



Subject: TECH.INF 2014-10
Shipbuilding and Repair Quality Standard
Number: 32/93/0039
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موضوع: اطلاعیه فنی ۱۰-۲۰۱۴

استاندارد کیفی تعمیرات و ساخت کشتی

شماره: ۳۲/۹۳/۰۰۳۹

تاریخ: ۱۳۹۳/۰۷/۱۹

All respectful ICS surveyors/customers

With gratitude,

Whereas Construction and Repair of a ship has to be considered to apply Quality Standards. These quality standards have been sent hereby through technical information.

This tech.inf. consists of two parts. Quality standards for the construction of new ships (part A) and quality standards for repairing of a ship (part B).

The document related to the above mentioned subject and also the supplementary attachments are accessible through the following address on ICS Network (ICS-WAN):

<\\server\ICS Organization\Convention and LegislationDepartment\publication\tech\2014\10>

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با سلام و احترام

از آنجائیکه ساخت و تعمیرات کشتی می بایست از استاندارد واحدی تبعیت نمایند، بدینوسیله بیوست اطلاعات فنی در خصوص استاندارد کیفی ساخت/تعمیر کشتی حضورتان ارسال می گردد. همانطور که مستحضرید این اطلاعیه فنی به دو قسمت استاندارد کیفی در خصوص ساخت و استاندارد کیفی در خصوص تعمیرات کشتی تقسیم بندی شده است.

این اطلاعیه فنی بانضمام پیوستهای تکمیلی آن در بخش CLD از شبکه داخلی موسسه با آدرس ذیل قابل دسترسی می باشد.

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رحضوان پناه

سرپرست واحد کنوانسیونها و مقررات دریایی

موسسه رده بندی ایرانیان

ترک دعوی: اگرچه در گردآوری کلیه راهنماهای فنی ارائه شده توسط موسسه رده بندی ایرانیان، تا حد ممکن تلاش در دقت و صحت محتوا صورت گرفته است، این موسسه متحمل مسئولیتی در قبال هرگونه اشتباهات، خسارت های احتمالی و جرانی که ممکن است در ارتباط با بکارگیری مفاهیم و مطالب ارائه شده رخ دهد، نمیباشد.

■ موسسه رده بندی ایرانیان

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تلفن: ۰۲۱ ۴۲۱۸۶۰۰۰

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PART A:
SHIPBUILDING AND REMEDIAL QUALITY STANDARD FOR NEW CONSTRUCTION

1.SCOPE

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

1.1) This standard provides guidance on shipbuilding quality standards for the hull structure during new construction and the remedial standard where the quality standard is not met.

Whereas the standard generally applies to

- conventional merchant ship types,
- parts of hull covered by the rules of the Classification Society,
- 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 Classification Society.

The standard does generally 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

1.2) 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. In cases where no 'limit' value is specified, the value beyond the 'standard' range may be accepted subject to the

consideration of the Classification Society.

1.3) 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 Classification Society in each case. In assessing the criticality of hull structure and structural components, reference is made to ref. 1, 2 and 3.

1.4) Details relevant to structures or fabrication procedures not covered by this standard are to be approved by the Classification Society on the basis of procedure qualifications and/or recognized national standards.

1.5) 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 skew distribution is evident. Relying upon remedial steps that truncate a skewed distribution of the quality attribute is unacceptable.

2. GENERAL REQUIREMENTS FOR NEW CONSTRUCTION

2.1) In general, the work is to be carried out in accordance with the Classification Society rules and under the supervision of the Surveyor to the Classification Society.

2.2) Welding operations are to be carried out in accordance with work instructions accepted by the Classification Society.

2.3) 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 Classification

Society, see Section 3. Welding operations are to be carried out under proper supervision by the shipbuilder. The working conditions for welding are to be monitored by the Classification Society in accordance with UR Z23.

3. QUALIFICATION OF PERSONNEL AND PROCEDURES

3.1) Qualification of welders

3.1.1) Welders are to be qualified in accordance with the procedures of the Classification Society or to a recognized national or international standard. Recognition of other standards is subject to submission to the Classification Society for evaluation. Subcontractors are to keep records of welder's qualification and, when required, furnish valid approval test certificates.

