

## **RULES FOR**

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# **MATERIALS AND WELDING 2018**

### **NOTICE NO. 1 – July 2018**

The following Rule Changes were approved by the ABS Rules Committee on 1 June 2018 and become **EFFECTIVE AS OF 1 JULY 2018**.

*(See <http://www.eagle.org> for the consolidated version of the 2014 Rules for Materials and Welding (Part 2), with all Notices and Corrigenda incorporated.)*

*Notes - The date indicated in the parentheses in the Rules for Materials and Welding (Part 2) is the date that the requirement becomes effective for new construction based on the contract date for construction (also applicable to certification of steel based on a contract for new construction between builder and Owner on or after 1 July 2014 when the date of purchase order of the materials is on or after 1 July 2014).*

## **PART 2            RULES FOR MATERIALS AND WELDING**

### **CHAPTER 1       MATERIALS FOR HULL CONSTRUCTION**

#### **SECTION 1       GENERAL REQUIREMENTS**

*(Revise Subsection 2-1-1/3, as follows:)*

### **3       Surface Quality (1 July 2018)**

#### **3.1    General**

The steel is to be free from cracks, injurious surface flaws, injurious laminations and similar defects prejudicial to the use of the material for the intended application.

The finished material is to have a surface quality in accordance with a recognized standard such as EN 10163 Parts 1 (General), 2 (Plates), or ASTM A6 or an equivalent standard accepted by ABS, unless otherwise specified in this Section. In case there is conflict between the requirements, the more stringent requirements are to be followed.

#### **3.3    Manufacturer Responsibility**

The responsibility for meeting the surface quality requirements rests with the manufacturer of the material, who is to take the necessary manufacturing precautions and is to inspect the products prior to delivery. At that stage, however, rolling or heat treatment scale may conceal surface discontinuities and defects. If, during the subsequent descaling or working operations, the material is found to be defective, ABS may require materials to be repaired or rejected.

##### **3.3.1**

The surface quality inspection method shall be in accordance with recognized national or international standard agreed between purchaser and manufacturer, accepted by ABS.

3.3.2

If agreed by the manufacturer and purchaser, steel may be ordered with improved surface quality over and above these requirements.

**3.5 Acceptance Criteria**

3.5.1 Imperfections

Imperfections, for example pitting, rolled-in scale, indentations, roll marks, scratches and grooves, regarded as being inherent to the manufacturing process, are permissible irrespective of their number, provided the maximum permissible limits of Class A of EN 10163-2 or limits specified in a recognized equivalent standard accepted by ABS, are not exceeded and the remaining plate or wide flat thickness remains within the average allowable minus thickness tolerances specified in 2-1-1/15. Total affected area with imperfections not exceeding the specified limits are not to exceed 15% of the total surface on each side.

3.5.2 Defects

Affected areas with imperfections with a depth exceeding the limits of Class A of EN10163-2 or the maximum permissible limits specified in a recognized equivalent standard accepted by ABS, shall be repaired irrespective of their number.

Cracks, injurious surface flaws, shells (over lapping material with non-metallic inclusion), sand patches, laminations and sharp edged seams (elongated defects) visually evident on surface and/or edge of plate are considered defects, which would impair the end use of the product and which required rejection or repair, irrespective of their size and number.

**3.7 Repair**

3.7.1 Grinding Repair

Unless otherwise agreed, grinding may be applied provided all the conditions below are adhered to:

- i)* The nominal product thickness will not be reduced by more than 7% or 3 mm (0.12 in.), whichever is the less.
- ii)* Each single ground area below the minimum thickness does not exceed 0.25 m<sup>2</sup> (2.7 ft<sup>2</sup>).
- iii)* All ground areas below the minimum thickness do not exceed 2% of the total surface in question.
- iv)* Ground areas lying in a distance less than their average width to each other are to be regarded as one single area.
- v)* Ground areas lying opposite each other on both surface shall not decrease the product thickness by values exceeding the limits as stated under *i*).

Defects or unacceptable imperfections are to be completely removed by grinding and the remaining plate or wide flat thickness shall remain within the average allowable thickness tolerance specified in 2-1-1/15. The ground areas shall be a smooth transition to the surrounding surface of the product. Complete elimination of the defect can be verified by visual inspection, Magnetic particle (MP) or liquid penetrant (LP) testing. Note: The NDE technique initially used to detect a defect is to be applied after grinding to verify defect removal. NDE operators are to be qualified to the satisfaction of the attending Surveyor.

NDE can be carried out in accordance with the manufacturer's conformance standard, provided the conformance standard is submitted to ABS Materials for acceptance.

3.7.2 Welding Repair

Weld repair procedures and the method for repair are to be reported and be approved by ABS. To confirm defects have been removed prior to weld repair, MP or LP may be required. Repair of defects such as unacceptable imperfections, cracks, shells or seams shall be followed by MP or LP testing.

Local defects which cannot be repaired by grinding as stated in 2-1-1/3.7.1 may be repaired by welding with the agreement of ABS subject to the following conditions:

- i) Any single welded area shall not exceed 0.125 m<sup>2</sup> (1.35 ft<sup>2</sup>) and the sum of all areas shall not exceed 2% of the surface side in question.
- ii) The distance between two welded areas shall not be less than their average width.
- iii) The weld preparation shall not reduce the thickness of the product below 80% of the nominal thickness. For occasional defects with depths exceeding the 80% limit, special consideration at the Surveyor's discretion will be necessary.
- iv) If weld repair depth exceeds 3 mm, UT may be requested by ABS. If required, UT shall be carried out in accordance with an approved procedure.
- v) The repair shall be carried out by qualified welders using an approved procedure for the appropriate steel grade. The electrodes shall be of low hydrogen type and shall be dried in accordance with the manufacturer's requirements and protected against re-humidification before and during welding.

### 3.9 Bars, Shapes and Tubulars

The surface quality and condition requirement herein are not applied to products in forms of bars and tubulars, which will be subject to manufacturer's conformance standards.

*(Revise Subsection 2-1-1/21, as follows:)*

## 21 Ultrasonic Examination of Plate and Wide Flats (1 July 2018)

### 21.1

If plates and wide flats are ordered with ultrasonic inspection this is to be made in accordance with an accepted standard such as EN10160, ASTM A435 or equivalent, at the discretion of ABS. Acceptance criteria is to be agreed between the purchaser and manufacturer, and accepted by ABS. The products will be specially marked in accordance with 2-1-2/13.13.

Refer to 2-1-8/11.1 for requirements extra high strength steels.

### 21.3

Verification of internal soundness is the responsibility of the manufacturer. The acceptance of internal soundness by the ABS Surveyor shall not absolve the manufacturer from this responsibility.

