IRCLASS
Indian Register of Shipping

CLASSIFICATION NOTES:

WELDING PROCEDURE QUALIFICATION TESTS OF STEELS FOR HULL CONSTRUCTION AND MARINE STRUCTURES

JULY 2026

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Welding Procedure Qualification tests of Steels for Hull Construction and Marine Structures

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Section 1

Scope

1.1 This document gives requirements for qualification tests of welding procedures intended for the use of weldable steels as specified in Part 2, Chapters 3, 4 and 5 of the *Rules and Regulations for the Construction and Classification of Steel Ships* (hereinafter referred to as Main Rules) for hull construction and marine structures.

1.2 This document excludes the qualification of welding procedures for constructing containment systems in ships carrying liquefied gases in bulk and in ships using gases or other low flashpoint fuels.

1.3 The range of approval for the qualification of welding procedures intended for the use of EH47 steels as specified in Part 2, Chapter 3 of the Main Rules, is included in section 5.2.2 of this document.

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 IRS may be applied.

1.5 All new welding procedure qualification tests are to be carried out in accordance with this document from 1 January 2027. Welding procedures qualified in accordance with national or international welding procedure qualification standards may also be accepted at the discretion of IRS provided that the qualification requirements for examination, testing and range of approval are considered to meet the technical requirements of this document – see also 1.6.

1.6 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 is to be followed.

1.7 This document does not invalidate welding procedure specification and welding procedure qualification records made and accepted by IRS before 01 January 2027.

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 document.

1.9 Although the term “plates” is used throughout this document, the requirements of this document are also applicable to other steel product forms such as wide flats, sections, and bars.

Section 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 the manufacturer or shipyard's responsibility to establish and document whether a procedure is suitable for a 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 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 procedure test according to this document 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.

Section 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 document.

3.1.2 The shipyard or manufacturer is to submit to IRS 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 as well as revised pWPS is to be qualified in accordance with this document.

3.1.3 On satisfactory qualification of the pWPS, IRS 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 document.

Section 4

Qualification of welding procedure

4.1 General

4.1.1 Preparation and welding of test pieces is 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.

4.1.4 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 50 [kJ/cm] (for all strength levels);
- For QT condition, heat input greater than 35 [kJ/cm] for strength levels 420 [N/mm^2] and above.

4.1.6 For steel strength levels 890 and 960 [N/mm^2], 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 Part 2, Chapter 11 of the Main Rules. 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

4.2.1.1 The test assembly is to be of a size sufficient to ensure a reasonable heat distribution and in accordance with Fig. 1 with minimum dimensions, as follows:

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
Length b ≥1000 mm

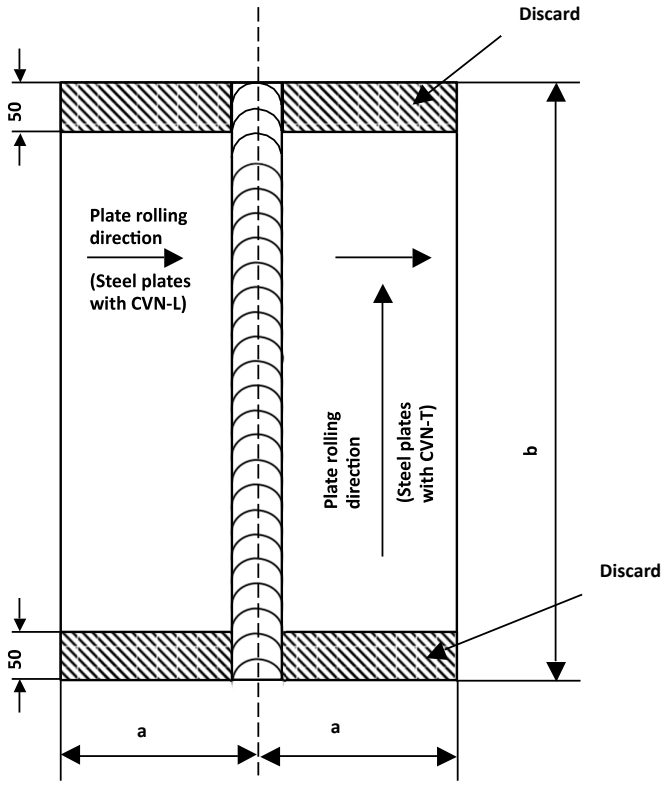


Fig. 1 Test assembly for butt weld

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

4.2.1.3 For high strength steel plates impact tested in the transverse direction (CVN-T), 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 (dye penetrant testing or magnetic particle testing)	100%
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