3.1.2) Welding operators using fully mechanized or fully automatic processes need generally 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 operation experience shall be maintained on individual operator's files and records, and be made available to the Classification Society for inspection when requested.

3.2) Qualification of welding procedures

Welding procedures are to be qualified in accordance with URW28 or other recognized standard accepted by the Classification Society.

3.3) Qualification of NDE operators

Personnel performing non-destructive examination for the purpose of assessing quality of welds in connection with new construction covered by this standard, are to be qualified in accordance with Classification Society rules or to a recognized international or national qualification scheme. Records of operators and their current certificates are to be kept and made

available to the Surveyor for inspection.

4. MATERIALS

4.1) Materials for Structural Members

All materials, including weld consumables, to be used for the structural members are to be approved by the Classification Society as per the approved construction drawings and meet the respective IACS Unified Requirements. Additional recommendations are contained in the following paragraphs.

All materials used should be manufactured at a works approved by the Classification Society for the type and grade supplied.

4.2) Surface Conditions

4.2.1) Definitions

Minor Imperfections:

Pitting, rolled-in scale, indentations, roll marks, scratches and grooves

Defects:

Cracks, shells, sand patches, sharp edged seams and minor imperfections exceeding the limits of table 1

Depth of Imperfections or defects:

The depth is to be measured from the surface of the product

4.2.2) Acceptance without remedies

Minor imperfections, in accordance with the nominal thickness (t) of the product and the limits described in Table 1, are permissible and may be left as they are.

Imperfection surface area Ratio(%)	15~20%	5 ~15%	0 ~5%
t < 20 mm	0.2 mm	0.4 mm	0.5 mm
20 mm ≤ t < 50 mm	0.2 mm	0.6 mm	0.7 mm
50 mm ≤ t	0.2 mm	0.7 mm	0.9 mm

Table 1 Limits for depth of minor imperfection, for acceptance without remedies.

Imperfection surface area Ratio (%) is obtained as influenced area / area under consideration (i.e. plate surface area) x 100%.

For isolated surface discontinuities, influenced area is obtained by drawing a continuous line which follows the circumference of the discontinuity at a distance of 20 mm. (Figure 1)
 For surface discontinuities appearing in a cluster, influenced area is obtained by drawing a continuous line which follows the circumference of the cluster at a distance of 20 mm. (Figure 2)

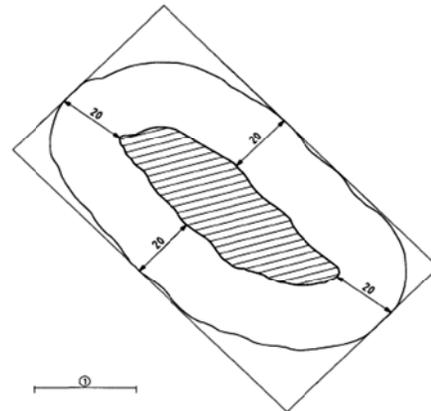


Figure 1- Determination of the area influenced by an isolated discontinuity
 (Ref. Nr. EN 10163-1:2004+AC: 2007 E)

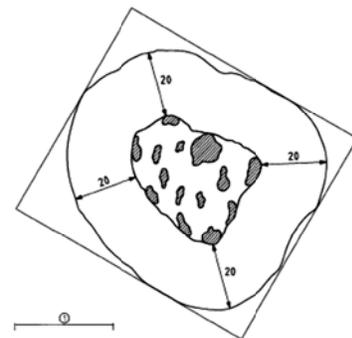


Figure 2 - Determination of the area influenced by clustered discontinuities
 (Ref. Nr. EN 10163-1:2004+AC:2007 E)

4.2.3) Remedial of Defects

Defects are to be remedied by grinding and/or welding in accordance with IACS Rec.12.

4.2.4) Further Defects

4.2.4.1) Lamination

Investigation to be carried out at the steel mill into the cause and extent of the detected laminations. Severe lamination is to be remedied by local insert plates. The minimum breadth or length of the plate to be replaced is to be:

- 1600 mm for shell and strength deck plating in way of cruciform or T-joints,
- 800 mm for shell, strength deck plating and other primary members,
- 300 mm for other structural members.



