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Qualification scheme for welders of steels

(March 2009)

1. Scope

1.1 This document provides guidance for a qualification scheme for welders intended to be engaged in the welding of steels specified in UR W7, W8, W11 and W16 for hull structures.

1.2 Guidance for the qualification scheme for welders intended to be engaged in the welding of aluminium alloys is given in Rec.105.

1.3 This qualification scheme does not cover fully mechanized or fully automatic welding processes. Welders engaged in such welding processes should have experience of the specific welding work concerned.

2. General

2.1 Those welders intended to be engaged in welding of hull structures in shipyards and manufacturers should be tested and qualified in accordance with this scheme and issued with a qualification certificate endorsed by the Society.

2.2 This guidance document is applicable to welding of hull structures both during new construction and the repair of ships.

2.3 The training of welders, control of their qualification and maintenance of their skills are normally the responsibility of shipyards and manufacturers.

2.4 Welders qualified in accordance with national or international standards may be also be engaged in welding of hull structures, at the discretion of the Society.

3. Qualification of welders

3.1 A welder should be qualified in relation to the following variables of welding:

- a) base material
- b) welding process
- c) type of welded joint
- d) plate thickness
- e) welding position

3.2 The welding processes for welder's qualification are to be classified in Table 1 as,

- M - Manual welding
- S - Semi-automatic welding
- T - TIG welding

3.3 Welders engaged in partial-mechanised welding and partial-automatic welding as specified in Table 2 should as a minimum be qualified for manual welding (M) or semi-automatic welding (S).

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Table 1 Welding processes for welder's qualification

Symbol	Welding process in actual welding works		ISO 4063
M	Manual welding	Manual metal arc welding (metal arc welding with covered electrode)	111
S	Semi-automatic welding	Self-shielded tubular-cored arc welding Metal inert gas (MIG) welding Metal active gas (MAG) welding Tubular cored metal arc welding with active gas shield Tubular cored metal arc welding with inert gas shield	114 131 135 136 137
T	TIG welding	Tungsten inert gas (TIG) welding	141

Table 2 Welding processes for welder's qualification
(partially mechanised welding and partially automatic welding)

Welding process in actual welding works		ISO 4063
Partially mechanised welding Partially automatic welding	Submerged arc welding with one wire	121
	Submerged arc welding multiple wire electrode	123
	Submerged arc welding metallic powder addition	124
	Submerged arc welding tubular wire	125
	Fillet welding using simplified carriage	-

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Table 3 Types of welded joint for welder's qualification

Type of welded joint used in the test assembly for the qualification test				Type of welded joint qualified
Butt weld	Single sided weld	With backing	WB	WB, WG, FW
		Without backing	NB	WB, NB, WG, NG, FW
	Double sided weld	With gouging	WG	WB, WG, FW
		Without gouging	NG	WB, WG, NG, FW
Fillet weld			FW	FW

3.4 The types of welded joint for welder's qualification are to be classified as shown in Table 3 in accordance with the qualification test.

A qualification test performed using butt welds automatically qualifies fillet welding.

The Society may qualify as FW, welders who are employed to perform fillet welding only. However, where such welders are engaged to weld fillet with groove they are to be qualified for butt welds.

3.5 The qualified plate thickness range arising from the welder qualification test plate thickness is shown in Table 4.

3.6 The welding positions qualified as a result of the actual welding position used in a satisfactory welder's qualification test, are shown in Table 5. Diagrams showing the definitions of weld position used in Table 5 are shown in Fig. 1, Fig. 2, Fig. 3 and Fig. 4.

Table 4 Plate thicknesses for welder's qualification

Thickness of test assembly T (mm)	Qualified plate thickness range t (mm)
$T \leq 3$	$T \leq t < 2T$
$3 < T \leq 20$	$3 < t \leq 2T$
$20 < T$	$3 < t$

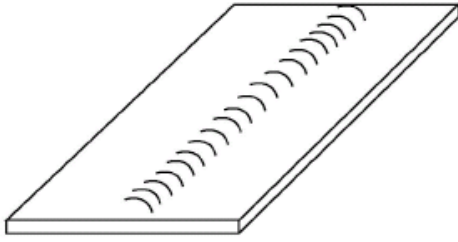
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Table 5 Welding positions for welder's qualification