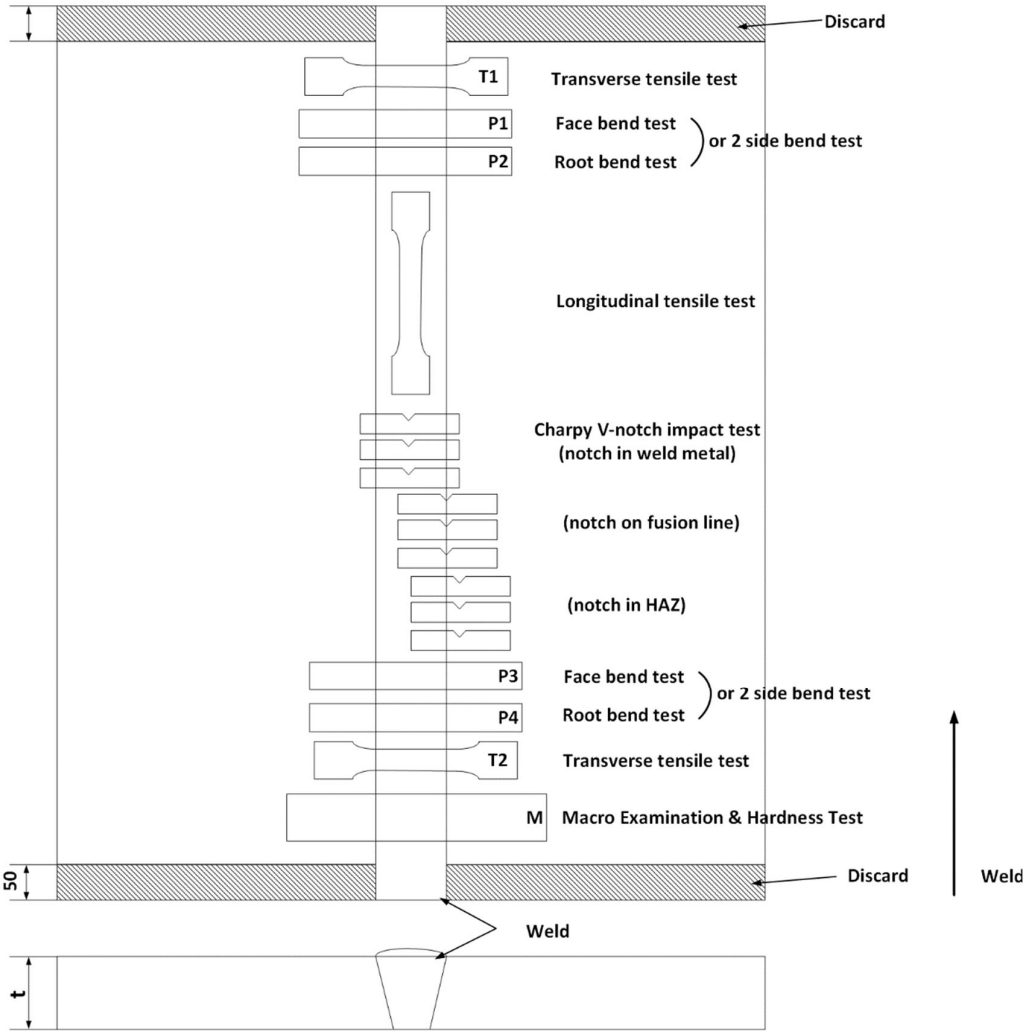


Fig 2. Test Sampling

4.2.2.1 Non-destructive testing

.1 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 High strength Quenched and Tempered steels with a specified minimum yield strength of:

420 N/mm^2 – 690 N/mm^2 the non-destructive testing is to be delayed for a minimum of 48 hours;

890 N/mm^2 – 960 N/mm^2 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 IRS.

.2 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

.1The testing is to be carried out in accordance with Part 2, Chapter 2 of the Main Rules. The tensile strength recorded for each specimen is not to be less than the minimum required for the base metal.

.2 For steel strength levels 890 and 960 N/mm^2, where an undermatching consumable approved in accordance with Part 2, Chapter 11 of the Main Rules 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.

.3 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

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

.2 The testing is to be carried out in accordance with Part 2, Chapter 2 of the Main Rules. 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.

.3 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.

.4 For steel strength levels 890 and 960 N/mm^2, where an undermatching consumable approved in accordance with Part 2, Chapter 11of the Main Rules 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

.1 Transverse bend tests for butt joints are to be in accordance with Part 2, Chapter 2 of the Main Rules.

.2 The mandrel diameter to thickness ratio (i.e. D/t) is to be that specified for the welding consumable (Part 2, Chapter 11 of the Main Rules) approvals + 1.

.3 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.

.4 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.

.5 For butt joints in heterogeneous steel plates or with undermatching weld metal (where approved for strength levels 890 and 960 N/mm^2), face and root longitudinal bend test specimens may be used instead of the transverse bend test specimens.

4.2.2.5 Impact test

4.2.2.5.1 Normal and higher strength hull structural steels according to Part 2, Chapter 3 of the Main Rules.

.1 The positions of specimens are to be in accordance with these requirements. Dimensions and testing are to be in accordance with the requirements of Part 2, Chapter 2 of the Main Rules.

.2 Test specimens 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.

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

Table 1 Impact test requirements for butt joints (t ≤ 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 IRS.

(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].

.4 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.

.5 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.

.6 The testing of sub – size specimen is to be in accordance with IRS Rules Part 2, Chapter 2.

4.2.2.5.2 High strength steels according to Part 2, Chapter 3 of Main Rules.

.1 The impact test is to be performed as described in 4.2.2.5.1 above.

.2 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.

.3 Test temperature and absorbed energy are to be in accordance with the requirements of base metal as specified in Part 2, Chapter 3 of the Main Rules.

.4 For steel strength levels 890 and 960 N/mm^2, where an undermatching consumable approved in accordance with Part 2, Chapter 11 of the Main Rules is used, the test temperature and absorbed energy is to meet the requirement of the approved design, see 4.1.6.

4.2.2.5.3 Weldable C and C-Mn hull and machinery steel castings and forgings according to Part 2, Chapters 4 and 5 of the Main Rules.

.1 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

.1 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.