Local limited lamination may be remedied by chipping and/or grinding followed by welding in accordance with sketch (a). In case where the local limited lamination is near the plate surface, the remedial may be carried out as shown in sketch (b). For limitations see paragraph 4.2.2.

4.2.4.2) Weld Spatters

Loose weld spatters are to be removed by grinding or other measures to clean metal surface (see Table 9.13), as required by the paint system, on:

- shell plating
- deck plating on exposed decks
- in tanks for chemical cargoes
- in tanks for fresh water and for drinking water
- in tanks for lubricating oil, hydraulic oil, including service tanks

5. GAS CUTTING

The roughness of the cut edges is to meet the following requirements:

Free Edges:

	Standard	Limit
Strength Members	150 m	300 m
Others	500 m	1000 m

Welding Edges:

	Standard	Limit
Strength Members	400 m	800 m
Others	800 m	1500 m

6. FABRICATION AND FAIRNESS

6.1) Flanged longitudinal and flanged brackets (see Table 6.1)

6.2) Built-up sections (see Table 6.2)

6.3) Corrugated bulkheads (see Table 6.3)

6.4) Pillars, brackets and stiffeners (see Table 6.4)

6.5) Maximum heating temperature on surface for line heating (see Table 6.5)

6.6) Block assembly (see Table 6.6)

6.7) Special sub-assembly (see Table 6.7)

6.8) Shape (see Table 6.8 and 6.9)

6.9) Fairness of plating between frames (see Table 6.10)

6.10) Fairness of plating with frames (see Table 6.11)

6.11) Preheating for welding hull steels at low temperature (See Table 6.12)

7. ALIGNMENT

The quality standards for alignment of hull structural components during new construction are shown in Tables 7.1, 7.2 and 7.3. The Classification Society may require a closer construction tolerance in areas requiring special attention, as follows:

- Regions exposed to high stress

concentrations

- Fatigue prone areas
- Detail design block erection joints
- High tensile steel regions

8.WELDING JOINT DETAILS

Edge preparation is to be qualified in accordance with URW28 or other recognized standard accepted by the Classification Society.

Some typical edge preparations are shown in Table 8.1, 8.2, 8.3, 8.4 and 8.6 for reference.

8.1) Typical butt weld plate edge preparation (manual and semi-automatic welding) for reference - see Table 8.1 and 8.2

8.2) Typical fillet weld plate edge preparation (manual and semi-automatic welding) for reference - see Table 8.3 and 8.4

8.3) Butt and fillet weld profile (manual and semi-automatic welding) - see Table 8.5

8.4) Typical butt weld plate edge preparation (Automatic welding) for reference - see Table 8.6

8.5) Distance between welds - see Table 8.7

9. REMEDIAL

All the major remedial work is subject to reporting by shipbuilder to the Classification Society for approval in accordance with their work instruction for new building.

Some typical remedial works are shown in Tables 9.1 to 9.13.

9.1) Typical misalignment remedial - see Tables 9.1 to 9.3

9.2) Typical butt weld plate edge preparation remedial (manual and semi-automatic welding) - see Table 9.4 and 9.5

9.3) Typical fillet weld plate edge preparation remedial (manual and semi-automatic welding) -

see Tables 9.6 to 9.8

9.4) Typical fillet and butt weld profile remedial (manual and semi-automatic welding) - see Table 9.9

9.5) Distance between welds remedial - see Table 9.10

9.6) Erroneous hole remedial - see Table 9.11

9.7) Remedial by insert plate - see Table 9.12

9.8) Weld surface remedial - see Table 9.13

9.9) Weld remedial (short bead) - see Table 9.14

TABLE 6.1 – Flanged Longitudinals and Flanged Brackets

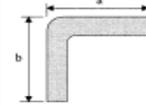
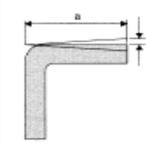
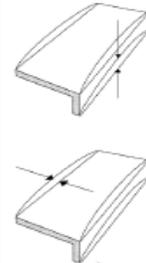
Detail	Standard	Limit	Remarks
<p>Breadth of flange</p>  <p>compared to correct size</p>	± 3 mm	± 5 mm	
<p>Angle between flange and web</p>  <p>compared to template</p>	± 3 mm	± 5 mm	per 100 mm of a
<p>Straightness in plane of flange and web</p> 	± 10 mm	± 25 mm	per 10 m