**PART 2            RULES FOR MATERIALS AND WELDING**  
**CHAPTER 1       MATERIALS FOR HULL CONSTRUCTION**  
**SECTION 2       ORDINARY-STRENGTH HULL STRUCTURAL STEEL**

*(Revise Subsection 2-1-2/7, as follows:)*

**7            Condition of Supply (1 July 2018)**

The conditions of supply are to be in accordance with the requirements in 2-1-2/Table 5 and the following:  
Controlled manufacturing processes require approval for each plant and combination of grade and thickness limit.

The applicable rolling procedures are defined as follows. Reference can also be made to ASTM A941, for cooling definitions.

**7.1        As Rolled – AR**

This procedure involves the rolling of steel at high temperature followed by air cooling, as it is rolled, with no further heat treatment. The rolling and finishing temperatures are typically in the austenite recrystallization region and above the normalizing temperature. The strength and toughness properties of steel produced by this process are generally less than steel heat treated after rolling or than steel produced by advanced processes.

**7.3        Heat Treatment**

**7.3.1      Normalizing Heat Treatment**

A normalizing heat treatment is to consist of heating plates, wide flats, bars or shapes above the critical temperature, AC3, and in the lower end of the austenite recrystallization region for a specific period of time to effect the desired transformation and then individually cooling the material in air. The process improves the mechanical properties of as rolled steel by refining the austenitic grain size and homogenizing the microstructure, provided that the steel is produced to fine austenitic grain size practice. Normalizing heat treatments are usually conducted at the steel manufacturer's plant. Such heat treatment may be carried out at a shipyard or fabricator's plant, provided the Surveyor is satisfied with the heat-treating facilities and procedures. In such cases, the shipyard or fabricator is to indicate on the purchase order that the mill tests are to be made on normalized coupons. Otherwise, tests on the normalized material will be required at the shipyard or fabricator's plant.

**7.3.2      Special Heat Treatment**

Other types of heat treatment are to be specially approved.

**7.5        Controlled Manufacturing Process**

**7.5.1      Controlled Rolling – CR (Normalized Rolling – NR)**

Controlled rolling is a procedure in which the final rolling temperature is generally controlled within the range used for normalizing heat treatments so that the austenite completely recrystallizes, allowed to cool in air, resulting in a material condition generally equivalent to that obtained by normalizing.

**7.5.2      Thermo-mechanical Rolling – TM (Thermo-mechanical Controlled Processing – TMCP)**

Thermo-mechanical controlled processing involves the strict control of the steel temperature and the rolling reduction. Generally, a high proportion of the rolling reduction is carried out close to or below the Ar3 transformation temperature and may involve rolling toward the lower end of the temperature range of the intercritical duplex phase region, thus permitting little if any recrystallization of the austenite. Unlike controlled rolling, the properties produced by TM (TMCP) cannot be reproduced by subsequent normalizing or other heat treatment.

The use of accelerated cooling on completion of rolling may also be accepted, subject to the special approval of ABS.

Accelerated cooling (AcC) is a process which aims to improve mechanical properties by controlled cooling with rates higher than air cooling immediately after the final TM (TMCP) operation. Direct quenching is excluded from accelerated cooling.

Where NR (CR) and TM with/without AcC are applied, the programmed rolling schedules are to be verified by ABS at the time of the steel works approval, and are to be made available when required by the attending Surveyor. On the manufacturer's responsibility, the programmed rolling schedules are to be adhered to during the rolling operation. Refer to 2-1-1/1.2.2. To this effect, the actual rolling records are to be reviewed by the manufacturer and occasionally by the Surveyor.

When deviation from the programmed rolling schedules or normalizing or quenching and tempering procedures occurs, the manufacturer shall take the further measures required in 2-1-1/1.2.2 to the Surveyor's satisfaction.

### **7.7 Quenching and Tempering – QT**

Quenching involves a heat treatment process in which steel is heated to an appropriate temperature above the AC3, held for a specific period of time, and then cooled with an appropriate coolant for the purpose of hardening the microstructure. Tempering subsequent to quenching is a process in which the steel is reheated to an appropriate temperature not higher than the AC1, maintained at that temperature for a specific period of time to restore toughness properties by improving the microstructure and reduce the residual stress caused by the quenching process.

## **15 Surface Finish**

*(Revise Paragraph 2-1-2/15.3, as follows:)*

### **15.3 Treatment of Surface Defects – Plates (1 July 2018)**

Refer to 2-1-1/3.

## **PART 2 RULES FOR MATERIALS AND WELDING**

### **CHAPTER 1 MATERIALS FOR HULL CONSTRUCTION**

#### **SECTION 7 ORDINARY AND HIGHER STRENGTH STEELS WITH ENHANCED CORROSION RESISTANCE PROPERTIES FOR CARGO OIL TANKS**

*(Revise Subsection 2-1-7/13, as follows:)*

### **13 Surface Quality (1 July 2018)**

Please refer to 2-1-1/3.

**PART 2            RULES FOR MATERIALS AND WELDING**  
**CHAPTER 4        WELDING AND FABRICATION**  
**SECTION 1        HULL CONSTRUCTION**

5      Production Welding

*(Revise Paragraph 2-4-1/5.5, as follows:)*

**5.5      Preheat and Interpass Temperature Control (1 July 2018)**

Preheat and interpass temperatures are to be in accordance with the approved welding procedure specification; that is appropriate to the alloy chemistry and thickness.

An increase in specified preheat is to be considered during the weld procedure qualification for steels with specific property requirements, such as, high toughness, extra high strength, crack arrest and enhanced corrosion resistance.

The minimum preheat temperature is to be maintained throughout all welding operations, including tack welds and temporary attachment welds.

The minimum and maximum interpass temperatures are to be maintained within the qualified WPS ranges throughout all welding operations, including tack welds and temporary attachment welds.

In all cases, preheat and interpass temperature control are to be sufficient to maintain dry surfaces and minimize the possibility of the formation of fractures.

When welding is performed under high humidity conditions or when the temperature of steel is below 0°C (32°F), the base metal is to be preheated to at least 20°C (70°F) or as specified in the WPS, whichever is the higher.

Particular close attention to control, with verification by the ABS Surveyor, of preheat and interpass temperature (using calibrated equipment) is to be applied when welding extra-high-strength steels, forgings and castings, and materials of thick cross-section or materials subject to high restraint, for example, cruciform T butt welds.

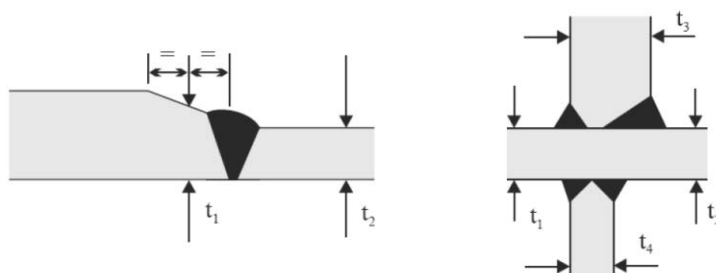
If any of the following apply, an increase in preheat temperature is to be considered:

- i)        Structural members in critical areas
- ii)       Members such as cruciform joints which have high restraint
- iii)      Increased material thickness as combined thickness; over 25 mm (1 in.), over 50 mm (2 in.), over 70 mm (2.8 in.), over 100 mm (4.0 in.)
- iv)      Welding connections of castings to thick rolled plates or large structures, which could act as heat sinks
- v)        Any weld repairs
- vi)      Higher Carbon content or high Carbon equivalent

*Notes:* Depending upon the welding code applied (e.g., AWS D1.1, ASME IX), a requalification of a WPS with a higher preheat might be required.