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

.3 The examination is to reveal a regular weld profile, thorough 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

.1 A hardness test is required for steels with a specified minimum yield strength of $R_{eH} \geq 355$ 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. 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.

.2 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.

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

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

4.3 Fillet welds

4.3.1 Assembly of test pieces

4.3.1.1 The test assembly is to be of a size sufficient to ensure a reasonable heat distribution and in accordance with Fig. 3 with the minimum dimensions, as follows:

manual and semi-automatic welding:

width a = 3 x t, min. 150 mm
length b = 6 x t, min. 350 mm

automatic welding

width a = 3 x t, min 150 mm
length b ≥ 1000 mm

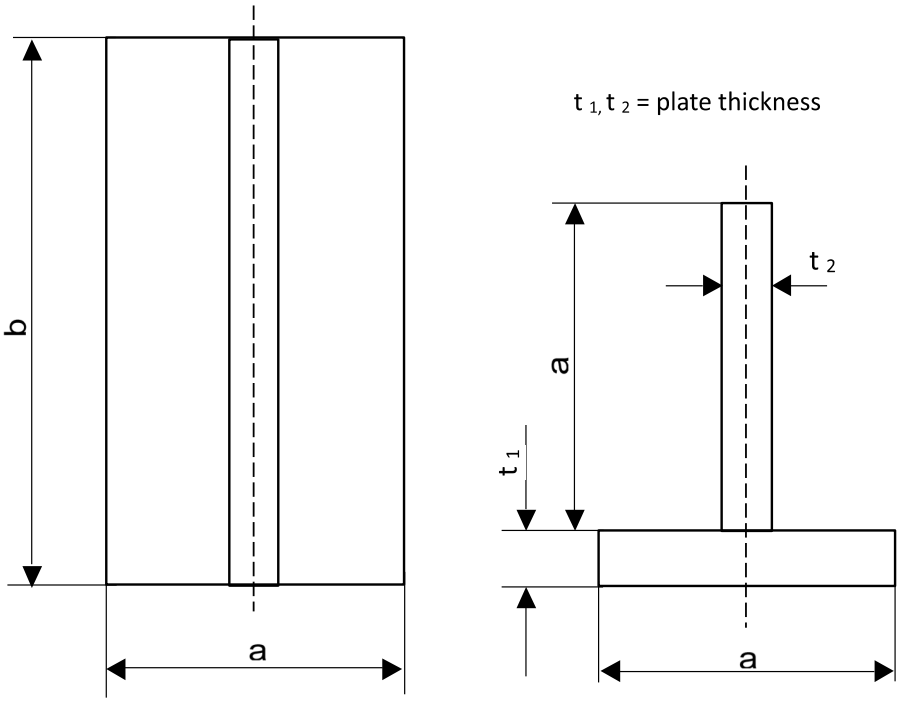


Fig. 3 Test assembly for fillet weld

4.3.2 Welding of test pieces

4.3.2.1 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

.1 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 high strength Quenched and Tempered steels with a specified minimum yield strength of:

420 N/mm^2 to 690 N/mm^2 the non-destructive testing is to be delayed for a minimum of 48 hrs;

and

890 N/mm^2 to 960 N/mm^2 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 IRS.

.2 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

.1 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.

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

.3 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

.1 A hardness test is required for steels with a specified minimum yield strength of $R_{eH} \geq 355$ 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.

.2 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.

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

Steel with a specified minimum yield strength $R_{eH} \leq 420$ N/mm^2	350 HV10[1]
Steel with a specified minimum yield strength 420 N/mm^2 < $R_{eH} \leq 690$ N/mm^2	420 HV10
Steel with a specified minimum yield strength 890 N/mm^2 ≤ $R_{eH} \leq 960$ 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 IRS.

4.3.3.4 Fracture tests

.1 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 requirements in Part 2, Chapter 2 of the Main Rules.

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 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 is to be carried out in accordance with Part 2, Chapter 1 of the Main Rules.

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 may be in accordance with relevant recognized 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 IRS identification.

Section 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 in accordance with Part 2, Chapter 3 of Main Rules.

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.

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

5.2.2 EH47 steel in accordance with Part 2, Chapter 3 of the Main Rules.

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 in accordance with Part 2, Chapter 3, Section 4 of the Main Rules.

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/mm^2, a test made in strength level 960 N/mm^2 qualifies both 960 and 890 N/mm^2, however, a test made in 890 N/mm^2 qualifies only 890 N/mm^2.

c) The approval of quenched and tempered steels do not qualify thermo-mechanically rolled steels (TMCP steels) and vice versa.

d) For 420-500 N/mm² 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 Annex E5.2.2.

5.2.4 Weldable C and C-Mn hull and machinery steel forgings in accordance with Part 2, Chapter 5 of the Main Rules.

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 in accordance with Part 2, Chapter 4 of the Main Rules.

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 ≤ 12	0.5 t (3 mm min) to 1.3 t	3 mm to 2t
12 < t ≤ 40	0.5 t to 1.1 t	0.5 t to 2 t
40 < t ≤ 100	0.7 t to 1.1 t	0.5 t to 2 t
t > 100	-	50 mm 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 IRS, 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 mm to 2 t	0.75 a to 1.5 a	no restriction
t ≥ 30	≥ 5 mm		

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
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 is to 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 is to 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 in 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 vertically 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 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/mm^2 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 Part 2 Chapter 11 of the Main Rules is permitted. The following welding process and consumable grade-specific requirements and exclusions will also apply:

a) For strength levels 890 N/mm^2 and 960 N/mm^2, 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 is to 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 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 steels in accordance with Part 2, Chapter 3 of the Main Rules, 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 Part 2, Chapter 3, Section 4 of the Main Rules 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/mm^2 and 960 N/mm^2 the upper and lower limits are 10% higher or 10% lower respectively than 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 is not to be reduced. Post-heating is not to be omitted but may be added.