TABLE 6.2 – Built Up Sections

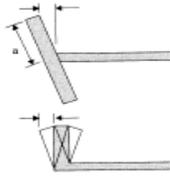
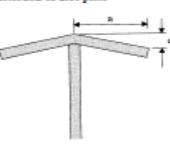
Detail	Standard	Limit	Remarks
 <p>Frames and longitudinal</p>	$\pm 1.5 \text{ mm}$	$\pm 3 \text{ mm}$	per 100 mm of a
 <p>Distortion of face plate</p>	$d \leq 3 + a/100 \text{ mm}$	$d \leq 5 + a/100 \text{ mm}$	
 <p>Distortion in plane of web and flange of built up longitudinal frame, transverse frame, girder and transverse web.</p>	$\pm 10 \text{ mm}$	$\pm 25 \text{ mm}$	per 10 m in length

TABLE 6.4 – Pillars, Brackets and Stiffeners

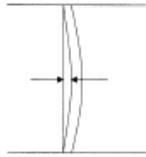
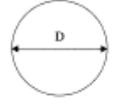
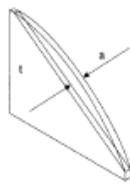
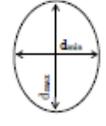
Detail	Standard	Limit	Remarks
 <p>Pillar (between decks)</p>	4 mm	6 mm	
 <p>Cylindrical structure diameter (pillar, masts, posts, etc.)</p>	$\pm D/200 \text{ mm}$ max. + 5 mm	$\pm D/150 \text{ mm}$ max. 7.5 mm	
 <p>Tripping bracket and small stiffener, distortion at the part of free edge</p>	$a \leq t/2 \text{ mm}$	t	
 <p>Ovality of cylindrical structure</p>			$d_{\max} - d_{\min} \leq 0.02 \times d_{\max}$

TABLE 6.3 – Corrugated Bulkheads

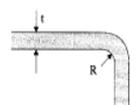
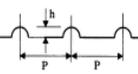
Detail	Standard	Limit	Remarks
 <p>Mechanical bending</p>	$R \geq 3t \text{ mm}$ $R \geq 4.5t \text{ mm}$ for CSR ships ^{Note 1}	2t mm ^{Note 2}	Material to be suitable for cold flanging (forming) and welding in way of radius
 <p>Depth of corrugation</p>	$\pm 3 \text{ mm}$	$\pm 6 \text{ mm}$	
 <p>Breadth of corrugation</p>	$\pm 3 \text{ mm}$	$\pm 6 \text{ mm}$	
 <p>Pitch and depth of swaged corrugated bulkhead compared with correct value</p>	h : = 2.5 mm Where it is not aligned with other bulkheads P : = 6 mm Where it is aligned with other bulkheads P : = 2 mm	h : = 5 mm Where it is not aligned with other bulkheads P : = 9 mm Where it is aligned with other bulkheads P : = 3 mm	

TABLE 6.5–Maximum Heating Temperature on Surface for Line Heating

Item	Standard	Limit	Remarks
Conventional Process AH32-EH32 & AH36-EH36	Water cooling just after heating	Under 650°C	
TMCP type AH36-EH36 (Ceq.>0.38%)	Air cooling after heating	Under 900°C	
	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:			
$C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} (\%)$			

