be made in the weld metal, the heat-affected zone and the base metal measuring and recording the hardness values. At least two rows of indentations are to be carried out. In addition, two indentations are required in the grain coarsened heat affected zone, one above and one below the hardness survey row. Typical examples are shown in Fig. C1 and C2 of Annex C.

For each row of indentations, there is to be a minimum of three individual indentations in the weld metal, the heat-affected zones (both sides) and the base metal (both sides). A typical example is shown in Annex C.

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The results from the hardness test are not to exceed the following:

Steel with a specified minimum yield strength $R_{eH} \leq 420 \text{ N/mm}^2$	350 HV10
Steel with a specified minimum yield strength $420 \text{ N/mm}^2 < R_{eH} \leq 690 \text{ N/mm}^2$	420 HV10
Steel with a specified minimum yield strength $890 \text{ N/mm}^2 \leq R_{eH} \leq 960 \text{ N/mm}^2$	450 HV10

4.3 Fillet welds

4.3.1 Assembly of test pieces

The test assembly is to be of a size sufficient to ensure a reasonable heat distribution and according to Fig. 3 with the minimum dimensions:

- manual and semi-automatic welding:

width $a = 3 \times t$, min. 150 mm
length $b = 6 \times t$, min. 350 mm

- automatic welding

width $a = 3 \times t$, min 150 mm
length $b \geq 1000 \text{ mm}$

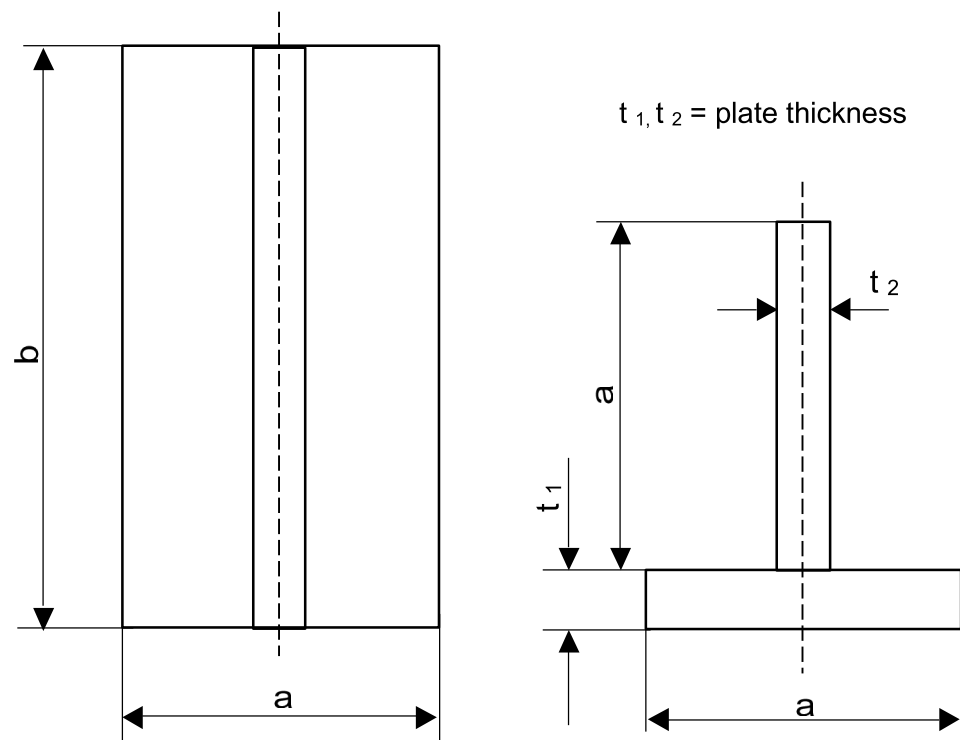


Fig. 3 Test assembly for fillet weld

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4.3.2 Welding of test pieces

The test assembly is welded on one side only. For single-run manual and semi-automatic welding, a stop/restart is to be included in the test length and its position is to be clearly marked for subsequent examination.

4.3.3 Examination and tests

- Visual testing 100 %
- Surface crack detection 100 %
(dye penetrant testing or magnetic particle testing)
- Macro examination two specimens as per 4.3.3.2
- Hardness test required as per 4.3.3.3
- Fracture test required as per 4.3.3.4

4.3.3.1 Non-destructive testing

Test assemblies are to be examined by visual and by non-destructive testing prior to the cutting of test specimen. In case that post-weld heat treatment is required, non-destructive testing is to be performed after heat treatment. For steels according to UR W16 with a specified minimum yield strength of:

420 N/mm² to 690 N/mm² the non-destructive testing is to be delayed for a minimum of 48 hrs;

and

890 N/mm² to 960 N/mm² the non-destructive testing is to be delayed for a minimum of 72 hrs;

unless post-weld heat treatment has been carried out.

NDT procedures are to be agreed with the Society.

Imperfections detected by visual or non-destructive testing are to be assessed in accordance with ISO 5817:2023, Level B except for undercut, incorrect weld toe, excessive convexity and excessive throat thickness for which Level C applies.

4.3.3.2 Macro examination

The test specimens are to be prepared and etched on one side to clearly reveal the weld metal, fusion line, root penetration and the heat-affected zone.

A macro examination is to include about 10 mm of unaffected base metal.

The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal, sufficient root penetration and the absence of defects such as cracks, lack of fusion etc.

4.3.3.3 Hardness test

A hardness test is required for steels with a specified minimum yield strength of $R_{eH} \geq 355 \text{ N/mm}^2$. The Vickers method HV 10 is normally to be used. The indentations are to be made in the weld metal, the heat-affected zone and the base metal measuring and recording the hardness values. At least two rows of indentations are to be carried out.

For each row of indentations, there is to be a minimum of three individual indentations in the weld metal, the heat-affected zone (both sides) and the base metal (both sides). In addition, two indentations are required in the grain coarsened heat affected zone, one above and one below the hardness survey row. Typical examples are shown in Fig. C3, C4a and C4b of Annex C.

The results from the hardness test are not to exceed the following:

Steel with a specified minimum yield strength $R_{eH} \leq 420 \text{ N/mm}^2$	350 HV10 ¹
Steel with a specified minimum yield strength $420 \text{ N/mm}^2 < R_{eH} \leq 690 \text{ N/mm}^2$	420 HV10
Steel with a specified minimum yield strength $890 \text{ N/mm}^2 \leq R_{eH} \leq 960 \text{ N/mm}^2$	450 HV10

¹ A higher value up to 380 HV10 may be accepted for single pass fillet welds subject to special consideration by the Classification Society.