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 post-weld heat treatment 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^{o}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.

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

Para 1.6 of this document 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 is to 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 is only to be accepted if qualified under a recognised third-party organisation for welding qualifications, acceptable to IRS.

b) For assurance purposes, at the discretion of IRS, it may be necessary to carry out additional qualification tests to confirm the validity of the WPS.

c) Welding qualifications are to be supported by a WPQR, with the conditions and test results documented as per para 4.5 of this document.

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 document, then measures are to 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 document.

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 document.

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 document, 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 document.

A.3 Range of Approval:

a) Where the range of approval does not align with the requirements of this document, then measures are to 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 IRS are to be used.

c) Where non-approved welding consumables have been used in the WPQR, then equivalent welding consumables that are approved by IRS 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 IRS in accordance with this document.

d) Where a WPS has a range of approval for preheating and interpass temperature which differs from that stated in para 5.8 of this document, 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 document, then supplementary test piece(s) is required to approve all positions in accordance with para 5.4 of this document.

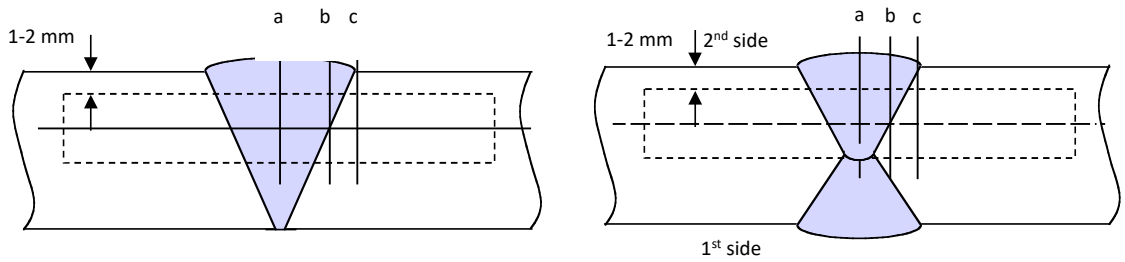
Note: the highest heat input position is normally vertical up (PF). The lowest heat input position is normally horizontal-vertical (PC).

f) Where the range of heat input is outside the range, as per the limits as stated in para 5.7 of this document, then the WPS range is to be adjusted to meet the requirements of this document.

g) Where a WPS has a range of approval for base metal which differs from that stated in para 5.2 of this document, then the approval range of the WPS is to be revised in terms of the strength and toughness levels and delivery conditions.

Annex B: Location of Charpy V-notch impact test

a) t ≤ 50 mm [1, 2, 3, 4]



b) t > 50 mm [1, 2, 3]

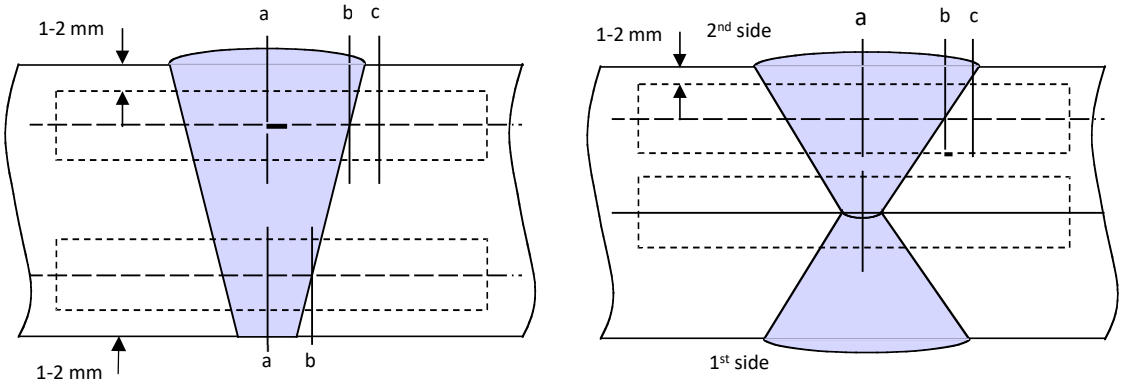
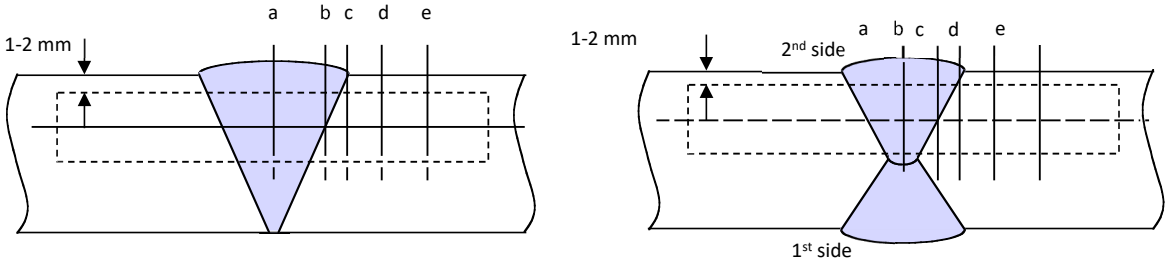