TABLE 6.6 – Block Assembly

Item	Standard	Limit	Remarks
Flat Plate Assembly			
Length and Breadth	± 4 mm	± 6 mm	
Distortion	± 10 mm	±20mm	
Squareness	± 5 mm	±10mm	
Deviation of interior members from plate	5 mm	10mm	
Curved plate assembly			
Length and Breadth	± 4 mm	± 8 mm	measured along the girth
Distortion	± 10 mm	± 20 mm	
Squareness	± 10 mm	± 15 mm	
Deviation of interior members from plate	5 mm	10 mm	
Flat cubic assembly			
Length and Breadth	± 4 mm	± 6 mm	
Distortion	± 10 mm	± 20 mm	
Squareness	± 5 mm	± 10 mm	
Deviation of interior members from plate	5 mm	10 mm	
Twist	± 10 mm	± 20 mm	
Deviation between upper and lower plate	± 5 mm	± 10 mm	
Curved cubic assembly			
Length and Breadth	± 4 mm	± 8 mm	measured along with girth
Distortion	± 10 mm	± 20 mm	
Squareness	± 10 mm	± 15 mm	
Deviation of interior members from plate	± 5 mm	± 10 mm	
Twist	± 15 mm	± 25 mm	
Deviation between upper and lower plate	± 7 mm	± 15 mm	

TABLE 6.7 – Special Sub-Assembly

Item	Standard	Limit	Remarks
Distance between upper/lower gudgeon	± 5 mm	± 10 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	
NOTE: Dimensions and tolerances have to fulfill engine and equipment manufacturers' requirements, if any.			

TABLE 6.8 – Shape

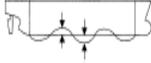
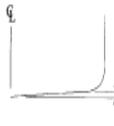
Detail	Standard	Limit	Remarks
Deformation for the whole length 	± 50 mm		per 100 m against the line of keel sighting
Deformation for the distance between two adjacent bulkheads 	± 15 mm		
Cocking-up of fore body 	± 30 mm		The deviation is to be measured from the design line.
Cocking-up of aft-body 	±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

TABLE 6.9 – Shape

Item	Standard	Limit	Remarks
Length between perpendiculars	$\pm L/1000$ mm where L is in mm		Applied to ships of 100 metre length and above. For the convenience of the measurement the point where the keel is connected to the curve of the stem may be substituted for the fore perpendicular in the measurement of the length.
Moulded breadth at midship	$\pm B/1000$ mm where B is in mm		Applied to ships of 15 metre breadth and above, measured on the upper deck.
Moulded depth at midship	$\pm D/1000$ mm where D is in mm		Applied to ships of 10 metre depth and above, measured up to the upper deck.

TABLE 6.10 – Fairness of Plating Between Frames

Item	Standard	Limit	Remarks	
Shell plate	Parallel part (side & bottom shell)	4 mm	8 mm	
	Fore and aft part	5 mm		
Tank top plate	4 mm			
Bulkhead	Longl. Bulkhead	6 mm	8 mm	
	Trans. Bulkhead			
	Swash Bulkhead			
Strength deck	Parallel part	4 mm	8 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 poop deck	Bare part	4 mm	8 mm	
	Covered part	6 mm	9 mm	
Super structure 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	8 mm		

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استاندارد کیفی تعمیرات و ساخت کشتی

شماره: ۳۲/۹۳/۰۰۳۹
 تاریخ: ۱۳۹۳/۰۷/۱۹

TABLE 6.11–Fairness of Plating with Frames

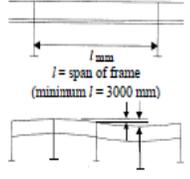
Item		Standard	Limit	Remarks
Shell plate	Parallel part	$\pm 2 l / 1000 \text{ mm}$	$\pm 3 l / 1000 \text{ mm}$	$l = \text{span of frame (mm)}$
	Fore and aft part	$\pm 3 l / 1000 \text{ mm}$	$\pm 4 l / 1000 \text{ mm}$	
Strength deck (excluding cross deck) and top plate of double bottom	-	$\pm 3 l / 1000 \text{ mm}$	$\pm 4 l / 1000 \text{ mm}$	To be measured between on trans. space (min. $l = 3000 \text{ mm}$)
Bulkhead	-		$\pm 5 l / 1000 \text{ mm}$	
Accommodation above the strength deck and others	-	$\pm 5 l / 1000 \text{ mm}$	$\pm 6 l / 1000 \text{ mm}$	
 <p>$l = \text{span of frame}$ (minimum $l = 3000 \text{ mm}$)</p> <p>To be measured between one trans. space.</p>				

