

### **GUIDE FOR**

## SHIPBUILDING AND REPAIR QUALITY STANDARD FOR HULL STRUCTURES DURING CONSTRUCTION

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American Bureau of Shipping Incorporated by Act of Legislature of the State of New York 1862

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### Foreword

This Guide contains information obtained from IACS Recommendation No. 47 "Shipbuilding and Repair Quality Standard". In order to be consistent with ABS requirements, some specific standards have been modified from the original. The modified standards are indicated in the "Remarks" column of the tables, along with the Rule reference.

This second edition of the Guide, developed based on IACS Recommendation No. 47 (Rev. 3, Nov. 2006), supersedes the first edition published in July 1998.

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### **1** Applicability

This Guide provides guidance on shipbuilding quality standards for the hull structure during construction.

Whereas the standard generally applies to:

- Conventional ship types
- Hull structures constructed from normal and higher strength hull structural steel, the applicability of the standard is in each case to be agreed upon by the Bureau

The standard generally does not apply to the new construction of:

- Special types of ships as, e.g., gas tankers
- Structures fabricated from stainless steel or other, special types or grades of steel

Details relevant to structures or fabrication procedures not covered by this standard are to be approved on a case-by-case basis of procedure qualifications and/or recognized national standards.

#### 2 Scope

The standard covers typical construction methods and gives guidance on quality standards for the most important aspects of such construction. Unless explicitly stated elsewhere in the standard, the level of workmanship reflected herein will in principle be acceptable for primary and secondary structure of conventional designs. A more stringent standard may however be required for critical and highly stressed areas of the hull, and this is to be agreed with the Bureau in each case.

It is intended that these standards provide guidance where established shipbuilding or national standards accepted by the Bureau do not exist.

For use of this standard, fabrication fit-ups, deflections and similar quality attributes are intended to be uniformly distributed about the nominal values. The shipyard is to take corrective action to improve work processes that produce measurements where a skewed distribution is evident. Relying upon remedial steps that truncate a skewed distribution of the quality attribute is unacceptable.

In this standard, both a "Standard" range and a "Limit" range are listed. The "Standard" range represents the target range expected to be met in regular work under normal circumstances. The "Limit" range represents the maximum allowable deviation from the "Standard" range. Work beyond the "Standard" range but within the "Limit" range is acceptable.

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### **3 General Requirements**

In general, the work is to be carried out in accordance with the Rules and to the satisfaction of attending Surveyor.

Provisions are to be made for proper accessibility, staging, lighting and ventilation. Welding operations are to be carried out under shelter from rain, snow and wind.

Welding of hull structures is to be carried out by qualified welders, according to approved and qualified welding procedures and with welding consumables approved by the Bureau. Welding operations are to be carried out under proper supervision by the shipbuilder.

### 4 Qualification of Personnel and Procedures

#### 4.1 Qualification of Welders

Welders are to be qualified in accordance with 2-4-3/11 of the ABS *Rules for Materials and Welding* (*Part 2*). Subcontractors are to keep records of welders' qualification and, when required, furnish valid approval test certificates.

Welding operators using fully mechanized or fully automatic processes generally need not pass approval testing provided that the production welds made by the operators are of the required quality. However, operators are to receive adequate training in setting or programming and operating the equipment. Records of training and production test results shall be maintained on individual operator's files and records, and be made available to the Bureau for inspection when requested.

#### 4.2 Qualification of Welding Procedures

Welding procedures are to be qualified in accordance with 2-4-1/1.7 of the ABS *Rules for Materials and Welding (Part 2)*. The welding procedure should be supported by a welding procedure qualification record. The specification is to include the welding process, types of electrodes, weld shape, edge preparation, welding techniques and positions.

#### 4.3 Qualifications of NDE Operators

Personnel performing nondestructive examination for the purpose of assessing quality of welds in connection with new construction covered by this Guide are to be qualified in accordance with the applicable Bureau's requirements or to a recognized national or international qualification scheme. Records of operators and their current certificates are to be kept and made available to the Surveyor for inspection.