Fig. B.1 Locations of V-notch for butt weld of normal heat input

a) t ≤ 50 mm(1, 2, 3, 5)



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

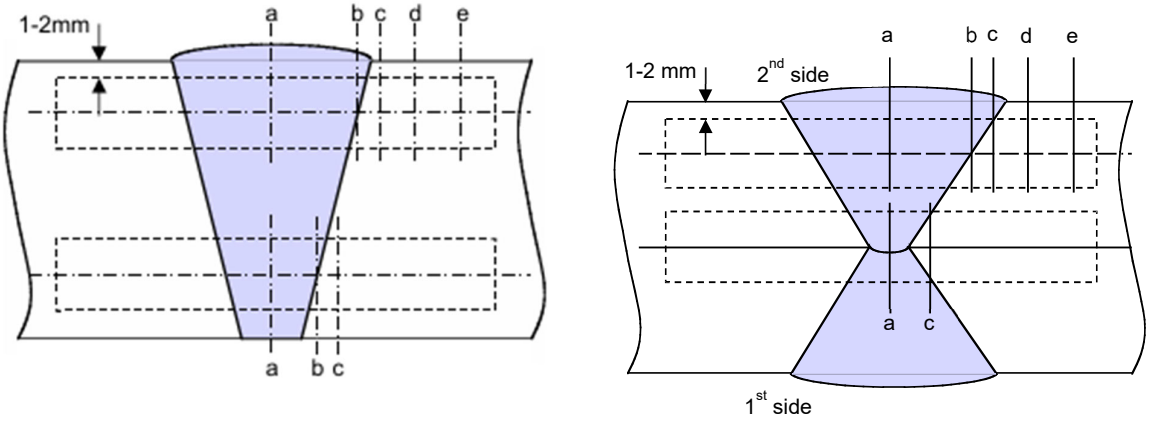


Fig. B.2 Locations of V notch for butt weld of high heat input

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 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.

(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 with thicknesses over 20 mm notch locations “a”, “b” and “c” are to be added to the root side.

Annex C: Hardness test

(Typical examples of hardness test)

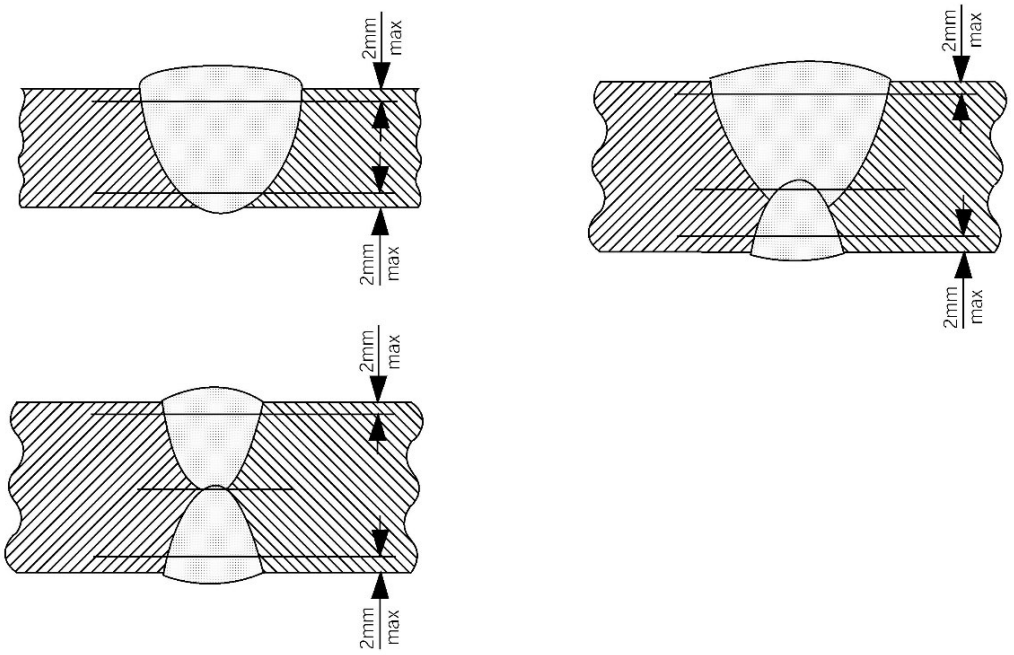


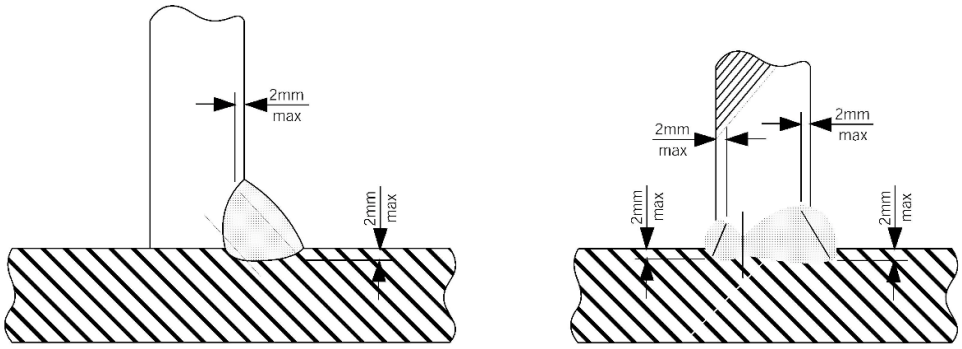
Fig C.1 Examples of hardness test with rows of indentations (R) in butt welds

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.