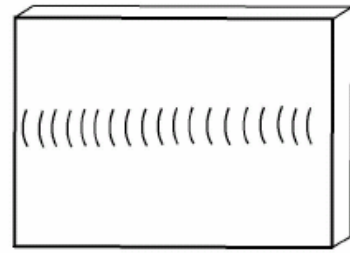
Qualification Test Position (See Fig. 3 and Fig. 4)	Welding positions in actual welding works	
	Butt welds (See Fig. 1)	Fillet welds (See Fig. 2)
1G	F	F, H
2G	F, H	F, H
3G-up	F, H, VU	F, H, VU
3G-down	F, VD	F, VD
4G	F, H, OH	F, H, OH
2G+3G-up+4G	F, H, VU, OH	F, H, VU, OH
1F	-	F
2F	-	F, H
3F-up	-	F, H, VU
3F-down	-	F, VD
4F	-	F, H, OH
2F+3F-up+4F	-	F, H, VU, OH

3.7 Welders engaged in tack welding should be qualified for either butt welds or fillet welds, for the welding process (Table 1) and the position (Table 5) corresponding to the joint to be welded.

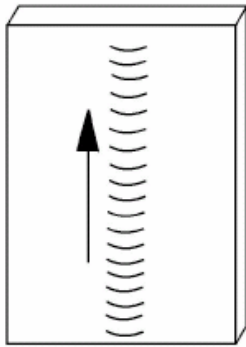
The Society may qualify those welders engaged in tack welding works only.

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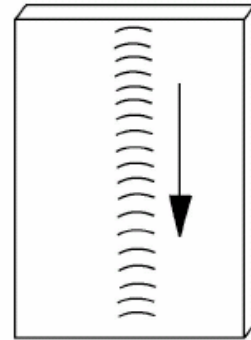
(a) Flat position (F)



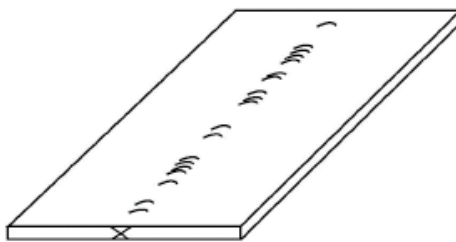
(b) Horizontal position (H)



(c) Vertical upward position (VU)

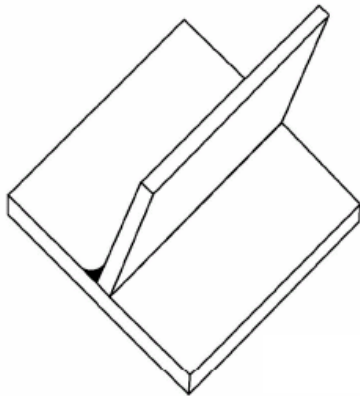


(d) Vertical downward position (VD)

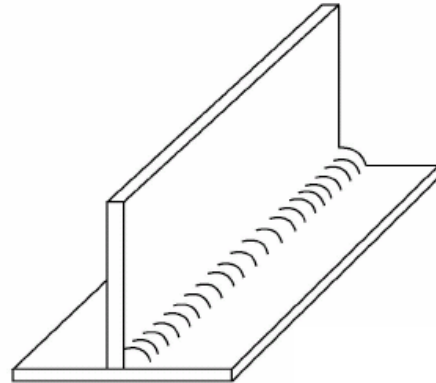


(e) Overhead position (OH)

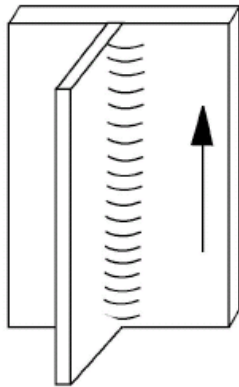
Fig. 1 Welding positions (Butt welds)

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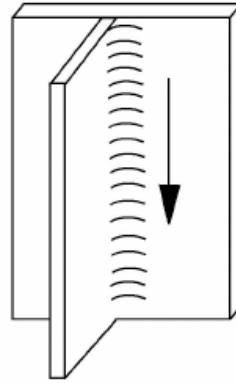
(a) Flat position (F)



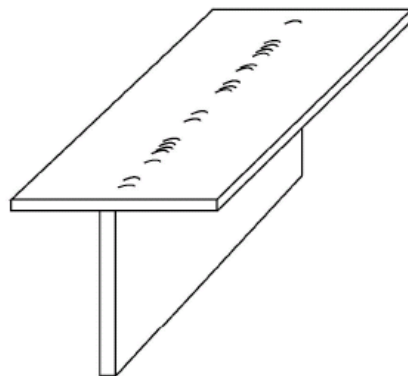
(b) Horizontal position (H)