### **5** Materials

#### 5.1 Materials for Structural Members

All materials, including weld consumables, to be used for the structural members are to be in accordance with Bureau approved construction plans and with the ABS *Rules for Materials and Welding (Part 2)*.

#### 5.2 Details, Standards and Tolerance Limits

Details, standards and tolerance limits may be found in the following Tables:

	Detail		Table #
Fabrica	tion and Fairness		
• Flar	nged Longitudinals and Flanged Brackets	•	1
• Bui	lt-Up Sections	•	2
• Cor	rugated Bulkheads	•	3
• Pilla	ars, Brackets And Stiffeners	•	4
• Max	ximum Heating Temperature On Surface For Line Heating	•	5
• Blo	ck Assembly	•	6
• Spe	cial sub-assembly	•	7
• Sha	pe	٠	8 and 9
• Fair	rness of Plating Between Frames	•	10
• Fair	rness of Plating with Frames	•	11
Alignme	ent		
Qua     Cor	ality Standards of Hull Structural Components During New nstruction	•	12, 13 and 14
		•	The Bureau may require a closer construction
			tolerance in areas requiring special attention, as follows:
			- Regions exposed to high stress
			concentrations
			- Fatigue prone area
			- Detail design block erection joints
			- Higher tensile steel regions
Welding	g Details		
• Typ	bical Butt Plate Edge Preparation (Manual Welding)	•	15 and 16
• Typ	vical Fillet Weld Plate Edge Preparation (Manual Welding)	•	17 and 18
• Typ	vical Butt and Fillet Weld Profile (Manual Welding)	•	19
• Dist	tance Between Welds	•	20
• Aut	tomatic Welding	•	21
Repair			
• Typ	pical Misalignment Repair	٠	22 to 24
• Typ	bical Butt Weld Plate Edge Preparation Repair (Manual Welding)	•	25 and 26
• Typ	bical Fillet Weld Edge Preparation Repair (Manual Welding)	•	27 to 29
• Typ	pical Fillet and Butt Weld Profile Repair (Manual Welding)	•	30
• Dist	tance Between Welds Repair	•	31
• Erro	oneous Hole Repair	•	32
• Rep	pair By Insert Plate	•	33
• We	ld Surface Repair	•	34

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### TABLE 2 Built-up Sections

Detail	Standard	Limit	Remarks
Frames and longitudinal	± 1.5 mm	± 3 mm	per 100 mm of <i>a</i>
Distortion of face plate	<i>d</i> ≤ 3 + <i>a</i> /100 mm	<i>d</i> ≤ 5 + <i>a</i> /100 mm	
Distortion of built-up longitudinal, girder, and transverse at upper edge and flange	± 10 mm	± 25 mm	per 10 m in length

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### TABLE 3 Corrugated Bulkheads



Detail	Standard	Limit	Remarks
Pillar (between decks)	4 mm	6 mm	
Cylindrical structure diameter (pillars, masts, posts, etc.)	± <i>D</i> /200 mm max. + 5 mm	± <i>D</i> /150 mm max. 7.5 mm	
Tripping bracket and small stiffener, distortion at the part of free edge	<i>a</i> ≤ <i>t</i> /2 mm	t	
Snipe end of secondary face plates and stiffeners			See 3-1-2/15.3 of the ABS Rules for Building and Classing Steel Vessels

### TABLE 4 Pillars, Brackets and Stiffeners

# TABLE 5Maximum Heating Temperature on Surface for Line Heating

Item		Standard	Limit	Remarks
Conventional Process	Water cooling just after heating	Under 650°C		
AH32-EH32 & AH36-EH36	Air cooling after heating	Under 900°C		
TCMP type AH32-EH32 & AH36-EH36 (Ceq. > 0.38%)	Air cooling and subsequent water cooling after heating	Under 900°C (starting temperature of water cooling to be under 500°C)		
TMCP type AH32-DH32 & AH36-DH36 (Ceq. ≤ 0.38%)	Water cooling just after heating or air cooling	Under 1000°C		
TMCP type EH32 & EH36 (Ceq. ≤ 0.38%)	Water cooling just after heating or air cooling	Under 900°C		