TABLE 7.1 – Alignment

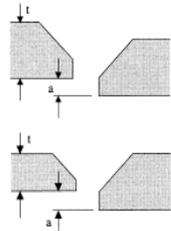
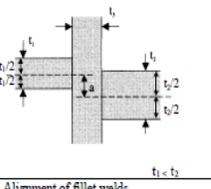
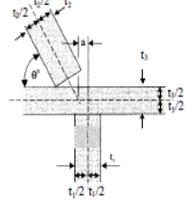
Detail	Standard	Limit	Remarks
Alignment of butt welds 		$a \leq 0.15t$ strength member $a \leq 0.2t$ other but maximum 4.0 mm	t is the lesser plate thickness
Alignment of fillet welds 		Strength member and higher stress member: $a \leq t_1/3$ Other: $a \leq t_1/2$	Alternatively, heel line can be used to check the alignment. Where t_1 is less than t_2 , then t_1 should be substituted for t_2 in the standard.
Alignment of fillet welds 		Strength member and higher stress member: $a \leq t_1/3$ Other: $a \leq t_1/2$	Alternatively, heel line can be used to check the alignment. Where t_1 is less than t_2 , then t_1 should be substitute for t_2 in the standard.

TABLE 6.12 – Preheating for welding hull steels at low temperature

Item		Standard		Limit	Remarks
		Base metal temperature needed preheating	Minimum preheating temperature		
Normal strength steels	A, B, D, E	Below -5°C	$20^\circ \text{C}^{(1)}$		
Higher strength steels (TMCP type)		Below 0°C			
Higher strength steels (Conventional type)	AH32 – EH32 AH36 – EH36	Below 0°C			
(Note) 1) This level of preheat is to be applied unless the approved welding procedure specifies a higher level.					

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TABLE 7.2 – Alignment

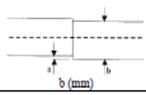
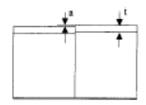
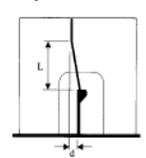
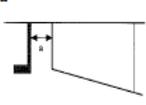
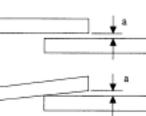
Detail	Standard	Limit	Remarks
Alignment of flange of T-longitudinal 	Strength member $a \leq 0.04b$ (mm)	$a = 8.0$ mm	
Alignment of height of T-bar, L-angle bar or bulb 	Strength member $a \leq 0.15t$ Other $a \leq 0.20t$	$a = 3.0$ mm	
Alignment of panel stiffener 	$d \leq L/50$		
Gap between bracket/intercostal and stiffener 	$a \leq 2.0$ mm	$a = 3.0$ mm	
Alignment of lap welds 	$a \leq 2.0$ mm	$a = 3.0$ mm	

TABLE 7.3 – Alignment

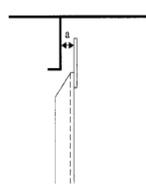
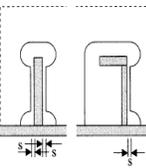
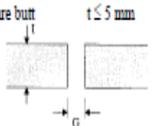
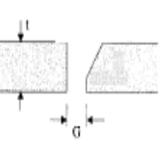
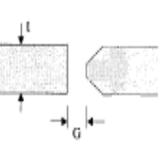
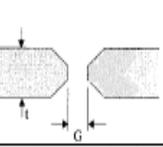
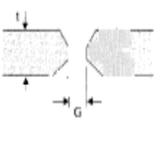
Detail	Standard	Limit	Remarks
Gap between beam and frame 	$a \leq 2.0$ mm	$a = 5.0$ mm	
Gap around stiffener cut-out 	$s \leq 2.0$ mm	$s = 3.0$ mm	

TABLE 8.1 – Typical Butt Weld Plate Edge Preparation (Manual Welding and Semi-Automatic Welding) for Reference