(c) Vertical upward position (VU)



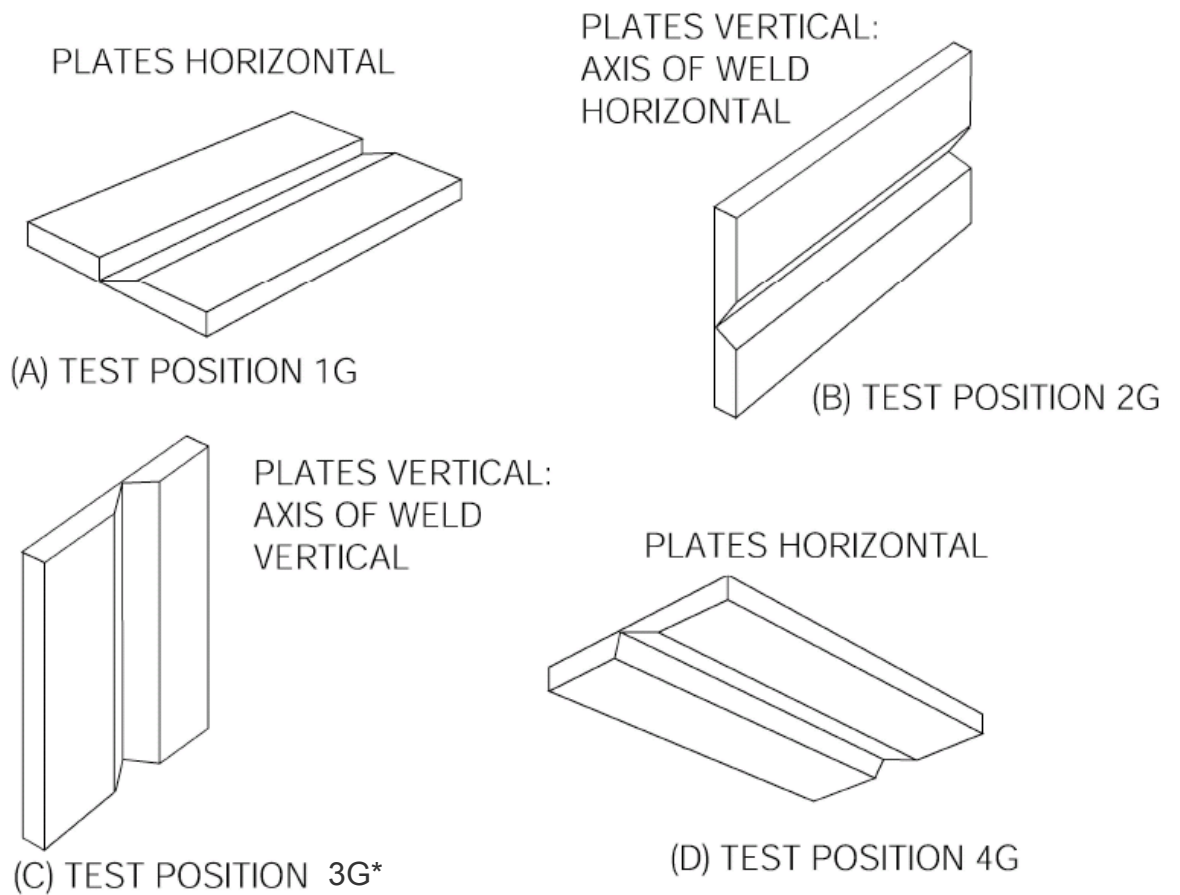
(d) Vertical downward position (VD)



(e) Overhead position (OH)

Fig. 2 Welding positions (Fillet welds)

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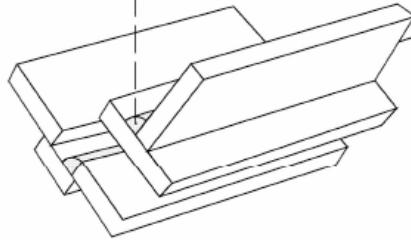
- * 3G-up : The welding position is VU (Butt welds).
- 3G-down : The welding position is VD (Butt welds).