Note:

$$Ceq = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} (\%)$$

### TABLE 6 Block Assembly

Flat Plate Assembly			
Length and Breadth	± 2.5 mm	$\pm 5 \text{ mm}$	
Distortion	$\pm 10 \text{ mm}$	$\pm 20 \text{ mm}$	
Squareness	$\pm 5 \text{ mm}$	± 10 mm	
Deviation of interior members from plate	5 mm	10 mm	
Curved Plate Assembly			
Length and Breadth	± 2.5 mm	$\pm 5 \text{ mm}$	Measured along the girth
Distortion	$\pm 10 \text{ mm}$	$\pm 20 \text{ mm}$	
Squareness	± 10 mm	± 15 mm	
Deviation of interior members from	5 mm	10 mm	
plate			
Flat Cubic Assembly			
Length and Breadth	$\pm 2.5 \text{ mm}$	± 5 mm	
Distortion	$\pm 10 \text{ mm}$	± 20 mm	
Squareness	$\pm 10 \text{ mm}$	± 10 mm	
Deviation of interior members from plate	5 mm	10 mm	
Twist	$\pm 10 \text{ mm}$	± 20 mm	
Deviation between upper and lower	$\pm 5 \text{ mm}$	$\pm$ 10 mm	
plate			
Curved cubic assembly			
Length and Breadth	2.5 mm	$\pm 5 \text{ mm}$	Measured along the girth
Distortion	$\pm 10 \text{ mm}$	± 20 mm	
Squareness	$\pm 10 \text{ mm}$	± 15 mm	
Deviation of interior members from plate	5 mm	10 mm	
Twist	± 15 mm	± 25 mm	
Deviation between upper and lower plate	$\pm$ 7 mm	± 15 mm	

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### TABLE 7 Special Sub-Assembly

Item	Standard	Limit	Remarks
Distance between upper and lower gudgeon	± 5 mm	$\pm 10 \text{ mm}$	
Distance between aft edge of boss and aft peak bulkhead	± 5 mm	± 10 mm	
Twist of sub-assembly of stern frame	5 mm	10 mm	
Deviation of rudder from shaft center line	4 mm	8 mm	
Twist of rudder plate	6 mm	10 mm	
Flatness of top plate of main engine bed	5 mm	10 mm	
Breadth and length of top plate of main engine bed	± 4 mm	± 6 mm	

### TABLE 8 Shape

Detail	Standard	Limit	Remarks
Deformation for the whole length	± 50 mm		per 100 m against the line of keel sighting
Deformation for the distance between two adjacent bulkheads	± 15 mm		
Cocking -up of fore body	± 30 mm		
Cocking-up of aft-body	± 20 mm		
Rise of floor amidships	± 15 mm		

### TABLE 9 Shape

Item	Standard	Limit	Remarks
Length between perpendiculars	± 50 per 100 m		Applied to ships of 100 m length and above. For the convenience of the measurement the point where the keel is connected to the curve of the stern may be substituted for the fore perpendicular in the measurement of the length.
Length between aft edge of boss and main engine	± 25 mm		
Molded breadth at midship	± 15 mm		Applied to ships of 15 m breadth and above. Measured on the upper deck
Molded depth at midship	± 10 mm		Applied to ships of 10 meter depth and above

	Item	Standard	Limit	Remarks
Shell plate	Parallel part (side & bottom shell)	4 mm		
	Fore and aft part	5 mm		
Tank Top plate		4 mm		
Bulkhead	Longitudinal bulkhead	6 mm	8 mm	y
	Transverse bulkhead	6 mm		
	Swash bulkhead	6 mm		$\leftarrow$ $S$
Strength deck	Parallel part	4 mm		
	Fore and aft part	6 mm	9 mm	
	Covered part	7 mm	9 mm	
Second deck	Bare part	6 mm	8 mm	
	Covered part	7 mm	9 mm	
Forecastle deck	Bare part	4 mm	8 mm	
For Street	Covered deck	6 mm	9 mm	
Superstructure deck	Bare part	4 mm	6 mm	
	Covered part	7 mm	9 mm	
House wall	Outside wall	4 mm	6 mm	
	Inside wall	6 mm	8 mm	
	Covered part	7 mm	9 mm	
Interior member (web of girder, etc)		5 mm	7 mm	
Floor and girder in	double bottom	5 mm	7 mm	