Calculation of Combined Thickness below:

Combined thickness  $t_{comb} = t_1 + t_2 + t_3 + t_4$ , see figure



Preheating may be performed by gas burners, oxy-gas torch, electric blankets, induction heating, or by heating in a furnace.

All specified preheat and interpass temperatures are to be measured or verified by appropriate temperature measuring devices in close proximity to weld. (Typically 75 mm (3 inches) from the weld).

Preheat is to be applied in such a manner as to allow for the complete material thickness to reach the required temperature.

If a torch is used to preheat welds, including tack or short welds, it is to be manipulated around the surrounding joint area to produce uniform heating. Intense, non-uniform heating is to be avoided and may be detrimental, leading to distortion, high residual stress, undesirable metallurgical phases and do little to retard weld cooling.

Preheating may also be necessary before thermal cutting operations.

**PART 2            RULES FOR MATERIALS AND WELDING**

**CHAPTER 4       WELDING AND FABRICATION**

**SECTION 3       WELD TESTS**

11    Welders

*(Revise Paragraph 2-4-3/11.3, as follows:)*

**11.3    Qualification Tests (1 July 2018)**

The tests, if required for qualification in the various positions for different materials and thicknesses, are given in 2-4-3/Table 1. The tests are referred to by Nos. Q1 to Q4 inclusive for which specimens are to be prepared in accordance with 2-4-3/Figure 9 to 2-4-3/Figure 12 respectively, and physically tested if the welder is qualified by this method. Alternatively, upon the request of the employer, the welder may be qualified by use of radiography, except for gas metal arc welding with the short circuit transfer technique for which bend tests are required. Test assemblies for either physical testing or radiographic examination are to be prepared according to material thickness and welding position, as indicated in 2-4-3/Table 1.

As an alternative, welders may be qualified in accordance with Part 2, Appendix 11 or a recognized standard. The application of such recognized standard is to be submitted for agreement by the Surveyor.

*(Add new Appendix 11, as follows:)*

**PART 2                    RULES FOR MATERIALS AND WELDING**

**APPENDIX 11        QUALIFICATION FOR WELDERS AND WELDING OPERATORS** *(1 July 2018)*

**SECTION 1            GENERAL**

1

The general guidelines and requirements defined in the *ABS Rules for Materials and Welding (Part 2)* are to be applied. This Appendix covers the qualification for welders and welding operators for structural welding of marine and offshore vessels.

3

These requirements apply to ABS's acceptance of welders and welding operators for welding of steel and non-ferrous metals.

5

This Appendix specifies the requirements for welder and operator qualifications including:

- Ship hull structure and other ship structure
- Offshore hull and other offshore structure

7

The training of welders and welding operators, control of their qualification, and maintenance of their skills are the responsibility of the builders and subcontractors. When requested, these are to be documented and demonstrated to the satisfaction of ABS.

9

The certified welders and welding operators are to be recorded by builders and subcontractors with welders' training, as well as date and documents of qualification tests. The qualification documents are to include the information about the base metal, type of welding consumable, welding process, type of welded joint, material thickness, welding position, and destructive and nondestructive test results. One example is shown in Annex 2-A11-A1.



## **PART 2            RULES FOR MATERIALS AND WELDING**

### **APPENDIX 11    QUALIFICATION FOR WELDERS AND WELDING OPERATORS**

#### **SECTION 2        WELDERS QUALIFICATION FOR HULL STRUCTURES**

*\* Notes:*

- 1        This Appendix is to be applied by ABS to applications for welder or welding operator qualification (initial or renewal) dated on or after 1 January 2018.
- 2        This document does not invalidate welder's qualifications issued and accepted by ABS before 1 January 2018, provided the welder's qualifications are considered by ABS to meet the technical intent of this Appendix. These qualifications are to be renewed in accordance with this Appendix latest by 31 December 2020.
- 3        Certificates that expire after 1 January 2018 are to be renewed in accordance with this Appendix.

#### **1        Scope**

##### **1.1**

The general requirements for weld tests defined in Section 2-4-3 are to be applied.

##### **1.3**

This Section gives requirements for a qualification scheme for welders intended to be engaged in the fusion welding of steels for hull structures as specified in the *ABS Rules for Materials and Welding (Part 2)* as follows:

- Section 2-1-2: Ordinary-Strength Hull Structural Steel
- Section 2-1-3: Higher-Strength Hull Structural Steel
- Section 2-1-5: Hull Steel Castings
- Section 2-1-6: Hull Steel Forgings
- Section 2-1-7: Ordinary and Higher Strength Steels with Enhanced Corrosion Resistance Properties for Cargo Oil Tanks
- Section 2-1-8: Extra High Strength Steels

and other steels, at the discretion of ABS, such as:

- H47 and H36/H40/H47 BCA (Brittle Crack Arrest) Steel.

##### **1.5**

This qualification scheme does not cover welders engaged in oxy-acetylene welding.

##### **1.7**

This qualification scheme does not cover welding of pipes or structural tubulars.

#### **3        General**

##### **3.1**

Those welders intended to be engaged in welding of hull structures in shipyards, manufacturers, and subcontractor are to be tested and qualified in accordance with this scheme and issued with a qualification certificate endorsed by ABS.

##### **3.3**

This Appendix is applicable to welding of hull structures during new construction, conversion, and the repair of vessels or offshore structures.

### 3.5

Welders or welding operators qualified in accordance with recognized national or international welder qualification standards may also be engaged in welding of hull structures at the discretion of ABS, provided that the qualification testing, range of approval, and revalidation requirements are considered to meet the technical intent of this Section.

### 3.7

If the production weld has restricted access the ABS Surveyor is to verify the welder has the necessary skill to achieve a satisfactory production weld under the anticipated production conditions.

## 5 Range of Qualification of Welders

### 5.1

A welder is to be qualified in relation to the following variables:

- i) Base metal
- ii) Welding consumables type
- iii) Welding process
- iv) Type of welded joint
- v) Plate thickness
- vi) Welding position

### 5.3

In case of steels, base metals for qualification of welders or welding operators are divided into two groups. Steels with a specified minimum yield strength  $ReH \leq 460 \text{ N/mm}^2$  (67 ksi) are considered Group 1. Steels with a specified minimum yield strength  $460 (67) < ReH \leq 690 \text{ N/mm}^2$  (100 ksi) are considered Group 2. Welding of any one metal in a group covers qualification of the welder or welding operator within the group.