Fig. 3 Test positions (Butt welds)

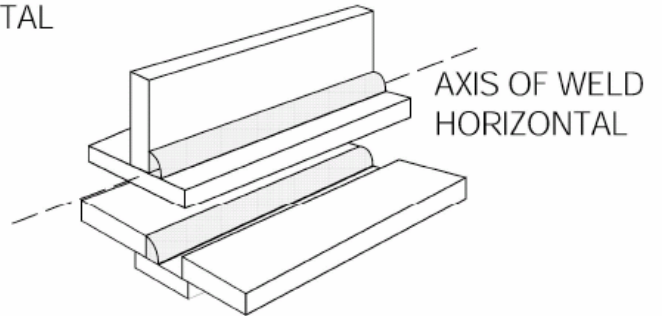
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THROAT OF WELD
VERTICAL

AXIS OF WELD
HORIZONTAL



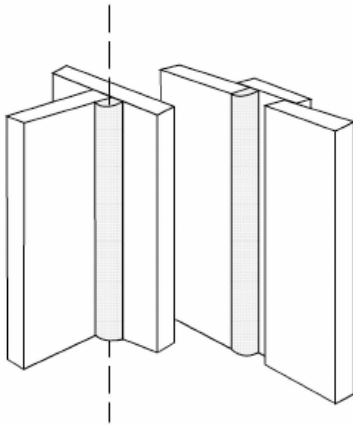
(A) FLAT POSITION 1F



Note: One plate must be horizontal

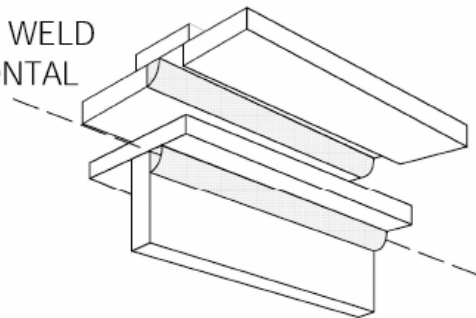
(B) HORIZONTAL POSITION 2F

AXIS OF WELD VERTICAL



(C) VERTICAL POSITION 3F*

AXIS OF WELD
HORIZONTAL



Note: One plate must be horizontal

(D) OVERHEAD POSITION 4F

- * 3F-up : The welding position is VU (Fillet welds).
- 3F-down : The welding position is VD (Fillet welds).

Fig. 4 Test positions (Fillet welds)

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4.1.1 Welding of the test assemblies and testing of test specimens should be witnessed by the Surveyor.

4.2 Test assemblies

4.2.1 Test assemblies for butt welds and for fillet welds are to be prepared as shown in Fig. 5, Fig. 6 and Fig. 7 in each qualification test.

4.2.2 Testing materials and welding consumables shall conform to one of the following requirements or to be of equivalent grade approved by the Society.

a) Testing materials

- Hull structural steels specified in UR W11
- High strength quenched and tempered steels specified in UR W16

b) Welding consumables

- Consumables for hull structural steels specified in UR W17
- Consumables for high strength quenched and tempered steels specified in UR W23

4.2.3 Welding processes for semi-automatic welding (S) may be tested for any semi-automatic welding processes specified in Table 1.

4.3 Examination and test

4.3.1 The test assemblies specified in 4.2 should be examined and tested as follows:

a) For butt welds

- Visual examination
- Bend test

Note: Radiographic test or fracture test may be carried out in lieu of bend test.

b) For fillet welds

- Visual examination
- Fracture test

Note: Two macro sections may be taken in lieu of the fracture test.

Additional tests may be required, at the discretion of the Society.

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4.3.2 Visual examination

The welds should be visually examined prior to the cutting of the test specimen for the bend test.

The result of the examination is to show the absence of cracks or other serious imperfections.

Imperfections detected are to be assessed in accordance with quality level B in ISO 5817, except for the following imperfection types for which level C applies;

- excess weld metal
- excess penetration
- excessive convexity
- excessive throat thickness

4.3.3 Bend test

Transverse bend test specimens are to be in accordance with UR W2.

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

The test specimens are to be bent through 180 degrees.

One face bend test and root bend test specimen are to be tested. For thickness 12mm and over, two side specimens may be tested as an alternative.

After the test, the test specimens should not reveal any open defects in any direction greater than 3mm. Defects appearing at the corners of a test specimen during testing should be investigated case by case.

4.3.4 Radiographic test

When radiographic testing is used for butt welds, imperfections detected should be assessed in accordance with ISO 5817, class B, except for excess penetration for which level C applies.