# TABLE 10Fairness of Plating Between Frames

# TABLE 11Fairness of Plating with Frames

Item		Standard	Limit	Remarks
Shell Plate	Parallel part	$\pm 2\ell/1000 \text{ mm}$	$\pm 3\ell/1000 \text{ mm}$	$\ell$ = span of frame To be measured between
	Fore and aft part	$\pm 3\ell/1000 \text{ mm}$	$\pm 4\ell/1000 \text{ mm}$	one trans. space (min. $\ell = 3$ m)
Strength deck (excluding cross deck) and top plate of double bottom		± ℓ/1000 mm	± 4ℓ/1000 mm	
Bulkhead		$\pm 4\ell/1000 \text{ mm}$	$\pm 5\ell/1000 \text{ mm}$	
Others		$\pm 5\ell/1000 \text{ mm}$	$\pm 6\ell/1000 \text{ mm}$	
		$\ell$ m $\ell$ = span of fra (minimum $\ell$ = 3 To be measured between one	ame B m) t t t t t t t t t t t t t	

### TABLE 12 Alignment

Detail	Standard	Limit	Remarks
Alignment of butt welds	$a \le 0.15t$ strength	$a \le 3.0 \text{ mm}$	
	$a \le 0.2t$ other		
Alignment of fillet welds	Strength and higher	Strength and higher	Where $t_3$ is less than $t_1$
$\downarrow^{t_1} \xrightarrow{t_3} \downarrow^{a_1} \downarrow^{a_1} \downarrow^{a_2}$	tensile: $a \le t_1/4$ measured on the median	tensile: $a \le t_1/3$ measured on the median	then $t_3$ should be substituted for $t_1$ in the standard
	or	or	
	$a_1 \le (3t_1 - 2t_2)/4$	$a_1 \le t_1/3$	
	line	line	
	Other:	Other:	
	$a \le t_1/3$ measured on the median	$a \le t_1/2$ measured on the median	
	or	or	
	$a_1 \le (5t_1 - 3t_2)/6$ measured on the heel line	$a_1 \le t_1/2$ measured on the heel line	
Alignment of fillet welds	Strength and higher tensile:	Strength and higher tensile:	Where $t_3$ is less than $t_1$ then $t_3$ should be
	$a \le t_1/4$ measured on the median	$a \le t_1/3$ measured on the median	substituted for $t_1$ in the standard
	or	or	
$\theta^{\circ}$	$a_1 \leq (3t_1 - 2t_2)/4$	$a_1 \le t_1/3$	
	measured on the heel line	measured on the heel line	
$\rightarrow a_1 \leftarrow 1$	Other:	Other:	
	$a \le t_1/3$ measured on the median	$a \le t_1/2$ measured on the median	
	or	or	
	$a_1 \leq (5t_1 - 3t_2)/6$	$a_1 \le t_1/2$ measured on	
	measured on the heel line	uie neer nne	

### TABLE 13 Alignment

Detail	Standard	Limit	Remarks
Alignment of flange of T-longitudinal $ \begin{array}{c} & \downarrow \\ \hline \\ \hline \\ \hline \\ a \uparrow \\ \hline \\ b \end{array} $	$a \le 0.04b$ strength	a = 8.0 mm	
Alignment of height of T-bar, L-angle bar or bulb	Primary members $a \le 0.15t$ Secondary members $a \le 0.20t$	<i>a</i> = 3.0 mm	
Alignment of panel stiffener $ \begin{array}{c}             L \\             L \\         $	<i>d</i> ≤ <i>L</i> /50		
Gap between bracket/intercostal and stiffener $a$	<i>a</i> ≤ 2.0 mm	<i>a</i> = 3 mm	
Alignment of lap welds	<i>a</i> ≤ 2.0 mm	<i>a</i> = 3 mm	