4.3.3.4 Fracture tests

The fracture test is to be performed by folding the upright plate onto the through plate. Evaluation is to concentrate on cracks, porosity and pores, inclusions, lack of fusion and incomplete penetration. Any Imperfection that is detected is to be assessed in accordance with ISO 5817:2023, Level B.

4.4 Re-testing

- 4.4.1 If the test piece fails to comply with any of the requirements for visual or non-destructive testing one further test piece is to be welded and subjected to the same examination. If this additional test piece does not comply with the relevant requirements, the pWPS is to be regarded as not capable of complying with the requirements without modification.
- 4.4.2 If any test specimens fail to comply with the relevant requirements for destructive testing due to weld imperfections only, two further test specimens are to be obtained for each one that failed. These specimens can be taken from the same test piece if there is sufficient material available or from a new test piece and are to be subjected to the same test. If either of these additional test specimens does not comply with the relevant requirements, the pWPS is to be regarded as not capable of complying with the requirements without modification.
- 4.4.3 If a tensile test specimen fails to meet the requirements, the re-testing is to be in accordance with UR W 2.4.3.
- 4.4.4 If there is a single hardness value above the maximum values allowed, additional hardness tests are to be carried out (on the reverse of the specimen or after sufficient

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grinding of the tested surface). None of the additional hardness values is to exceed the maximum hardness values required.

- 4.4.5 The re-testing of Charpy impact specimens are to be carried out in accordance with UR W 2.7.4.
- 4.4.6 Where there is insufficient welded assembly remaining to provide additional test specimens, a further assembly is to be welded using the same procedure to provide the additional specimens.

4.5 Welding Procedure Qualification Record (WPQR)

- 4.5.1 Welding conditions for test assemblies and test results are to be recorded in a welding procedure qualification record. Forms of welding procedure qualification records can be taken from the Society's rules or from relevant standards.
- 4.5.2 A statement of the results of assessing each test piece, including repeat tests, is to be made for each welding procedure test. The relevant items listed for the WPS are to be included.
- 4.5.3 A statement that the test piece was made according to the particular welding procedure specification is to be signed by the Surveyor witnessing the test and is to include the Society's identification.

5 Range of approval**5.1 General**

- 5.1.1 All the conditions of validity stated below are to be met independently of each other.
- 5.1.2 Changes outside of the ranges specified are to require a new welding procedure test.

5.2 Base Material

- 5.2.1 Normal and higher strength hull structural steels according to UR W11
 - a) For each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested.
 - b) For each toughness grade, welding procedures are considered applicable to the same and two lower strength levels as that tested.
 - c) Where high heat input processes are being applied to plates without an approved high heat input grade notation, the welding procedures are only applicable for that toughness grade tested, and one strength level below.

For applicability of strength and toughness grade range for plates with approved high heat input grade notation, see E5.2.1.

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- d) Where steels used for construction are supplied from different delivery conditions from those tested the Society may require additional tests.

5.2.2 YP47 steel according to UR W31.

- a) Welding procedures are considered applicable to the same and lower toughness grades as that tested.
- b) Welding procedures are considered applicable to the same strength grade.

5.2.3 High strength steels according to UR W16

- a) For each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested
- b) For each toughness grade, welding procedures are considered applicable to the same and one lower strength level as that tested. For steel strength levels 890 and 960 N/mm², a test made in strength level 960 N/mm² qualifies both 960 and 890 N/mm², however, a test made in 890 N/mm² qualifies only 890 N/mm².
- c) The approval of quenched and tempered steels do not qualify thermo-mechanically rolled steels (TMCP steels) and vice versa.
- d) For 420-500 strength levels. Where high heat input processes are being applied to plates without an approved high heat input grade notation, the welding procedures are only applicable for that toughness grade and strength level tested. High heat input welding processes are not applicable to steels with strength levels 550–960 N/mm².
- e) For applicability of strength and toughness grade range for plates with approved high heat input grade notation, see E5.2.2.

5.2.4 Weldable C and C-Mn hull and machinery steel forgings according to UR W7.

- a) Welding procedures are considered applicable to the same and lower strength levels as that tested, and where applicable, the same and lower toughness levels as that tested.
- b) The approval of quenched and tempered hull and machinery steel forgings do not qualify other delivery conditions and vice versa.
- c) The approval of carbon steel, carbon manganese steel forgings do not qualify alloy forgings.

5.2.5 Weldable C and C-Mn hull and machinery steel castings according to UR W8.

- a) Welding procedures are considered applicable to the same and lower strength levels as that tested, and where applicable, the same and lower toughness levels as that tested.

- b) The approval of quenched and tempered hull and machinery steel castings do not qualify other delivery conditions and vice versa.
- c) The approval of carbon steel, carbon manganese steel castings do not qualify alloy castings.

5.3 Thickness

- 5.3.1 The qualification of a WPS carried out on a test assembly of base material thickness t and nominal throat thickness a , is valid for the thickness range given in Tables 2 and 3.

Table 2 Approval range of thickness for butt and T-joint welds

Thickness of test piece, $t^{(1)}$ mm	Range of Approval ^{(2), (3), (4), (5), (6)}	
	Single-run or single-run from both sides	Multi – run
$3 < t \leq 12$	0.5 t (3 min) to 1.3 t	3 to 2t
$12 < t \leq 40$	0.5 t to 1.1 t	0.5 t to 2 t
$40 < t \leq 100$	0.7 t to 1.1 t	0.5 t to 2 t
$t > 100$	-	50 to 2 t

Note:

(1) For multi-process procedures, the recorded thickness contribution of each process is to be used as a basis for the range of approval for the individual welding process.

(2) For high heat input processes applied to plates without an approved high heat input notation, the upper limit of the range of approval is to be 1.0 t, and the lower limit of the range of approval is to be 0.7 t.

Guidance note:

The suitability of the applied high heat input to thinner plates is to be determined by the manufacturer or the shipyard based upon practical considerations, including plate manufacturer's recommendations, during welding qualification, together with previous experience.

(3) For unequal plate thickness, the lesser thickness is the ruling dimension.

(4) For t-joint butt welds, the approval range is to be applied individually to both base metals.

(5) For vertical-down welding, the test piece thickness "t" is always taken as the upper limit of the range of application.

(6) Further restrictions may be applied by individual classification societies at their discretion, for example where fracture mechanics test (CTOD) is applied.

Table 3 Approval range of thickness for fillet welds

Thickness of test piece, t mm	Range of Approval ^{(1), (2), (3), (4)} .		
	Material thickness	Throat thickness (a)	
		Single run	Multi run
$3 < t < 30$	3 to 2 t	0.75 a to 1.5 a	no restriction
$t \geq 30$	≥ 5		

Note:

- (1) For fillet welds, the range of approval for material thickness is to be applied individually to both base metals.