Steels with a specified minimum yield strength  $ReH > 690 \text{ N/mm}^2$  (100 ksi) are to be specially considered.

Depending upon the welders experience and level of skill, additional qualification test may be required, at the discretion of the ABS Surveyor, if the welder is only qualified in welding ordinary strength steel and is required to weld higher strength grades.

### 5.5

For Shielded/Manual metal arc welding, qualification tests are required using basic, acid or rutile covered electrodes. Basic (B) electrode covers basic (B), acid (A) and rutile (R) electrodes. Acid (A) or rutile (R) electrode covers acid (A) and rutile (R) electrodes. The type of covered electrodes (basic, acid or rutile) included in the range of approval is at the discretion of ABS.

Welding with filler material qualifies for welding without filler material, but not vice versa.

### 5.7

The welding processes for welder's qualification are classified in 2-A11-2/Table 1 as:

- M – Manual welding
- S – Semi-automatic welding/partly mechanized welding
- T – Gas Tungsten arc welding (GTAW) or Tungsten inert gas (TIG) welding

Each testing normally qualifies only for one welding process. A change of welding process requires a new qualification test.

For automatic welding (e.g., SAW), see Section 2-A11-4 for Welding Operators Qualification.

**TABLE 1**  
**Welding Processes for Welder’s Qualification (1 July 2018)**

<i>Symbol</i>	<i>Welding Process in Actual Welding Works</i>		<i>ISO 4063</i>
<b>M</b>	Manual welding	Shielded/Manual metal arc welding (metal arc welding with covered electrode)	111
<b>S</b>	Partly mechanized welding	Gas metal arc welding (GMAW)	131
		Metal active gas (MAG) welding	135, 138 <sup>(1)</sup>
		Flux cored arc welding (FCAW)	136 <sup>(2)</sup>
<b>T</b>	TIG welding	Gas Tungsten arc welding (GTAW)	141

Notes:

ABS may require separate qualification for solid wires, metal-cored wires and flux-cored wires as follows:

- 1 A change from MAG welding with solid wires (135) to that with metal cored wires (138), or vice versa is permitted.
- 2 A change from a solid or metal cored wire (135/138) to a flux cored wire (136) or vice versa requires a new welder qualification test.

**5.9**

The types of welded joint for welder’s qualification are to be classified as shown in 2-A11-2/Table 2 in accordance with the qualification test. Welders engaged in full/partial penetration T welds are to be qualified for butt welds for the welding process and the position corresponding to the joints to be welded.

**TABLE 2**  
**Types of Welded Joint for Welder’s Qualification (1 July 2018)**

<i>Type of Welded Joint Used in the Test Assembly for the Qualification Test</i>			<i>Type of Welded Joint Qualified</i>	
Butt weld	Single sided weld	With backing	A	A, C, F
		Without backing	B	A, B, C, D, F
	Double sided weld	With gouging	C	A, C, F
		Without gouging	D	A, C, D, F
Fillet weld	----	----	F	F

**5.11**

For fillet welding, welders who passed the qualification tests for multi-layer technique welding can be deemed as qualified for single-layer technique, but not vice versa.

**5.13**

The qualified plate thickness range arising from the welder qualification test plate thickness is shown in 2-A11-2/Table 3.

**TABLE 3**  
**Plate Thicknesses for Welder’s Qualification (1 July 2018)**

<i>Thickness of Test Assembly</i> <i>T</i>		<i>Qualified Plate Thickness Range</i> <i>t</i>	
<i>mm</i>	<i>in.</i>	<i>mm</i>	<i>in.</i>
$T < 3$	$T < 0.12$	$T \leq t \leq 2T$	$T \leq t \leq 2T$
$3 \leq T < 12$	$0.12 \leq T < 0.47$	$3 \leq t \leq 2T$	$0.12 \leq t \leq 2T$
$12 \leq T$	$0.47 \leq T$	$3 \leq t$	$0.12 \leq t$

5.15

The welding positions qualified as a result of the actual welding position used in a satisfactory welder’s qualification test, are shown in 2-A11-2/Tables 4 and 5. Diagrams showing the definitions of weld position used in 2-A11-2/Tables 4 and 5 are shown in 2-A11-2/Figure 1.

ABS may require a qualification test with fillet welding for welders who are employed to perform fillet welding only.

**TABLE 4**  
**Qualified Welding Positions When Testing with Butt Welding**  
**2-A11-2/Figure 1 (1 July 2018)**

<i>Qualification Test Position with Butt Weld</i>	<i>Qualified Welding Positions in Actual Welding Works</i>	
	<i>Butt Welds</i>	<i>Fillet Welds</i>
PA-Flat (1G)	1G, PA	1F, 2F, PA, PB
PC-Horizontal (2G)	1G, 2G, PA, PC	1F, 2F, PA, PB, PC
PE-Overhead (4G)	1G, 2G, 4G, PA, PC, PE	1F, 2F, 4F, PA, PB, PC, PD, PE
PF-Vertical upwards (3G)	1G, 3G Up, PA, PF	1F, 2F, 3F Up, PA, PB, PF
PG-Vertical downwards (3G)	3G Down, PG	3F Down, PG

**TABLE 5**  
**Qualified Welding Positions when Testing with Fillet Welding**  
**2-A11-2/Figure 1 (1 July 2018)**

<i>Qualification Test Position with Fillet Weld</i>	<i>Qualified Welding Positions in Actual Welding Works</i>
	<i>Fillet Welds</i>
PA-Flat (1F)	1F, PA
PB-Horizontal vertical (2F)	1F, 2F, PA, PB
PC-Horizontal	1F, 2F, PA, PB, PC
PD-Horizontal overhead (4F)	1F, 2F, 4F, PA, PB, PC, PD, PE
PE-Overhead	1F, 2F, 4F, PA, PB, PC, PD, PE
PF-Vertical upwards (3F Up)	1F, 2F, 3F Up, PA, PB, PF
PG-Vertical downwards (3F Down)	3F Down, PG

5.17

A welder qualified for butt or fillet welding can be engaged in tack welding for the welding process and position corresponding to those permitted in his certificate.

Alternatively, welders engaged in tack welding only can be qualified on the test assemblies shown in 2-A11-2/Figure 5 or 2-A11-2/Figure 6.

7 Test Assemblies

7.1

Welding of the test assemblies is to be witnessed by the Surveyor. Test assemblies for butt welds and for fillet welds are to be prepared as shown in 2-A11-2/Figures 2, 3, and 4 in each qualification test.

7.3

Test assemblies for butt tack welds and for fillet tack welds are to be prepared as shown in 2-A11-2/Figures 5 and 6.