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)

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



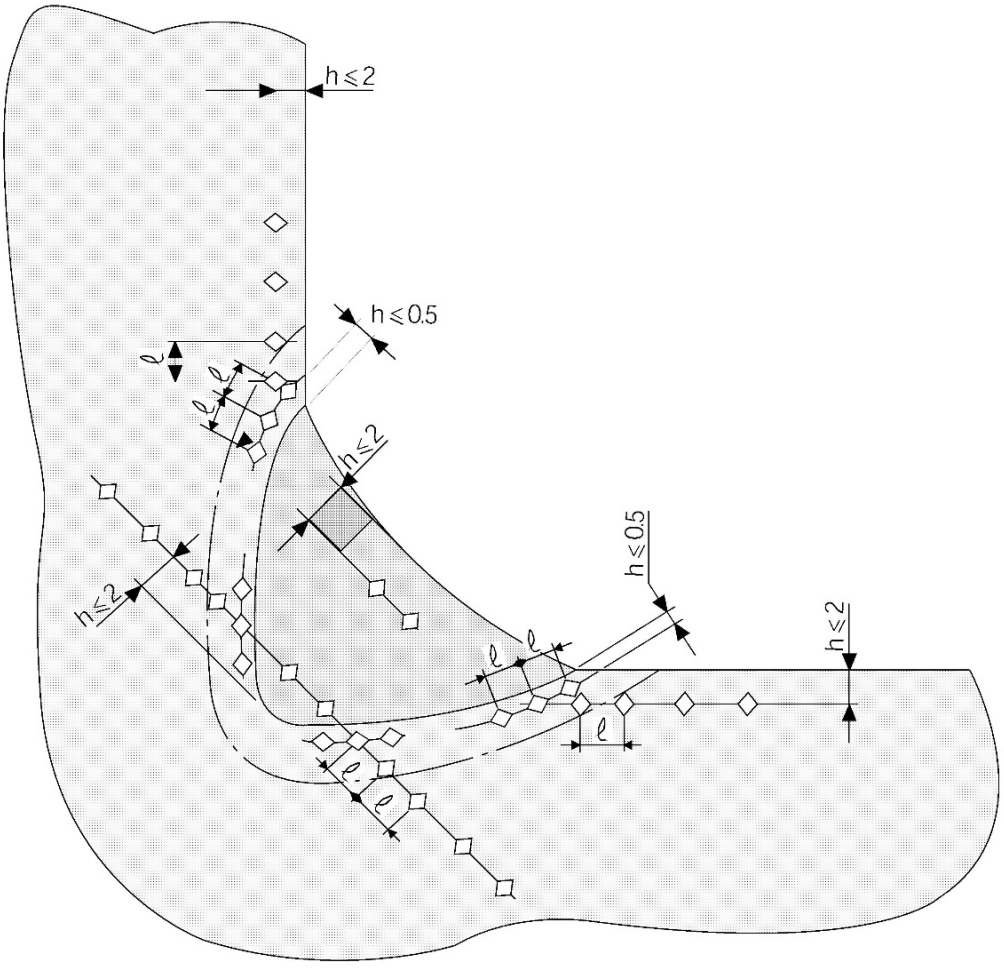


Fig C.4a Example showing the position of the indentations for hardness test in the weld metal, the heat-affected zone and the base metal of a fillet weld (dimensions in mm)