Explanatory Note – Worked Example

- i. Test piece A, thickness, 10 mm
- ii. Test piece B thickness, 6 mm

Applying Table 3, qualifies a range for test piece A of 3 to 20 mm welded to test piece B with a range of 3 to 12 mm.

- (2) For high heat input processes applied to plates without an approved high heat input notation where the fillet weld test was a single run:
- (i) the upper limit of the range of approval for material thickness is to be 1.0 t, and the lower limit of the range of approval is to be 0.7 t.
 - (ii) the upper limit of the range of approval for throat thickness for single run is to be 1.0 a.

Guidance note:

The suitability of the applied high heat input to thinner plates is to be determined by the manufacturer or the shipyard based upon practical considerations, including plate manufacturer's recommendations, during welding qualification, together with previous experience.

- (3) For vertical-down welding, the test piece thickness "t" is always taken as the upper limit of the range of application.

- (4) Where a fillet weld is qualified by means of a butt weld test, the throat thickness (a) range shall be based on the thickness of the deposited metal.

- (i) For high heat input processes applied to plates without an approved high heat input notation, where the butt weld test was a single run, the range of approval for the fillet weld shall be in accordance with note 2 (ii).

- 5.3.2 Notwithstanding the above, the approval of maximum thickness of base metal for any technique is to be restricted to the thickness of test assembly if three of the hardness values in the heat-affected zone are found to be within 25 HV of the maximum permitted, as stated 4.2.2.7 and 4.3.3.3.

5.4 Welding position

- 5.4.1 Approval for a test made in any position is restricted to that position (see Annex D). To qualify a range of positions, test assemblies are to be welded for highest heat input position and lowest heat input position and all applicable tests are to be made on those assemblies. This excludes welding in the vertical downwards position which requires separate qualification testing.
- 5.4.2 It is permissible that a test assembly welded in the PC position will qualify both PA and PC positions provided that the heat input is in accordance with 5.7.

5.5 Welding process

- 5.5.1 The approval is only valid for the welding process(es) used in the welding procedure test. It is not permitted to change from a multi-run to a single run.
- 5.5.2 For multi-process procedures the welding procedure approval may be carried out with separate welding procedure tests for each welding process. It is also possible to make the welding procedure test as a multi-process procedure test. The approval of such a test is only valid for the process sequence carried out during the multi-process procedure test. It is not permitted to use a single process from a multi-process weld WPS in production.
- 5.5.3 Separate approval is required for each degree of mechanisation of the welding process e.g., manual, partly mechanised, fully mechanised, or automatic welding.
- 5.5.4 For gas shielded welding processes, the qualification is restricted to the nominal composition of the shielding gas used in the qualification test.

5.6 Welding consumable

5.6.1 For welding procedure qualifications with heat input not exceeding 50 kJ/cm (or 35 kJ/cm for strength levels 420 N/mm² and above in the QT condition), a change in welding trade name to another approved welding trade name having the same approval grade mark, the same or lower hydrogen content, and all suffixes specified in UR W17 and UR W23 is permitted. The following welding process and consumable grade-specific requirements and exclusions will also apply.

- a) For strength levels 890 N/mm² and 960 N/mm², no change in the trade name of the consumable is permitted.

Additionally, for applications where the design temperature is below -20 degree C:

b) For SMAW and FCAW, a change of welding consumable trade name for consumables approved to grade 3Y and above, the manufacturer or the shipyard shall weld an additional test piece with the maximum heat input qualified. The impact test specimens taken from the weld metal are to be tested and are to meet the requirements of Table 1 Impact test requirements for butt joints ($t \leq 50$ mm).

c) For SAW, a change in combinations (wire and flux) approved to grade 2Y and below is permitted provided that the proposed combination is approved, that the welding flux of the combination is of the same type (e.g., agglomerated, fused, neutral, active, alloyed etc.) and

**W28
(cont)**

has the same nominal composition of main flux constituents. It is not permitted to change the wire and flux for consumables graded 3Y and above.

5.6.2 No change in welding consumable trade name is permitted for high heat input welding procedure qualifications.

5.7 Heat input

5.7.1 For normal and higher strength according to UR W11 steels the upper limit of heat input approved is 25% greater than that used in welding the test piece or 55kJ/cm whichever is smaller.

For high heat input processes as per 4.1.5:

(i) Where a plate without approved high heat input grade notation is used the upper limit is 10% greater than that used in welding the test piece.

(ii) For plates with approved high heat input grade notation, see Annex E.5.7.1

5.7.2 For high strength steels according to UR W16 the upper limit of heat input approved is 25% greater than that used in welding the test piece or 55kJ/cm (38.5kJ/cm for QT condition) whichever is smaller.

For high heat input processes as per 4.1.5:

(i) Where a plate without approved high heat input grade notation is used the upper limit is 10% greater than that used in welding the test piece.

(ii) For plates with approved high heat input grade notation, see Annex E.5.7.2

5.7.3 The lower limit of heat input approved is 25% lower than that used in welding the test piece.

5.7.4 For strength levels 890 N/mm² and 960 N/mm² the upper and lower limit is 10% to that used in the test.

5.8 Preheating and interpass temperature

5.8.1 The minimum preheating temperature is not to be less than that used in the qualification test.

5.8.2 The maximum interpass temperature is not to be higher than that used in the qualification test.

5.9 Post-heating

The temperature and duration of post-heating used in the test for hydrogen release shall not be reduced. Post-heating shall not be omitted but may be added.

W28
(cont)**5.10 Post-weld heat treatment**

- 5.10.1 The heat treatment used in the qualification test is to be maintained during manufacture. Holding time may be adjusted as a function of thickness.
- 5.10.2 For welding of TMCP steel the PWHT is not to be carried out above the lower transformation temperature.
- 5.10.3 The temperature used in production is not to deviate by more than 20°C from that used for the qualification.

5.11 Type of joint

- 5.11.1 Range of approval depending on the type of welded joints for test assembly is to be specified in Table 4.
- 5.11.2 Butt welds qualify full and partial penetration welds including t-joint welds and fillet welds.
- 5.11.3 A qualification test performed on a butt weld will also qualify for fillet welding within the thickness ranges specified for fillet welds specified in 5.3 above.

Table 4 Range of approval for the type of welded joint

Type of welded joint for test assembly			Range of approval	
Butt welding	One side	With backing	A	A, C
		Without backing	B	A, B, C, D
	Both side	With gouging	C	C
		Without gouging	D	C, D

5.12 Shop primers

Welding procedure qualification with shop primer will qualify those without but not vice versa.

5.13 Other variables

The range of approval relating to other variables may be taken according to the Society requirements.