## 7.5

Testing materials and welding consumables are to conform to one of the following requirements or to be of equivalent grade approved by ABS:

### 7.5.1 Testing Materials

- Section 2-1-2: Ordinary-Strength Hull Structural Steel
- Section 2-1-3: Higher-Strength Hull Structural Steel
- Section 2-1-5: Hull Steel Castings
- Section 2-1-6: Hull Steel Forgings
- Section 2-1-7: Ordinary and Higher Strength Steels with Enhanced Corrosion Resistance Properties for Cargo Oil Tanks
- Section 2-1-8: Extra High Strength Steels

and other steels, at the discretion of ABS, such as:

- H47 and H36/H40/H47 BCA (Brittle Crack Arrest) Steel.

### 7.5.2 Welding Consumables

- Consumables for hull structural steels specified in Part 2, Appendix 2 and Part 2, Appendix 3, or
- Other consumables, such as for BCA steels, at the discretion of ABS.

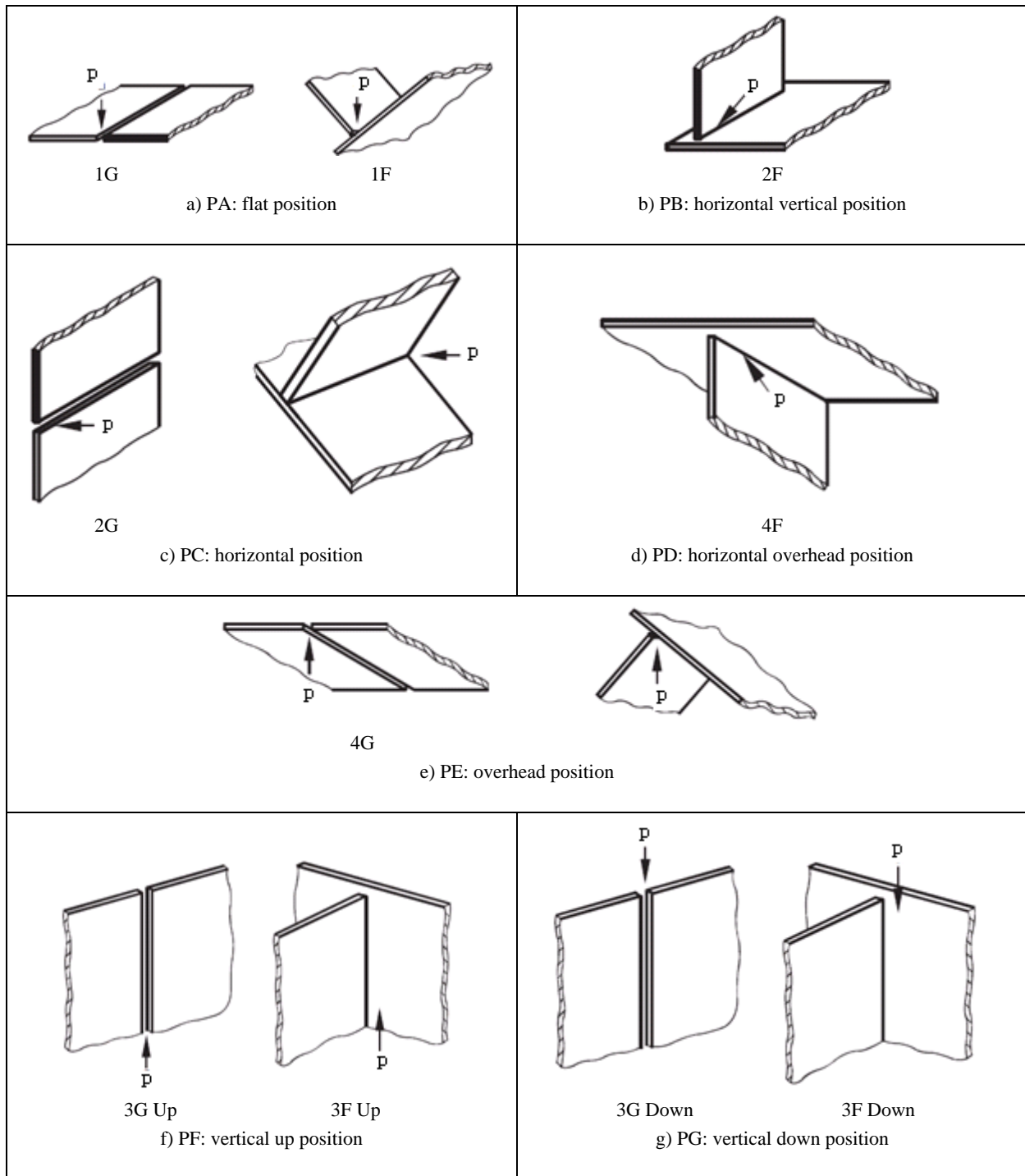
## 7.7

The welder qualification test assembly is to be welded according to a welding procedure specification (WPS or pWPS).

## 7.9

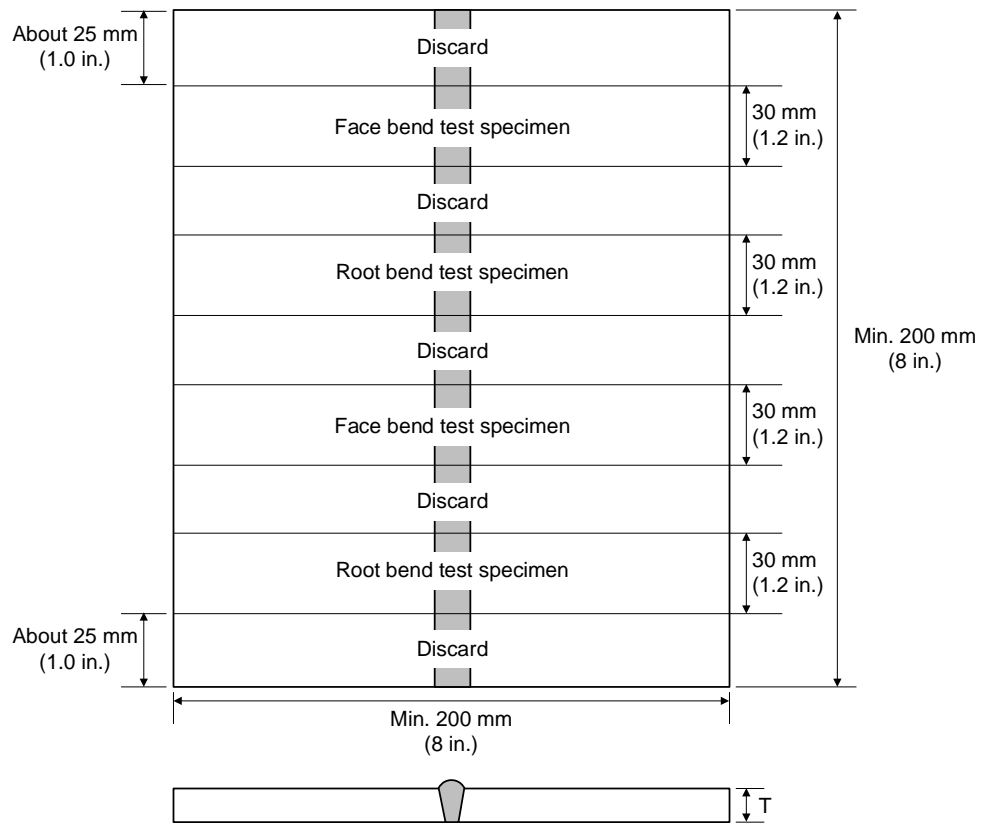
Root run and capping run are each to have a minimum of one stop and restart. The welders are allowed to remove minor imperfections in the stop by grinding before restarting welding.