### TABLE 14 Alignment

Detail	Standard	Limit	Remarks
Gap between beam and frame	<i>a</i> ≤ 2.0 mm	<i>a</i> = 5.0 mm	
Gap around stiffener cut-out $ \begin{array}{c} \hline                                    $	<i>s</i> ≤ 2.0 mm	<i>s</i> = 3.0 mm	

# TABLE 15Typical Butt Plate Edge Preparation (Manual Welding)



Note:

1

Different plate edge preparation may be accepted or approved by the Bureau on the basis of an appropriate welding procedure specification.

# TABLE 16Typical Butt Plate Edge Preparation (Manual Welding)

Detail	Standard	Limit	Remarks
Single vee butt, one side welding with backing strip (temporary or permanent)	<i>G</i> = 3 - 9 mm	<i>G</i> = 16 mm	see Note 1
$\begin{array}{c} \downarrow^{t} \\ \hline \\ $			
Single vee butt	$G \le 3 \text{ mm}$	G = 5  mm	see Note 1
$ \xrightarrow{t}_{G} $			

Note:

1

Different plate edge preparation may be accepted or approved by the Bureau on the basis of an appropriate welding procedure specification.

TABLE 17Typical Fillet Weld Plate Edge Preparation (Manual Welding)



Note:

1

Different plate edge preparation may be accepted or approved by the Bureau on the basis of an appropriate welding procedure specification.

Detail Standard Limit Remarks Single 'J' tee *G* =2.5 - 4 mm see Note 1 t |G|*t* > 19 mm Double bevel tee symmetrical see Note 1  $G \le 3 \text{ mm}$ t GDouble bevel tee asymmetrical *t* > 19 mm see Note 1  $G \le 3 \text{ mm}$ t GDouble J bevel symmetrical G = 2.5 - 4 mmsee Note 1 t G

TABLE 18Typical Fillet Weld Plate Edge Preparation (Manual Welding)

Note:

1

Different plate edge preparation may be accepted or approved by the Bureau on the basis of an appropriate welding procedure specification.

### TABLE 19 Typical Butt and Fillet Weld Profile (Manual Welding)



# TABLE 20Distance Between Welds

Detail	Standard	Limit	Remarks
Scallops over weld seams		For significant members d ≥ 5 mm For other members d ≥ 0 mm	The "d" is to be measured from the toe of the fillet weld to the toe of the butt weld.
Distance between two butt welds		<i>d</i> ≥ 0 mm	
Distance between butt weld and fillet weld $d$		For significant members $d \ge 10 \text{ mm}$ For other members $d \ge 0 \text{ mm}$	
Distance between butt welds	For cut-outs $d \ge 30 \text{ mm}$ For margin plates $d \ge 300 \text{ mm}$	150 mm	

### TABLE 21 Automatic Welding

Detail	Standard	Limit	Remarks
Submerged Arc Welding (SAW)	$0 \le G \le 0.8 \text{ mm}$	G = 2  mm	Edge preparation as per Tables 15 and 16
$\rightarrow$ $_{G}$			SAW may follow WPS approved by the Bureau
$\rightarrow$ $_{G}$ $\leftarrow$			See Note 1

Note:

1

Different plate edge preparation may be accepted or approved by the Bureau on the basis of an appropriate welding procedure specification.