Detail	Standard	Limit	Remarks
Square butt $t \leq 5$ mm 	$G \leq 3$ mm	$G = 5$ mm	see Note 1
Single bevel butt $t > 5$ mm 	$G \leq 3$ mm	$G = 5$ mm	see Note 1
Double bevel butt $t > 19$ mm 	$G \leq 3$ mm	$G = 5$ mm	see Note 1
Double vee butt, uniform bevels 	$G \leq 3$ mm	$G = 5$ mm	see Note 1
Double vee butt, non-uniform bevel 	$G \leq 3$ mm	$G = 5$ mm	see Note 1
NOTE 1 Different plate edge preparation may be accepted or approved by the Classification Society in accordance with URW28 or other recognized standard accepted by the Classification Society. For welding procedures other than manual welding, see paragraph 3.2 Qualification of weld procedures.			

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TABLE 8.2 – Typical Butt Weld Plate Edge Preparation (Manual Welding and Semi-Automatic Welding) for Reference

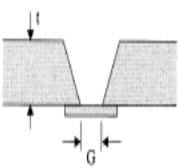
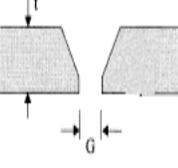
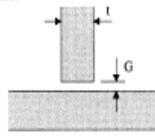
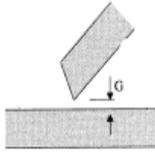
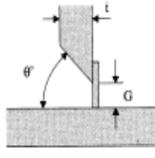
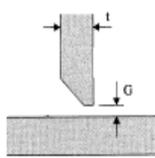
Detail	Standard	Limit	Remarks
Single Vee butt, one side welding with backing strip (temporary or permanent) 	$G = 3 \text{ to } 9 \text{ mm}$	$G = 16 \text{ mm}$	see Note 1
Single vee butt 	$G \leq 3 \text{ mm}$	$G = 5 \text{ mm}$	see Note 1
NOTE 1 Different plate edge preparation may be accepted or approved by the Classification Society in accordance with URW28 or other recognized standard accepted by the Classification Society. For welding procedures other than manual welding, see paragraph 3.2 Qualification of welding procedures.			

Table 8.3 – Typical Fillet Weld Plate Edge Preparation (Manual Welding and Semi-Automatic Welding) for Reference

Detail	Standard	Limit	Remarks
Tee Fillet 	$G \leq 2 \text{ mm}$	$G = 3 \text{ mm}$	see Note 1
Inclined fillet 	$G \leq 2 \text{ mm}$	$G = 3 \text{ mm}$	see Note 1
Single bevel tee with permanent backing 	$G \leq 4 \text{ to } 6 \text{ mm}$ $\theta^{\circ} = 30^{\circ} \text{ to } 45^{\circ}$	$G = 16 \text{ mm}$	Not normally for strength member also see Note 1
Single bevel tee 	$G \leq 3 \text{ mm}$		see Note 1
NOTE 1 Different plate edge preparation may be accepted or approved by the Classification Society in accordance with URW28 or other recognized standard accepted by the Classification Society. For welding procedures other than manual welding, see paragraph 3.2 Qualification of welding procedures.			

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Table 8.4 – Typical Fillet Weld Plate Edge Preparation (Manual Welding and Semi-Automatic Welding) for Reference

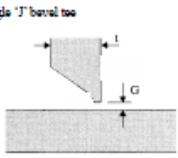
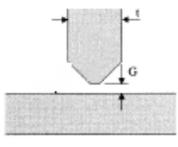
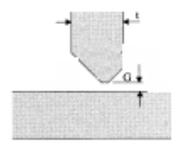
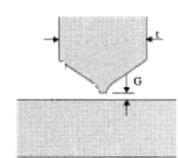
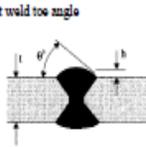
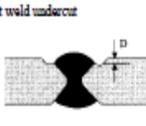
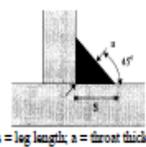
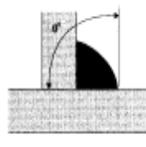
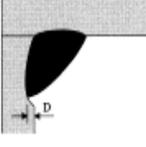
Detail	Standard	Limit	Remarks
 <p>Single 'J' bevel toe</p>	$G = 2.5 \text{ to } 4 \text{ mm}$		see Note 1
 <p>Double bevel toe symmetrical $t > 19 \text{ mm}$</p>	$G \leq 3 \text{ mm}$		see Note 1
 <p>Double bevel toe asymmetrical $t > 19 \text{ mm}$</p>	$G \leq 3 \text{ mm}$		see Note 1
 <p>Double 'J' bevel toe symmetrical</p>	$G = 2.5 \text{ to } 4 \text{ mm}$		see Note 1
<p>NOTE 1 Different plate edge preparation may be accepted or approved by the Classification Society in accordance with URW28 or other recognised standard accepted by the Classification Society. For welding procedures other than manual welding, see paragraph 3.2 Qualification of welding procedures.</p>			