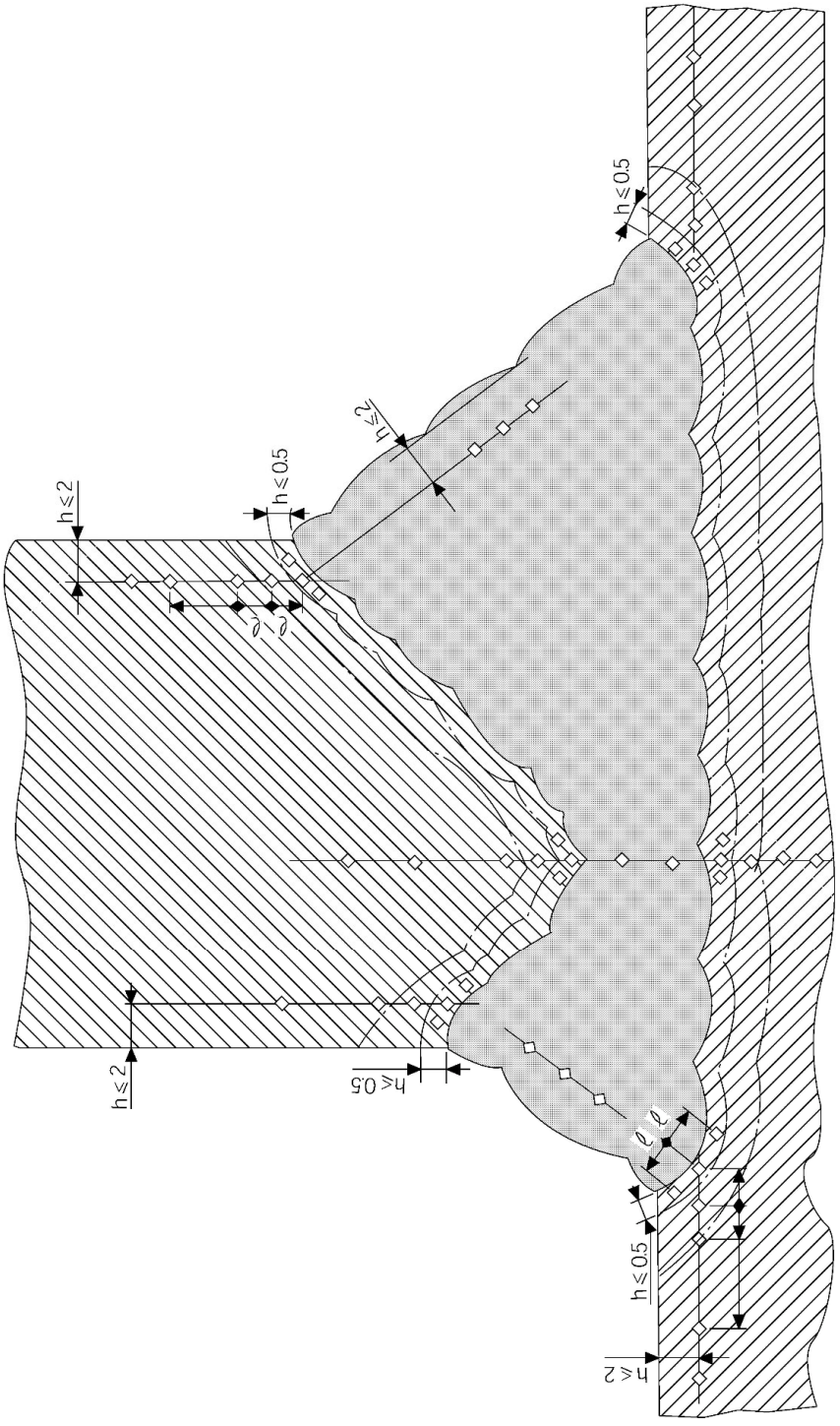
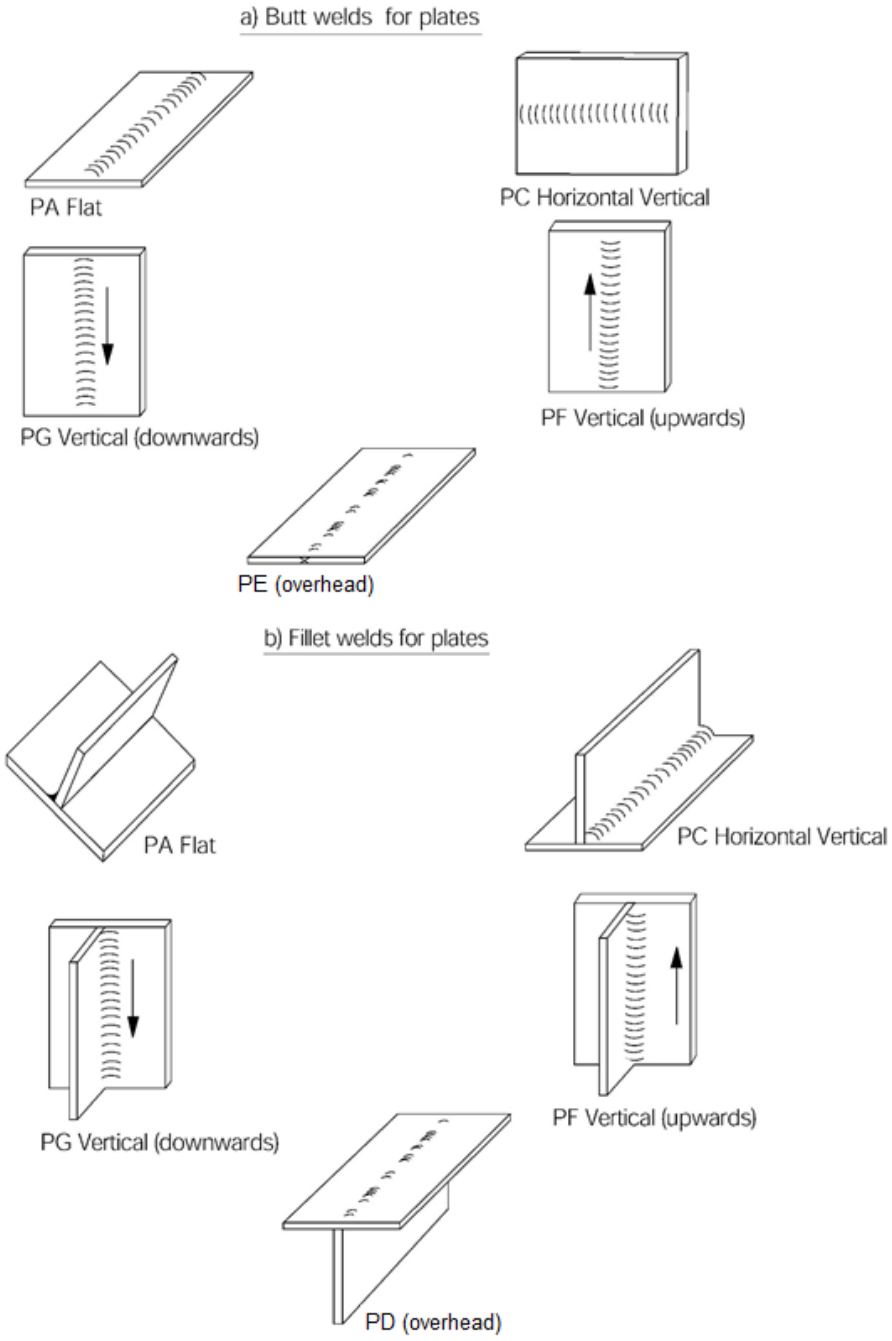