Annex A

(Editorial note for IACS document preparation: Previous Annex A now renumbered to Annex B. This Annex A is new.)

Technical requirements for the acceptance of welding qualifications to national or international standards

UR W28, 1.5.1 states *“Welding procedures qualified in accordance with other national or international welding procedure qualification standards may result in a difference in the examination, testing, and range of approval. For the acceptance of such qualifications, then Annex A shall be followed”*.

Where welding procedures are qualified to the requirements of national and international standards, those standards or codes are to be applied in full, cross-mixing requirements of Standards and Codes is not permitted. In order to accept proposals for those welding qualifications, A1 to A3 below are considered as typical scenarios and solutions, which are not exhaustive.

A.1 Examination:

- a) In the case that the manufacturer proposes a WPS which has had no Class Society involvement, then it shall only be accepted if qualified under a recognised third party organisation for welding qualifications, acceptable to the Class Society.
- b) For assurance purposes, at the discretion of the Class Society, it may be necessary to carry out additional qualification tests to confirm the validity of the WPS.
- c) Welding qualifications shall be supported by a WPQR, with the conditions and test results documented as per 4.5 of this UR W28.
- d) Where weld procedures have been qualified without non-destructive testing being performed on the qualification test pieces, then NDT is to be carried on a supplementary test piece, or on the first production welds.

A.2 Testing:

- a) Where tests and their extent do not meet the requirements of this UR W28, then measures shall be taken to address the missing tests.
- b) Where a welding procedure is qualified without impact tests, a supplementary test piece is to be welded and tested in accordance with 4.2.2.5 of this UR W28.
- c) In the case that national or international standard steel grades have been used in the procedure qualification test, the acceptance criteria for impact tests are to be in accordance with the requirements of this UR.
- d) Where a welding procedure is qualified without hardness tests, a supplementary test piece is to be welded and tested in accordance with 4.2.2.7 or 4.3.3.3 of this UR W28, as applicable.
- e) For fillet weld procedures qualified without fracture tests, a supplementary test piece is to be welded and tested in accordance with 4.3.3.4 of this UR W28.

A.3 Range of Approval:

- a) Where the range of approval does not align with the requirements of this UR, then measures shall be taken to revise the qualified range of the WPS.
- b) Where non approved welding consumables have been used in the WPQR, then for production welding, equivalent welding consumables which are approved by the Class Society shall be used.
- c) Where non-approved welding consumables have been used in the WPQR, then equivalent welding consumables that are approved by the Classification Society are to be specified in the WPS. To qualify the new WPS a supplementary test piece is to be welded using the approved welding consumable under the WPS conditions and is to be tested as a minimum for impact toughness, however other tests may be required by the Classification Society in accordance with this UR.
- d) Where a WPS has a range of approval for preheating and interpass temperature which differs from that stated in 5.8 of this UR W28, then the approved limits are to be revised accordingly.
- e) Where the WPQR does not support the WPS range of approval for welding position in accordance with this UR, then supplementary test piece(s) is required to approve all positions in accordance with 5.4 of this UR W28.

Note: the highest heat input position is normally vertical up (PF). The lowest heat input position is normally horizontal-vertical (PC).

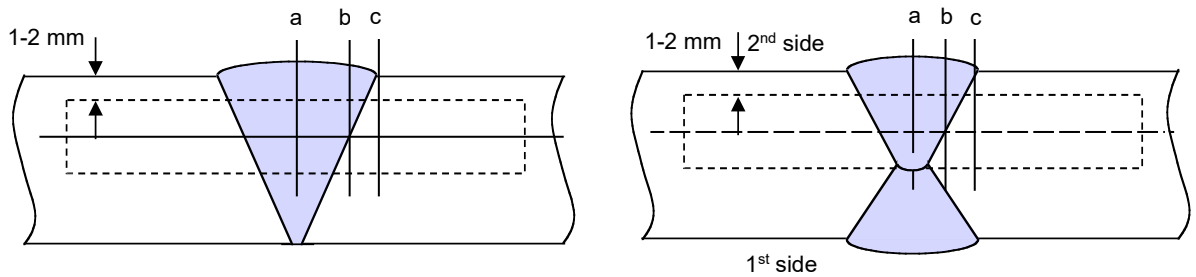
- f) Where the range of heat input is outside the range, as per the limits as stated in 5.7 of this UR W28, then the WPS range should be adjusted to meet the requirements of this UR.
- g) Where a WPS has a range of approval for base metal which differs from that stated in 5.2 of this UR W28, then the approval range of the WPS is to be revised in terms of the strength and toughness levels and delivery conditions.

Annex B

(Editorial note for IACS document preparation: Previous Annex B now renumbered to Annex C)

Location of Charpy V-notch impact test

a) $t \leq 50$ mm (1, 2, 3, 4)



b) $t > 50$ mm (1, 2, 3)