**FIGURE 1**  
**Welding Positions (1 July 2018)**



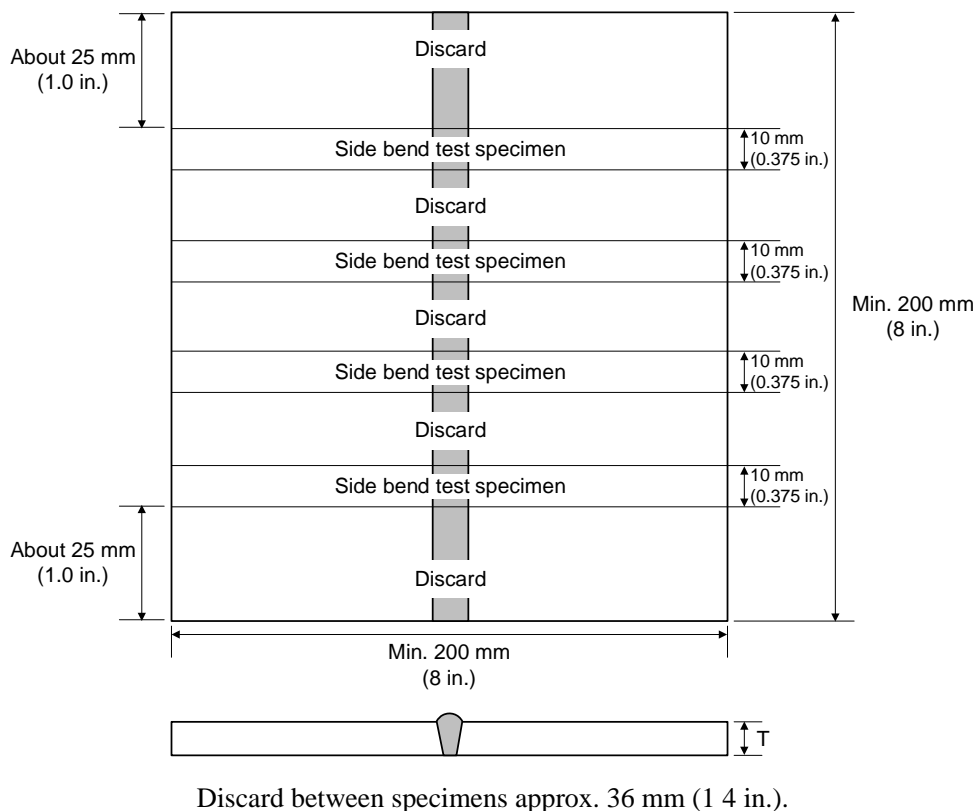
Note:  $p$  is the welding position.

**FIGURE 2**  
**Dimensions and Types of Test Assembly for Butt Welds**  
*( $T < 12\text{ mm (0.5 in.)}$ ) (1 July 2018)*

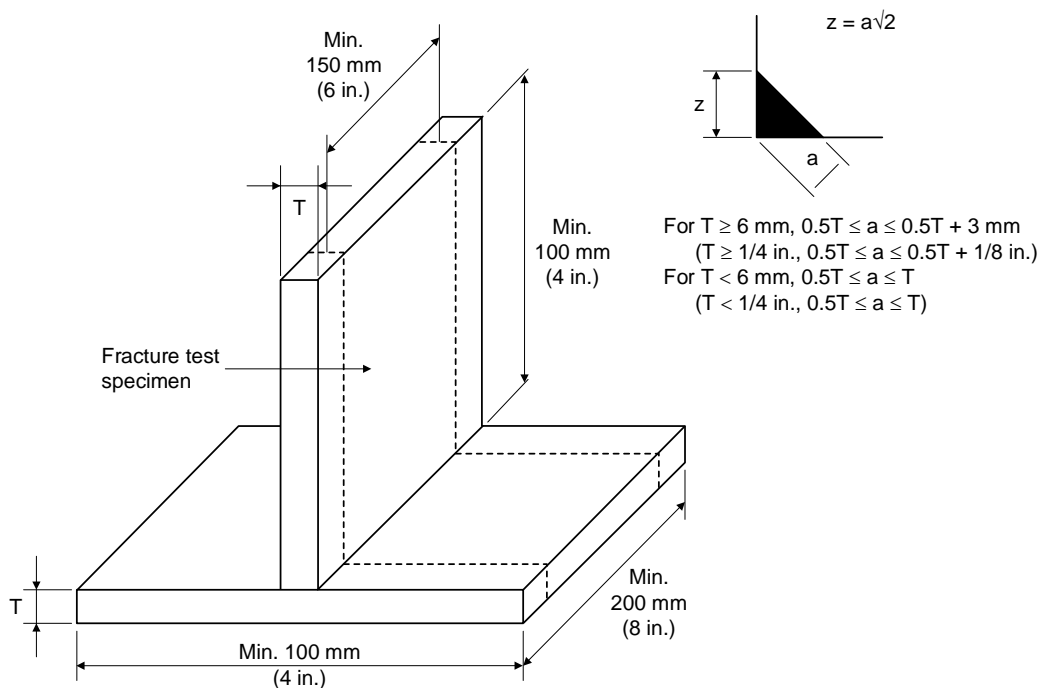


Discard between specimens approx. 10 mm (0.375 in.).