4.3.5 Fracture test (Butt welds)

When fracture test is used for butt welds, full test specimen in length is to be tested in accordance with ISO 9606-1. Imperfections detected should be assessed in accordance with ISO 5817, class B, except for excess penetration for which level C applies.

4.3.6 Fracture test (Fillet welds)

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

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4.3.7 Macro examination

When macro examination is used for fillet welds, 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.

Macro sections should include about 10mm 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.

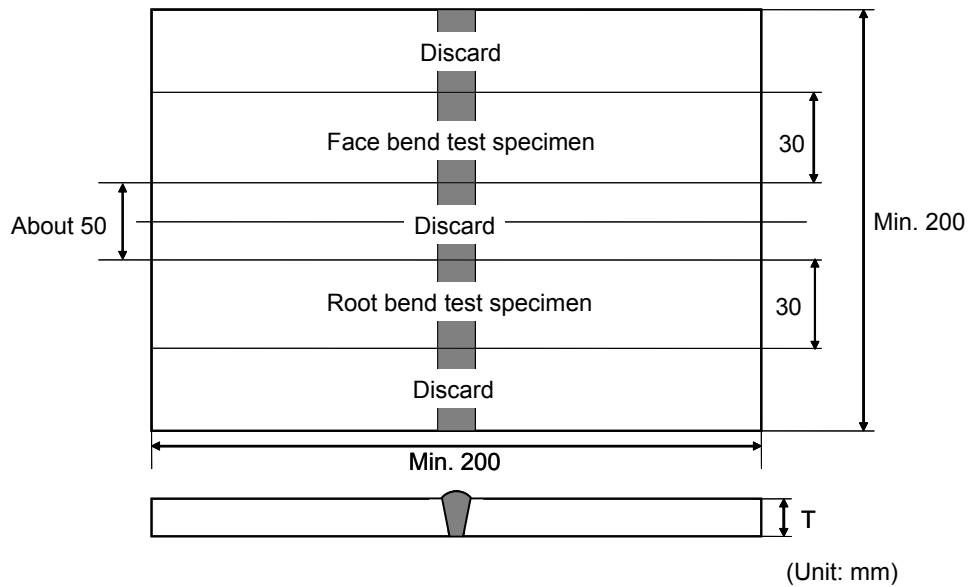


Fig. 5 Dimensions and types of test assembly for butt welds

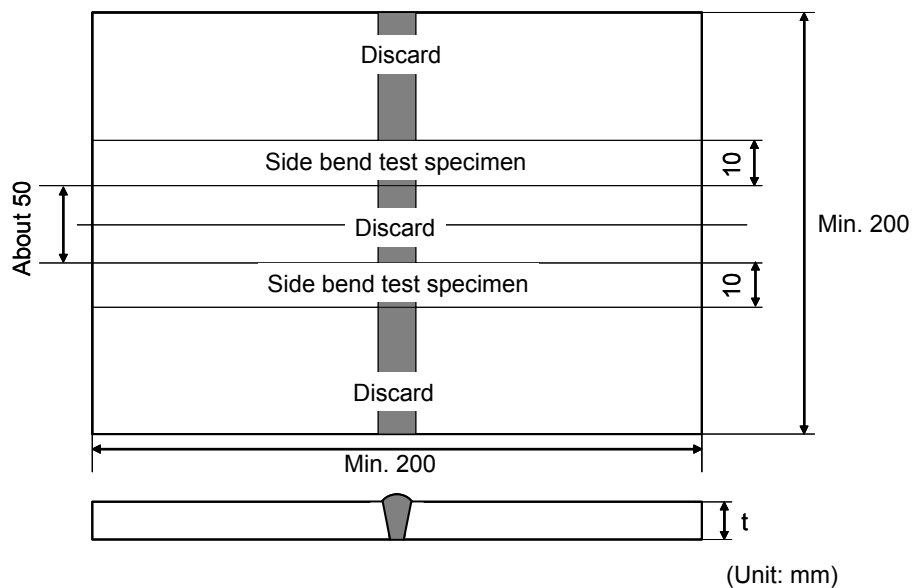


Fig. 6 Dimensions and types of test assembly for butt welds ($T \geq 12\text{mm}$)