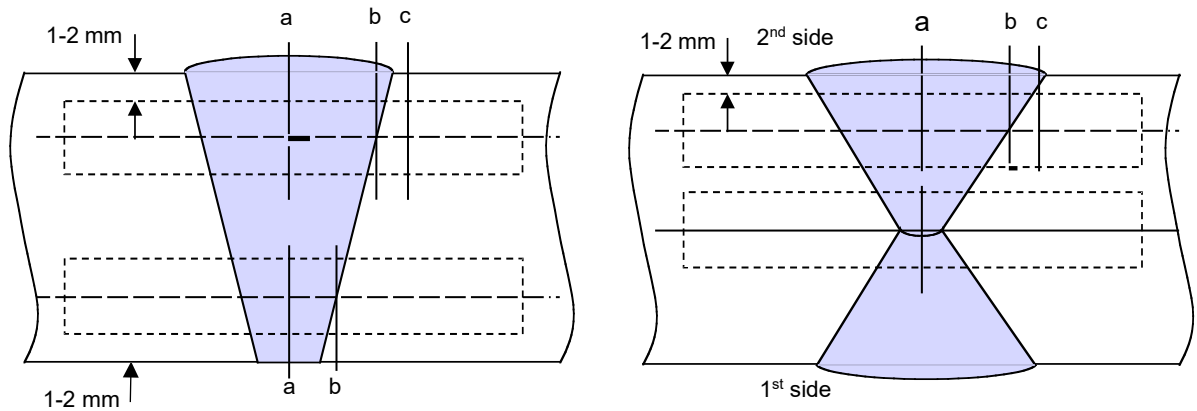


Fig. B.1 Locations of V-notch for butt weld of normal heat input

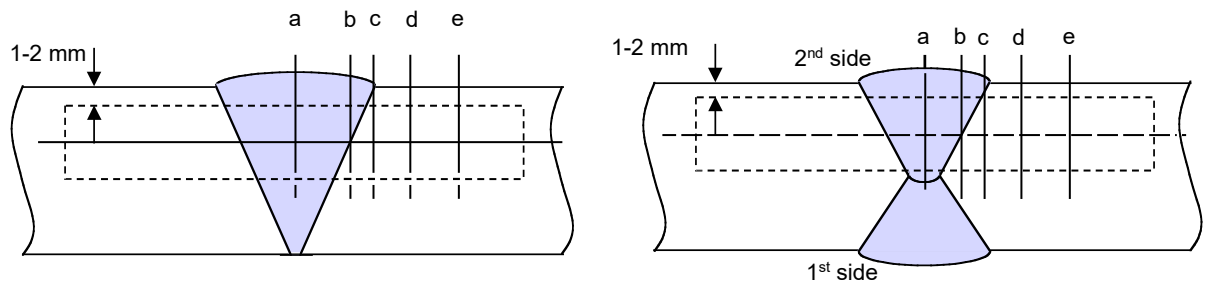
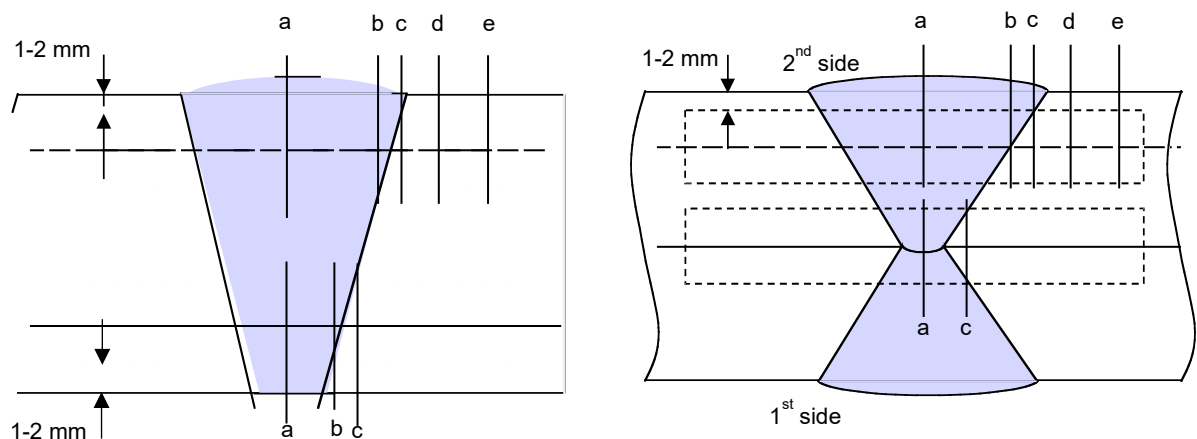
W28
(cont)a) $t \leq 50 \text{ mm}$ ^(1, 2, 3, 5)b) $t > 50 \text{ mm}$ ^(1, 2, 3)

Fig. B.2 Locations of V notch for butt weld of high heat input

(editorial note for IACS document preparation: Notch locations text moved to below Fig. B2, as the locations are applicable to all of these diagrams, not just 'B2')

Notch locations:

a: centre of weld "WM"

b: on fusion line "FL"

c: in HAZ, 2 mm from fusion line

d: in HAZ, 5 mm from fusion line

e: in HAZ, 10 mm from fusion line in case of heat input $> 200 \text{ kJ/cm}$

Notes:

- (1) Samples are located transverse to the weld and the V-notch is to be cut perpendicular to the surface of the weld.
- (2) For welding from one side, the specimens are located from 1 to 2 mm below the surface of the base material from the side that the weld was made.
- (3) For welding from both sides, the specimens are located from 1 to 2 mm below the surface of the base metal from the side containing the last weld run.

**W28
(cont)**

- (4) For one side single run welding over 20 mm notch location “a” is to be added on root side.
- (5) For welding from one side welding with thicknesses over 20 mm notch locations “a”, “b” and “c” are to be added to the root side.

Annex C

(Editorial note for IACS document preparation: Previous Annex C now renumbered to Annex D)

Hardness test

(Typical examples of hardness test)

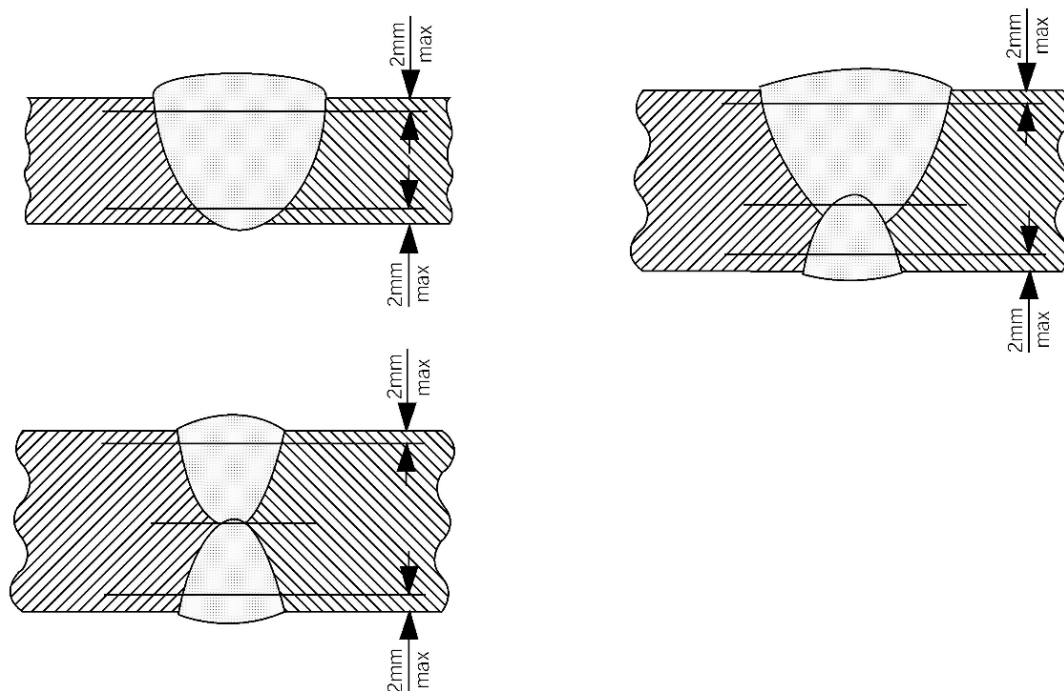


Fig C.1 Examples of hardness test with rows of indentations (R) in butt welds

Table C.1 Recommended distances / between indentations for hardness test in the heat-affected zones.