**FIGURE 3**  
**Dimensions and Types of Test Assembly for Butt Welds**  
*( $T \geq 12 \text{ mm (0.5 in.)}$ ) (1 July 2018)*

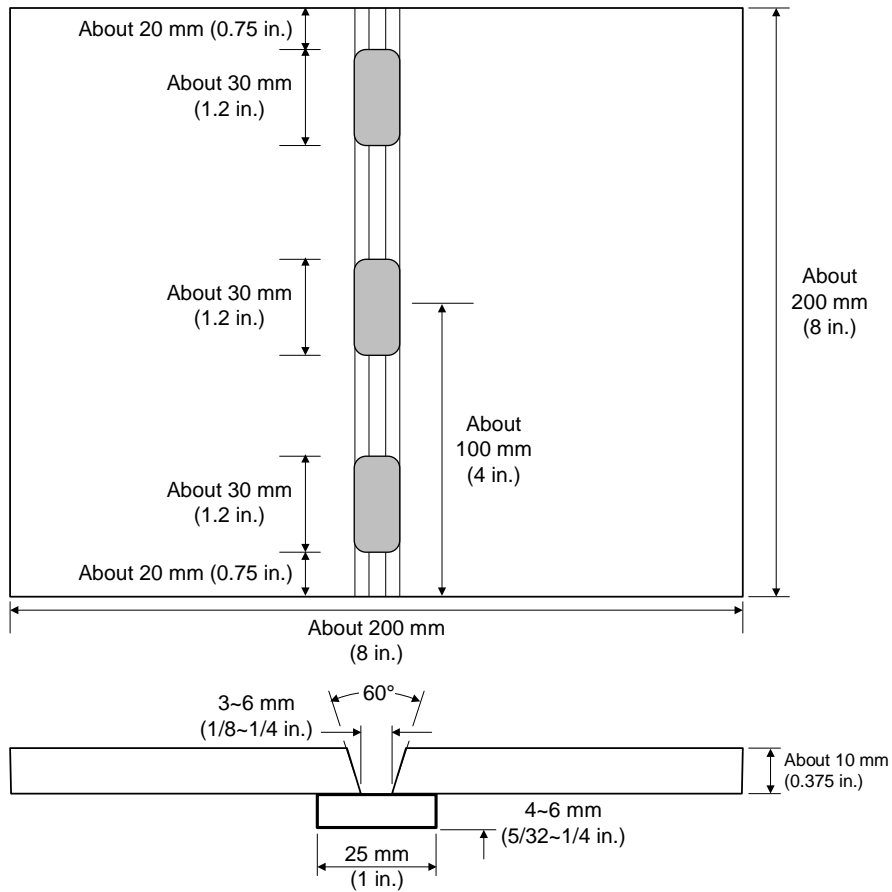


**FIGURE 4**  
**Dimensions and Types of Test Assembly for Fillet Welds** *(1 July 2018)*

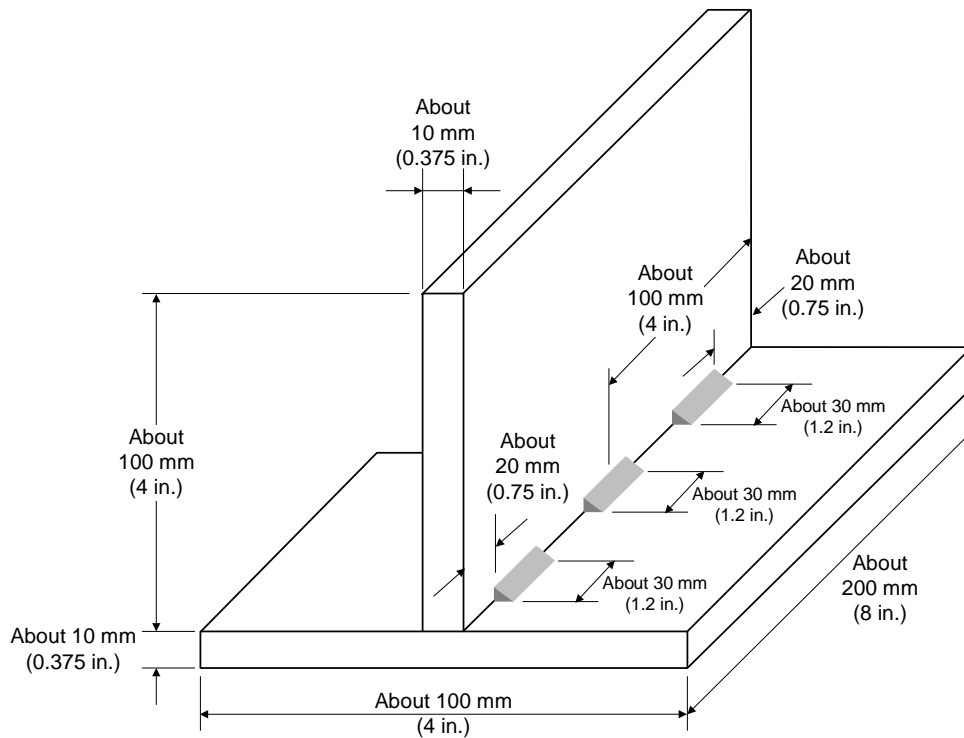




**FIGURE 5**  
**Dimensions and Types of Test Assembly for Tack Butt Welds (1 July 2018)**



**FIGURE 6**  
**Dimensions and Types of Test Assembly for Tack Fillet Welds (1 July 2018)**



## 9 Examination and Test

### 9.1 Types of Tests

Testing of test specimens is to be witnessed by the Surveyor. The test assemblies specified in 2-A11-2/7.3 are to be examined and tested as follows:

i) For butt welds:

- Visual examination
- Bend test

*Note:* Radiography can be used to qualify the welder, except for GMAW with short circuit transfer technique for which bend tests are required.

ii) For fillet welds:

- Visual examination
- Fracture test

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

iii) For tack welds:

- Visual examination
- Fracture test

### 9.3 Visual Examination

The welds are to be visually examined prior to the cutting of the test specimen for the bend test and fracture 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

### 9.5 Bend Test

Transverse bend test specimens are to be in accordance with 2-4-3/Figure 5.

The mandrel diameter to thickness ratio (i.e.,  $D/T$ ) is to be as follows,

Ordinary Strength	Four times the thickness of the specimen
Y and Y400	Four times the thickness of the specimen
YQ420, YQ460 & YQ500	Five times the thickness of the specimen
YQ550, YQ620 & YQ690	Six times the thickness of the specimen.

For normal and high strength steels, forgings, and castings, the test specimens are to be bent on a mandrel with diameter  $4t$ , where  $t$  is the thickness of the specimen. For extra high strength steels with H47 grade, the mandrel diameter is to be  $5t$ .

Two face bend test and two root bend test specimens are to be tested for initial qualification test, and one face and one root bend test specimens for extension of approval. For thickness 12 mm (0.5 in.) and over, four side specimens (two side specimens for extension of approval) with 10 mm (0.375 in.) in thickness may be tested as an alternative.

At least one bend test specimen is to include one stop and restart in the bending part, for root run or for cap run.

The test specimens are to be bent through 180 degrees shown in 2-4-3/Figure 7. After the test, the test specimens are not to reveal any open defects in any direction greater than 3 mm (0.125 in.). Defects appearing at the corners of a test specimen during testing are to be investigated on a case-by-case basis.

### 9.7 Radiographic Test

When radiographic testing is used for butt welds, imperfections detected are to be assessed in accordance with ISO 5817, level B.

### 9.9 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 9017. Imperfections detected are to be assessed in accordance with ISO 5817, level B.

### 9.11 Fracture Test (Fillet Welds)

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. Imperfections that are detected are to be assessed in accordance with ISO 5817, level B.