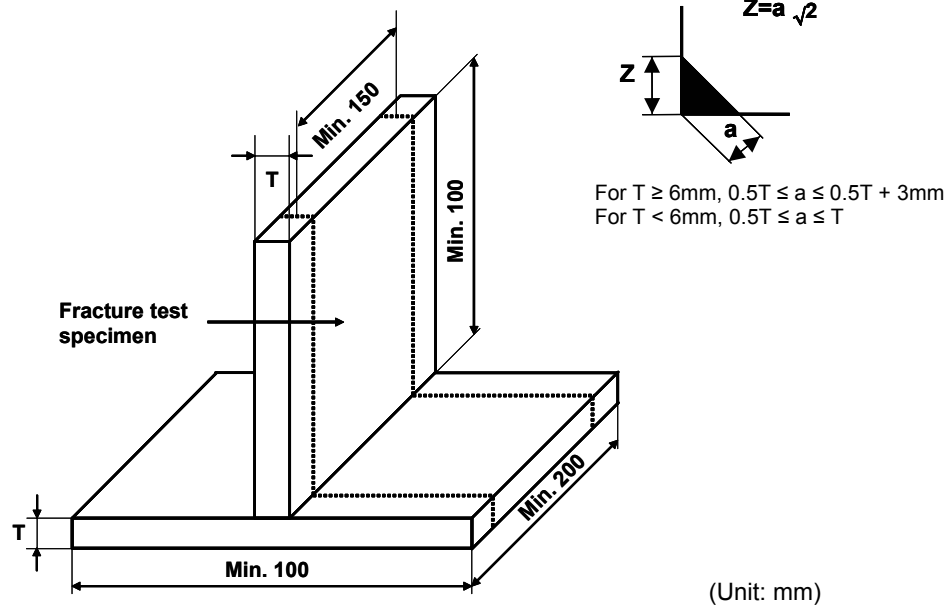


Fig. 7 Dimensions and types of test assembly for fillet welds

4.4 Retest

4.4.1 When a welder fails a qualification test, the following should apply.

4.4.1.1 In cases where the welder fails to meet the requirements in part of the tests, a retest may be welded immediately, consisting of another test assembly of each type of welded joint and position that the welder failed. In this case, the test is to be done for duplicate test specimens of each failed test.

All retest specimens should meet all of the specified requirements.

4.4.1.2 In cases where the welder fails to meet the requirements in all parts of the required tests or in the retest prescribed in 4.4.1.1, the welder should undertake further training and practice.

4.4.1.3 When there is specific reason to question the welder's ability or the period of effectiveness has lapsed, the welder should be re-qualified in accordance with the tests specified in 4.1 and 4.2.

4.4.2 Where any test specimen does not comply with dimensional specifications due to poor machining, a replacement test assembly should be welded and tested.

5. Period of Validity

5.1 Initial approval

5.1.1 Normally the validity of the welder's approval begins from the date when all the required tests are satisfactorily completed.

A welder's approval normally remains valid for a period of time left to the discretion of the Society provided that the certificate or the relevant document is signed at six-month intervals

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by the shipyards/manufacturers responsible for weld quality, and that all the following conditions are fulfilled:

- a) The welder should be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted;
- b) The welder's work should in general be in accordance with the technical conditions under which the approval test is carried out;
- c) There should be no specific reason to question the welder's skill and knowledge.

5.1.2 If any of these conditions are not fulfilled, the approval should be cancelled.

5.2 Extension of approval

5.2.1 The validity of the approval on the certificate may be prolonged for further periods within the original range of approval, provided each of the following conditions in accordance with 5.1.1 are fulfilled and:

- a) the production welds made by the welder are of the required quality;
- b) records of tests, e.g. documentation of radiographic or ultrasonic inspections or test reports on fracture tests or comments of the appointed coordinators, are maintained on file with the welder's approval certificate.

The Society may request tests in order to extend the validity of the approval on the certificate.

5.2.2 The Society should verify compliance with the above conditions and sign the extension of the welder's approval certificate.

6. Certification

6.1 Qualification certificates are normally issued when the welder has passed the qualification test by the Society. Each Shipyard and Manufacturer should be responsible for the control of the validity of the certificate and the range of the approval. Other procedures to control qualifications, such as approval of list of qualified welders, may be applied at the discretion of the Society.

6.2 The following items should be specified in the certificate:

- a) Range of qualification for materials, welding processes, types of welded joint, plate thicknesses and welding positions;
- b) Expiry date of the validity of the qualification;
- c) Name, date of birth, identification and the photograph of the welder;
- d) Name of shipbuilder / manufacturer.

6.3 The status of approvals of each individual qualification is to be demonstrated to the Classification Society when requested.

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