### TABLE 22 Typical Misalignment Repair

### Detail Repair Standard Remarks Gap between bracket/intercostal and When 3 mm $< a \le 5$ mm stiffener Weld leg length to be increased by increase in gap а When 5 mm $< a \le 10$ mm Chamfer $30^{\circ}$ - $40^{\circ}$ and build up with welding When a > 10 mmIncrease gap to 50 mm and fit collar plate $t_1$ t b $t_1 \ge t_2$ b = (2t + 25) mm, min. 50 mm Gap between beam and frame a > 3 mm - release and adjust а

### TABLE 23 Typical Misalignment Repair

### TABLE 24 Typical Misalignment Repair



# TABLE 25 Typical Butt Weld Plate Edge Preparation Repair (Manual Welding)



# TABLE 26 Typical Butt Weld Plate Edge Preparation Repair (Manual Welding)



# TABLE 27 Typical Fillet Weld Plate Edge Preparation Repair (Manual Welding)



 TABLE 28

 Typical Fillet Weld Plate Edge Preparation Repair (Manual Welding)



 TABLE 29

 Typical Fillet Weld Plate Edge Preparation Repair (Manual Welding)

Detail	Repair Standard	Remarks
Single 'J' tee $\theta^{\circ}$ $r$ $G$ $G$	As single bevel tee	
Double bevel tee symmetrical $ \begin{array}{c}                                     $	When 3 mm < $G \le 16$ mm Build up with welding using ceramic or other approved backing bar, remove, back gouge and back weld When $G > 16$ mm Insert plate of minimum height 300 mm to be fitted	
Double J bevel symmetrical $\theta^{\circ}$ $r$ $f$ $g$ $f$		

# TABLE 30Typical Fillet and Butt Weld Plate Edge Preparation Repair<br/>(Manual Welding)

Detail	Standard	Remarks
Fillet weld leg length	Increase leg or throat by welding over	Minimum short bead H.T. (Ceq > 0.36%) Length $\geq$ 50 mm H.T. (Ceq $\leq$ 0.36%) Length $\geq$ 30 mm
Fillet weld toe angle	$\theta > 90^{\circ}$ Grinding, and welding, where necessary, to make $\theta < 90^{\circ}$	
Butt weld toe angle $t  \theta^{\circ}$ $h$ h R	$\theta > 90^{\circ}$ Grinding, and welding, where necessary, to make $\theta < 90^{\circ}$	
Butt weld undercut	Where $0.5 < D \le 1$ mm Undercut to be ground smooth (localized only) Where $D > 1$ mm Undercut to be filled by welding	
Fillet weld undercut		

# TABLE 31Distance Between Welds Repair

Detail	Standard	Remarks
Scallops over weld seams	Hole to be cut and ground smooth to obtain distance	



### TABLE 32 Erroneous Hole Repair

### TABLE 33 Repair by Insert Plate

Detail	Repair Standard	Remarks
Repair by insert plate	L = 300  mm minimum	
$(2) \xrightarrow{L} \xrightarrow{(2)} B$	<ul> <li>B = 300 mm minimum</li> <li>R = 5t mm, 100 mm minimum</li> <li>(1) Seam with insert piece is to be welded first</li> <li>(2) Original seam is to be released and welded over for a minimum of 100 mm</li> </ul>	
$(2) \xrightarrow{L} (2) \xrightarrow{R} (1) \xrightarrow{(1)} B$		
Repair of built section by insert plate	$L_{\min} \ge 300 \text{ mm}$	
$(3) \qquad L_{min} \qquad (3)$ $(2) \qquad (1) \qquad (1) \qquad (5)$ $(4) \qquad (4)$	Welding sequence $(1) \rightarrow (2) \rightarrow (3) \rightarrow (4)$ Web butt weld scallop to be filled during final pass (4)	

### TABLE 34 Weld Surface Repair

Detail	Repair Standard	Remarks
Weld spatter	<ol> <li>Remove spatter observed before blasting with scraper or chipping hammer etc.</li> <li>For spatter observed after blasting:         <ul> <li>a) Remove with a chipping hammer, scraper, etc.</li> <li>b) For spatter pet excite several with a</li> </ul> </li> </ol>	In principal, no grinding is applied to weld surface
	chipping hammer, scraper, etc., grind the sharp angle of spatter to make it obtuse	
Arc Strike	Removed the hardened zone by grinding or other measures such as overlapped weld bead and etc.	

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