Vickers hardness Symbol	Distance between indentations l (mm)
HV10	1

The distance of any indentation from the previous indentation is not to be less than the value allowed for the previous indentation by ISO 6507-1:2023.

W28
(cont)

Fig. C.2 Example showing the position of the indentations for a hardness test in the weld metal, the heat-affected zone and the base metal of a butt weld (dimensions in mm)

W28
(cont)

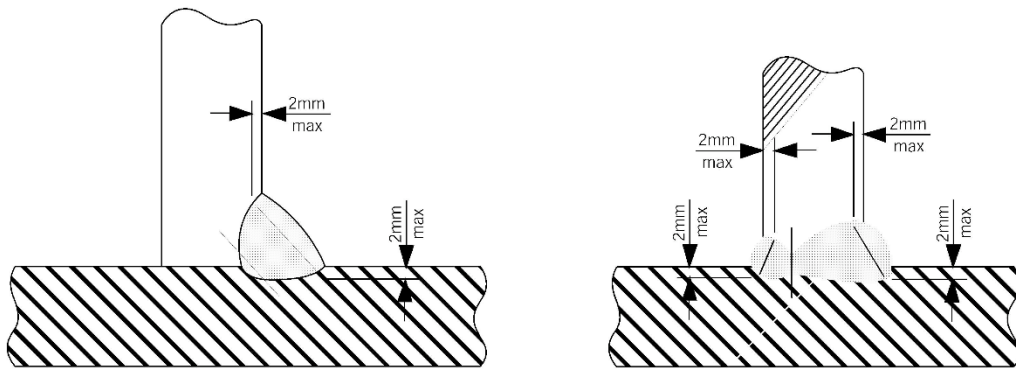


Fig C.3. Examples of hardness test with row indentation (R) in fillet welds and in T-joint welds

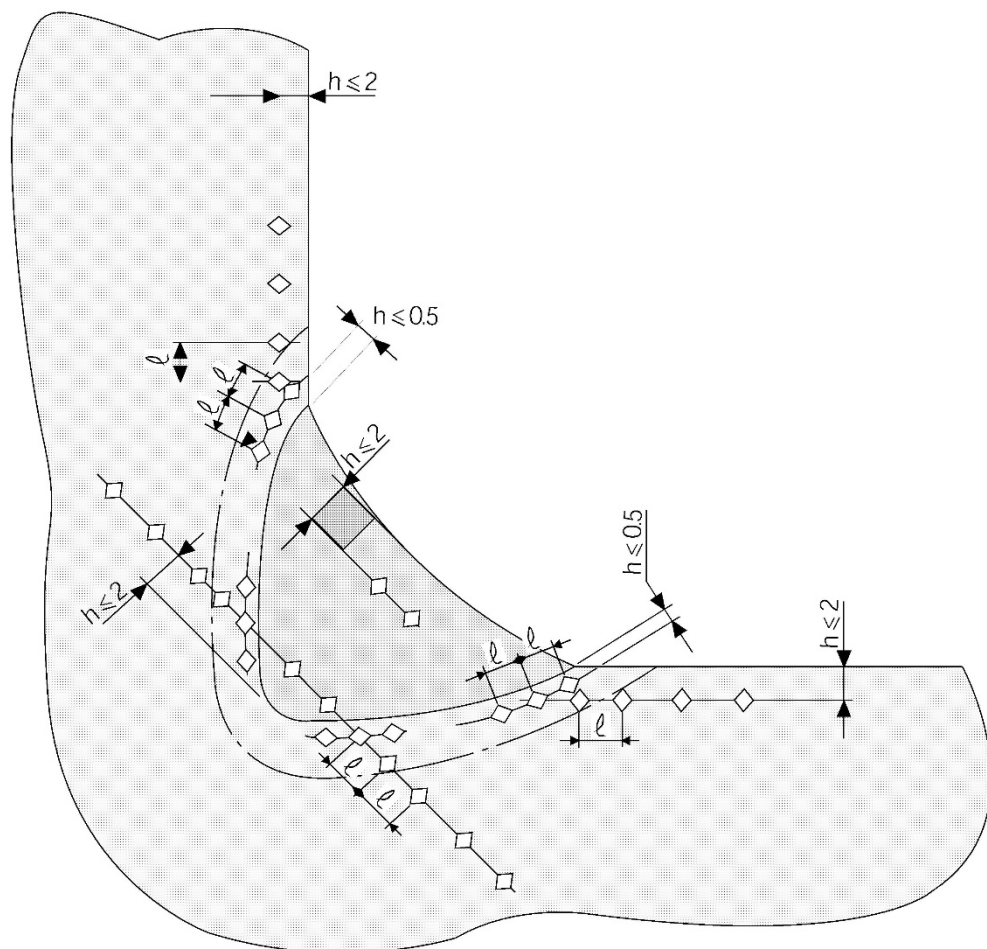


Fig C.4a Example showing the position of the indentations for hardness test in the weld metal, the heat-affected zone and the base metal of a fillet weld (dimensions in mm)