### **9.13 Macro Examination (Fillet Welds)**

When macro examination is used for fillet welds, two test specimens are to be prepared from different cutting positions. At least one macro examination specimen is to be cut at the position of one stop and restart in either root run or cap run. These specimens are to be etched on one side to clearly reveal the weld metal, fusion line, root penetration, and the heat affected zone.

Macro sections are to include at least 10 mm (0.375 in.) 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.

## **11 Retest**

### **11.1**

When a welder fails a qualification test, the following is to apply.

*i)* 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 are to meet all of the specified requirements.

*ii)* In cases where the welder fails to meet the requirements in all parts of the required tests or in the retest, the welder is to undertake further training and practice.

*ii)* When there is specific reason to question the welder's ability or the period of effectiveness has lapsed, the welder is to be requalified.

### **11.3**

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

## **13 Certification**

### **13.1**

Qualification certificates are normally issued when the welder has passed the qualification test by ABS. Each Shipyard, Manufacturer and Subcontractor is to be responsible for the control of the validity of the certificate and the range of the approval.

### **13.3**

The following items are to be specified in the certificate:

*i)* Range of qualification for base metal, welding processes, filler metal type, types of welded joint, plate thicknesses, and welding positions

*ii)* Expiry date of the validity of the qualification

*iii)* Name, identification, and the photograph of the welder

*iv)* Name of shipbuilder/manufacturer/subcontractor

### **13.5**

When a certificate is issued, the relative documents such as test reports and/or re-validation records are to be archived as annexes to the copy of the certificate according to the ABS Rules.

### **13.7**

The status of approvals of each individual qualification is to be demonstrated to ABS when requested.

## **15 Period of Validity of Initial Approval**

### **15.1**

Normally, the validity of the welder's approval begins from the issue date of qualification certificate when all the required tests are satisfactorily completed.

### **15.3**

The validity is to be confirmed at six-month intervals by the shipyards, manufacturers, or subcontractor personnel who are responsible for production weld quality, provided that all the following conditions are fulfilled to the satisfaction of the attending Surveyor:

- i)* The welder has been engaged with reasonable continuity on welding work containing the current range of approval without interruption longer than six months.
- ii)* The welder's work is in general to be in accordance with the technical conditions under which the approval test is carried out.
- iii)* There is to be no specific reason to question the welder's skill and knowledge.

### **15.5**

If any of these conditions are not fulfilled, ABS is to be informed and the certificate is to be withdrawn.

The validity of the certificate may be maintained in agreement with ABS as specified in 2-A11-2/17. The maintenance scheme of qualification is in accordance with 2-A11-2/17.1i) or 2-A11-2/17.1ii), or 2-A11-2/17.1iii).

## **17 Maintenance of the Approval**

### **17.1**

Revalidation is to be carried out by ABS. The skill of the welder is to be periodically verified by one of the following to the satisfaction of the attending Surveyor:

- i)* The welder is to be tested every three years.
- ii)* Every two years, two welds made during the last six months of the two years' validity period are to be tested by radiographic or ultrasonic testing or destructive testing and are to be recorded. The weld tested is to reproduce the initial test conditions except for the thickness. These tests revalidate the welder's qualifications for an additional two years.
- iii)* The manufacturer is to maintain the qualification and revalidation per the practice of AWS D1.1, or equivalent standards, refer to 2-A11-2/3.5 of this Appendix.

- The welder has been engaged with reasonable continuity on welding work containing the essential welding variables without interruption longer than six months.

The manufacturer's quality program is to be verified in accordance with ISO 3834-2, 3834-3 or equivalent requirement.

### **17.3**

ABS or the builder, manufacturer, or subcontractor is to verify compliance with the above conditions and sign the maintenance of the welder's qualification certificate.

**PART 2            RULES FOR MATERIALS AND WELDING**

**APPENDIX 11    QUALIFICATION FOR WELDERS AND WELDING OPERATORS**

**SECTION 3        WELDING OPERATORS QUALIFICATION**

1

The welding operator responsible for setting up and/or adjustment of fully mechanized and automatic equipment, such as submerged arc welding, gravity welding, electro-gas welding, and MAG welding with auto-carriage, etc., must be qualified.

3

ISO 14732 can be referred as the qualification test and approval range for the welding operator. At the discretion of ABS, the records for welder operator are to give the evidence with adequate regular training to set up, program, and operate welding equipment in accordance with the applicable WPS (welding procedure specification).

5

In addition to the above requirements, the welding operator qualification is to include, but not limited to, the following training and skills for:

- i)*        Groove dimension
- ii)*      Groove cleanliness
- iii)*     Weather and wind
- iv)*     Storing and handling of welding consumables

7

Appropriate records are to be maintained by shipbuilder, manufacturer, or subcontractor and are to be provided at the Surveyor's request.

At the discretion of ABS, the alternative welder operator certificate maybe accepted, per the applicable standards such as ISO 14732, AWS D1.1, ASME IX, or equivalent standards.

**PART 2                    RULES FOR MATERIALS AND WELDING**  
**APPENDIX 11        QUALIFICATION FOR WELDERS AND WELDING OPERATORS**  
**SECTION 4            CERTIFICATION PROCESS**

1

Test assemblies welding and testing are to be witnessed by the Surveyor. On the client’s request, ABS will certify the welder after the welder passes the qualification tests.

3

At the discretion of ABS, a welder or operator certified by other classification society or independent organization can be evaluated and accepted on a case-by-case basis. ABS reserves the right to re-validate, which may include testing prior to production, additional NDT and/or welding production tests may be required.

**PART 2                    RULES FOR MATERIALS AND WELDING**  
**APPENDIX 11        QUALIFICATION FOR WELDERS AND WELDING OPERATORS**  
**ANNEX 1              EXAMPLE OF WELDER’S QUALIFICATION CERTIFICATE**

**WELDER’S QUALIFICATION CERTIFICATE**

Welder’s name:		Photograph
Cert. No:		
Identification No.		
Employer’s name and address		
WPS/pWPS No.		
Date of initial approval		
This is to certify that the welder has passed the qualification test [/and re-validation record audit] according to the rules of ABS, and is qualified to undertake welding operation specified in range of qualification of this certificate.		
Items	Test piece	Range of qualification
Welding process		
Base metal		
Filler metal type		
Plate thickness		
Type of welded joint		
Welding position		
Other details		

This certificate is issued at [place], and valid until [DD/MM/YYYY].

Signature/seal of examiner: Issued on [DD/MM/YYYY].

	Report No. to be reviewed	Date of report	Signature of Employee	Date of signature
1				
2				
3				
4				
5				
6				

**TEST RECORD**

Type of test	Performed and accepted	Not required
Visual examination		
Radiographic examination		
Surface examination		
Macro examination		
Fracture test		
Bend test		
Additional tests		

\* At the discretion of ABS, this page can be as the back page of a certificate, and also can be as a separate file.