Fig C.4b. Example showing the position of the indentations for hardness test on the weld metal, the heat-affected zone and the base metal of a T-joint weld (dimensions in mm)

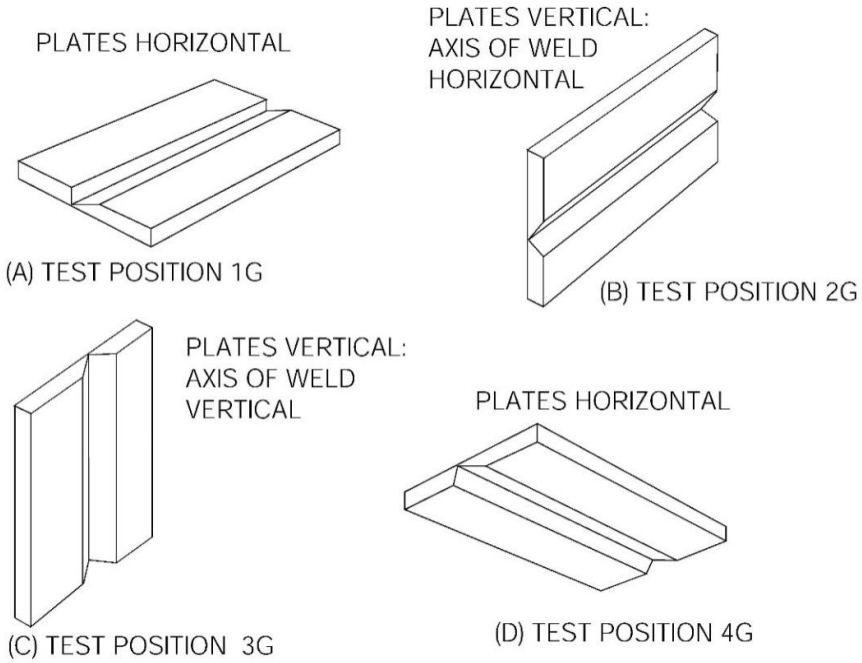
Annex D: Welding positions

D.1: Welding positions according to ISO

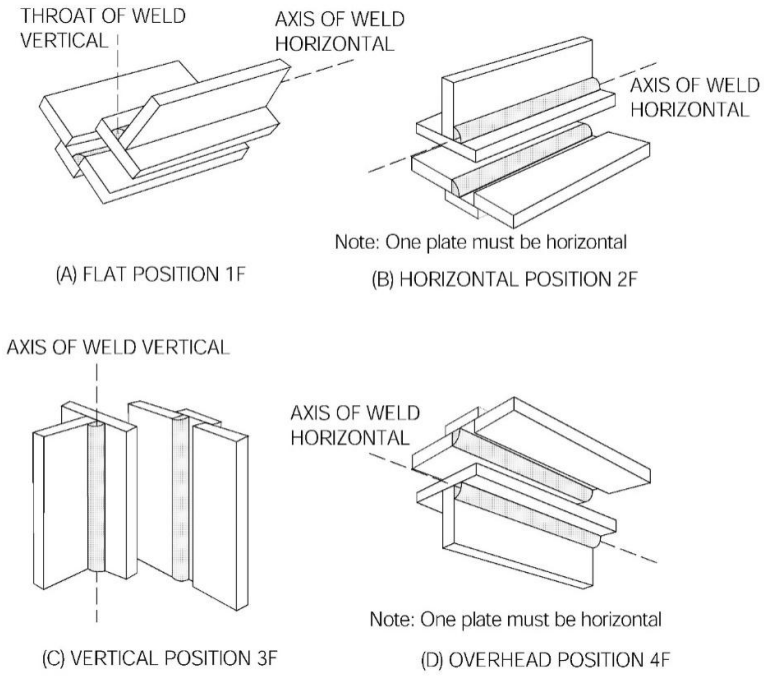


D.2: Welding positions according to AWS

a) Butt welds for plates



b) Fillet welds



Annex E: Provisions for welding qualification using approved high heat input plate

E1. The information in this Annex relates to welding with high heat input, which is defined in this document in section 4.1.5. This annex is applicable to welding qualifications using plates with approved high heat input grade notations, as described in Part 2, Chapter 3 of the Main Rules, 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 are to choose the plate heat input notation appropriate for the production welding, noting that the production welding heat input is not to exceed the welding qualification plate notation.
Therefore, the selected plate heat input notation for welding qualification is to 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.

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.

The corresponding main body requirements (clause wise) of this document are shown in [square brackets].

Base material [5.2]

E5.2.1 Normal and higher strength hull structural steels in accordance with Part 2, Chapter 3 of the Main Rules : 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^{o}C, 0^{o}C, and -20^{o}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 in accordance with Part 2, Chapter 3 of the Main Rules, for strength levels 420-500: Where high heat input 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^{o}C, 0^{o}C, and -20^{o}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.

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 are also to 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 main body text of this document.

Welding process [5.5]
E5.5.1 As per main body text of this document.

Welding consumables [5.6]
E5.6.1 As per main body text of this document.

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 N/mm²) 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.

End of Classification Notes