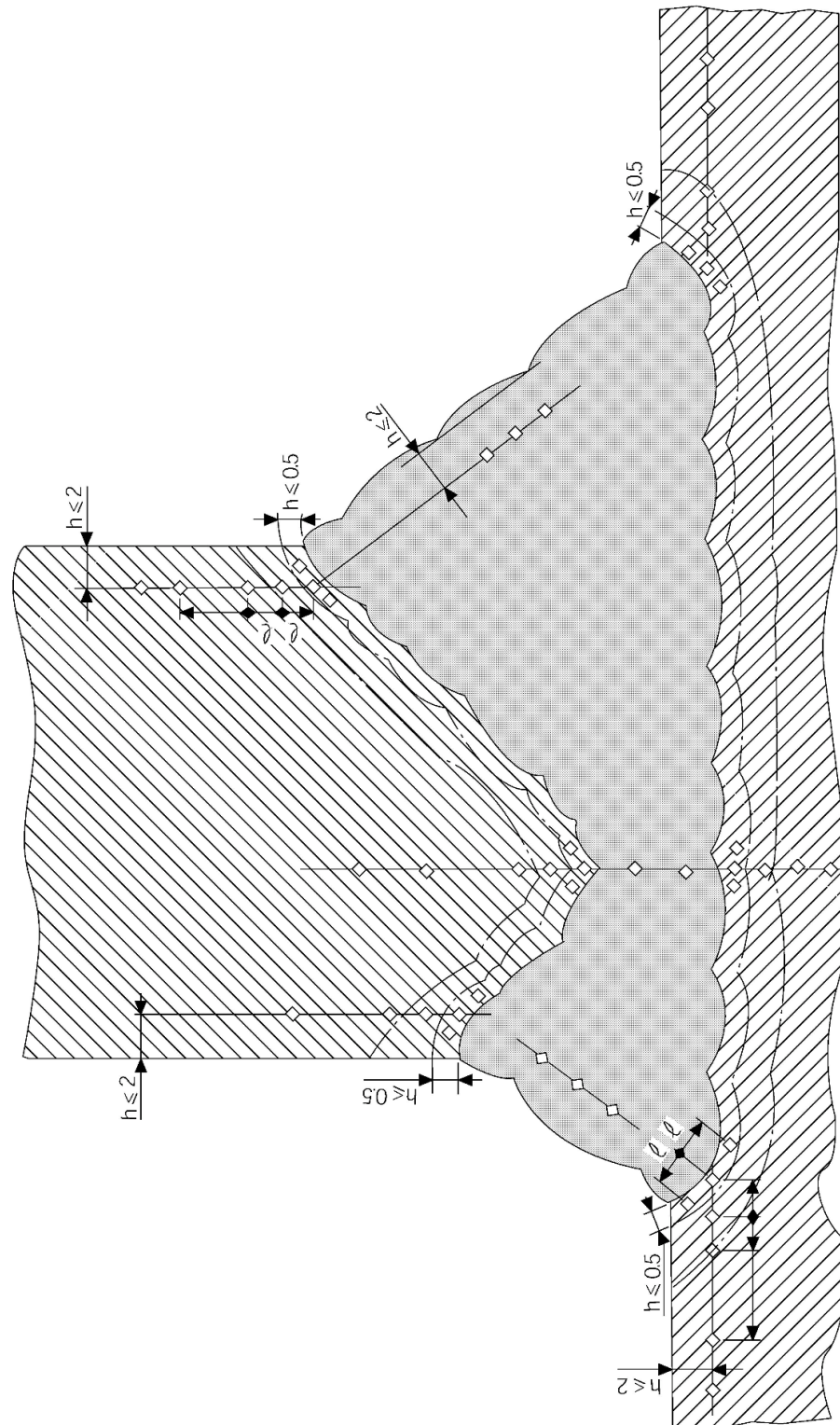
W28
(cont)

Fig C.4b. Example showing the position of the indentations for hardness test on the weld metal, the heat-affected zone and the base metal of a T-joint weld (dimensions in mm)

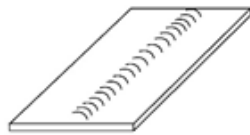
Annex D

(Editorial note for IACS document preparation: Previous Annex C now renumbered to Annex D)

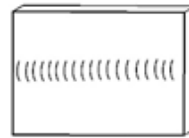
Welding position

Annex D.1: Welding positions according to ISO Standard

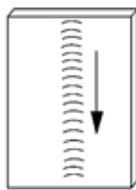
a) Butt welds for plates



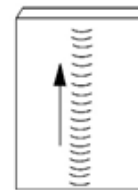
PA Flat



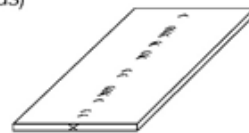
PC Horizontal Vertical



PG Vertical (downwards)



PF Vertical (upwards)

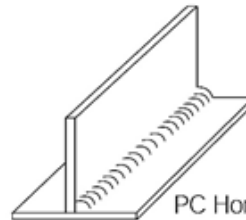


PE (overhead)

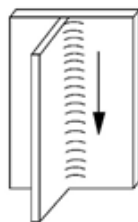
b) Fillet welds for plates



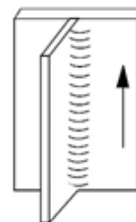
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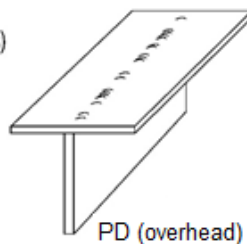
PC Horizontal Vertical



PG Vertical (downwards)



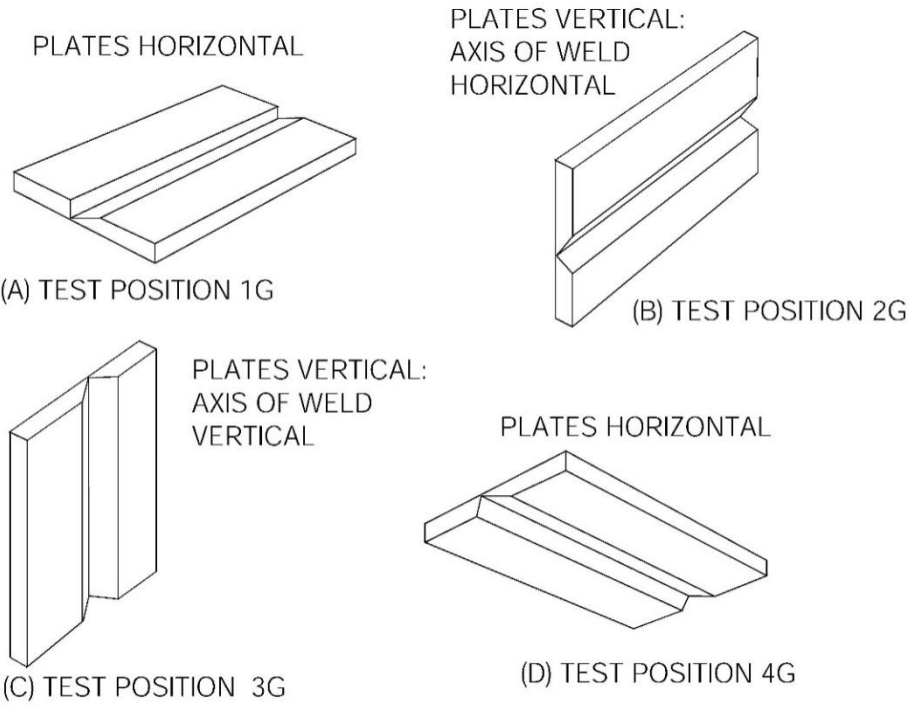
PF Vertical (upwards)



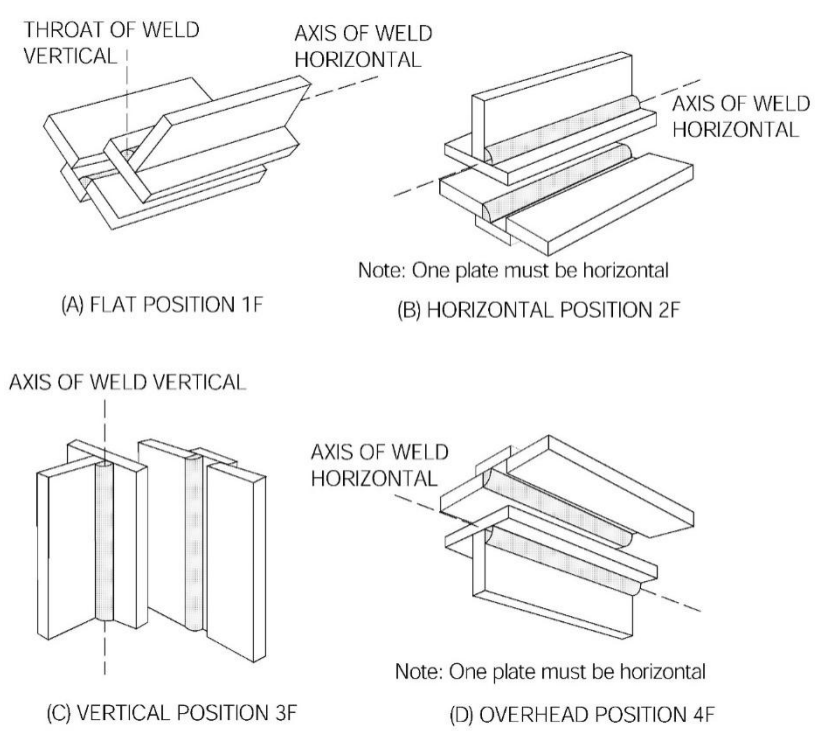
PD (overhead)

Annex D.2: Welding positions according to AWS Code

a) Butt welds for plates



b) Fillet welds



Annex E: Provisions for welding qualification using approved high heat input plate.
(Editorial note for IACS document preparation: This is a new Annex E)

This Annex is applicable to welding qualification tests undertaken in accordance with Rev.3 of this UR.

- E1. The information in this Annex relates to welding with high heat input, which is defined in this UR in section 4.1.5. This annex is applicable to welding qualifications using plates with approved high heat input grade notations, as described in UR W11 and W16, whereby a steel mill has optionally requested approval for their products for high heat input weldability.

Guidance note:

For approved plates as described in E1, the approval and grade notation relate to the maximum tested heat input level on the plate thickness that has undergone the weldability test. The high heat input used for the approval of thick plate may not be suitable for applications on thinner plates. The suitability of the applied heat input to thinner plates is to be determined by the manufacturer or the shipyard based upon practical considerations during welding qualification, and previous experience.

- E2 The plate material certificate will indicate a 'W' notation confirming the maximum heat input qualified. For welding qualification, the manufacturer or the shipyard shall choose the plate heat input notation appropriate for the production welding, noting that the production welding heat input shall not exceed the welding qualification plate notation. Therefore, the selected plate heat input notation for welding qualification shall be equal to, or higher than the production welding heat input, noting the heat input range given in E5.7.1 and E5.7.2.

*Explanatory Note:**Worked Example 1*

A qualification test for E36 material using 300 kJ/cm heat input may be performed on E36-W300 (or higher) plate, noting the heat input range for production welding given in E5.7.1.

- E3. The manufacturer or the shipyard is to consider the steel mill's recommendations for the welding of plates which are approved for high heat input welding.
- E4. Range of approval of base material:
- E4.1 A qualification performed with high heat input welding is applicable to steels with high heat input notation with the same or higher heat input notation to that used for qualification.
- E4.1.1 Other plates with a lower heat input notation may be used provided that the production heat input does not exceed the base material high heat input notation.

W28
(cont)

Explanatory Note:

Worked Example 2.

A qualification test for EH500 material using 100 kJ/cm heat input may be performed on EH500-W100 plate (or higher), noting the heat input range for production welding given in E5.7.2.

The range of approval of base material includes notations of high heat input W100 and above.

- E.5 Where approved high heat input plates are used in the welding procedure qualification, the following conditions and ranges apply in lieu of section 5, Range of Approval.

E.5.1 intentionally left blank.

For note, the corresponding UR W28 main body requirements are shown in [square brackets].

Base material [5.2]

E5.2.1 Normal and higher strength hull structural steels according to UR W11: Where high heat processes are being applied to plates with an approved high heat input notation, for each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested, and one strength level below.

Explanatory Note:

Worked Example 3.

- i. D36-W300 tested qualifies base material toughness grades with Charpy-V notch impact tested at +20°C, 0°C, and -20°C
- ii. D36-W300 tested qualifies base material with strength levels 36 and 32.

Applying i. and ii. means D36-W300 tested qualifies A32, D32, A36, D36 steel grades with a high heat input notation.

E5.2.2 High strength steels according to UR W16, for strength levels 420-500:

Where high heat processes are being applied to plates with an approved high heat input notation, for each strength level, welding procedures are considered applicable to the same and lower toughness grades as that tested, and one strength level below.

Explanatory Note:

Worked Example 4.

- i. EH500-W300 tested qualifies base material toughness grades with Charpy-V notch impact tested at +20°C, 0°C, and -20°C
- ii. EH500-W300 tested qualifies base material with strength levels 500 and 460.

Applying i. and ii. means EH500-W300 tested qualifies AH460, DH460, EH460, AH500, DH500, EH500 steel grades with a high heat input notation.

W28
(cont)

Thickness [5.3]

E5.3.1 For high heat input processes applied to plates with an approved high heat input notation, the upper limit of the range of approval is to be 1.2 t. The lower limits are to be 0.7t of material thickness.

Where the fillet weld test was a single run, in addition to the material thickness range, the upper limit of the range of approval for throat thickness is to be 1.2 a.

Guidance note:

Related to section E5.3.1, the manufacturer or the shipyard is to note that the suitability of the applied high heat input to thinner plates shall also be determined based upon practical considerations, including plate manufacturer's recommendations, during welding qualification, together with previous experience.

Welding position [5.4]

E5.4.1 As per UR W28 main body text

Welding process [5.5]

E5.5.1 As per UR W28 main body text

Welding consumables [5.6]

E5.6.1 As per UR W28 main body text

Heat input [5.7]

E5.7.1 For normal and higher strength steels the upper limit of heat input approved is 10% greater than that used in welding the test piece, provided that the heat input level does not exceed the heat input notation of the plate used in production.

E5.7.2 For high strength steels (420-500) the upper limit of heat input approved is 10% greater than that used in welding the test piece, provided that the heat input level does not exceed the heat input notation of the plate used in production. High heat input welding processes are not applicable to steels with strength levels 550–960 N/mm².

Explanatory Note:

Worked Example 5.

Test plate selected: E36-W300, the maximum selected heat input used in the welding procedure is 200 kJ/cm. The maximum qualified heat input from WPQT is 220 kJ/cm (i.e. corresponds to plus 10% of the maximum heat input used). Range of approval of production welding includes base material notations of high heat input W220 and above.

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