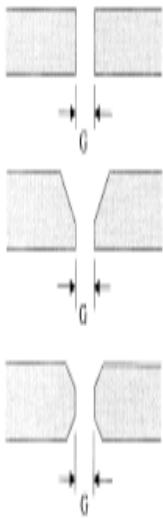
Table 8.5 – Butt And Fillet Weld Profile (Manual Welding and Semi-Automatic Welding)

Detail	Standard	Limit	Remarks
 <p>Butt weld toe angle</p>	$\theta \leq 60^\circ$ $h \leq 6 \text{ mm}$	$\theta \leq 90^\circ$	
 <p>Butt weld undercut</p>		$D \leq 0.5 \text{ mm}$ for strength member $D \leq 0.8 \text{ mm}$ for other	
 <p>Fillet weld leg length</p> <p>$s = \text{leg length}$; $a = \text{throat thickness}$</p>		$s \geq 0.9a_1$ $s \geq 0.9a_2$ over short weld lengths	$a_1 = \text{design } s$ $a_2 = \text{design } a$
 <p>Fillet weld toe angle</p>		$\theta \leq 90^\circ$	In areas of stress concentration and fatigue, the Classification Society may require a lesser angle.
 <p>Fillet weld undercut</p>		$D \leq 0.8 \text{ mm}$	

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Table 8.6 – Typical Butt Weld Plate Edge Preparation (Automatic welding) for Reference

Detail	Standard	Limit	Remarks
<p>Submerged Arc Welding (SAW)</p> 	$0 \leq G \leq 0.8 \text{ mm}$	$G = 1 \text{ mm}$	See Note 1.
<p>NOTE 1</p> <p>Different plate edge preparation may be accepted or approved by the Classification Society in accordance with URSV20 or other recognized standard accepted by the Classification Society. For welding procedures other than manual welding, see paragraph 3.2 Qualification of welding procedures.</p>			

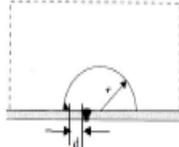
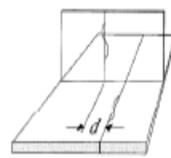
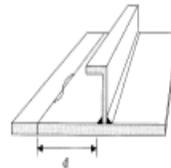
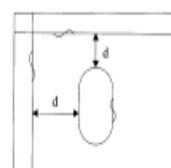
Detail	Standard	Limit	Remarks
<p>Scallops over weld seams</p> 		for strength member $d \geq 5 \text{ mm}$ for other $d \geq 0 \text{ mm}$	The "d" is to be measured from the toe of the fillet weld to the toe of the butt weld.
<p>Distance between two butt welds</p> 		$d \geq 0 \text{ mm}$	
<p>Distance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

Table 8.7 – Distance Between Welds

Table 9.1 – Typical Misalignment Remedial

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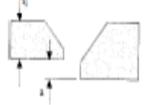
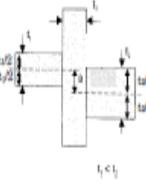
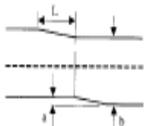
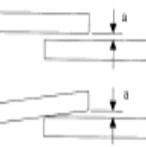
Detail	Remedial Standard	Remarks
Alignment of butt joints 	Strength member $a > 0.15t$, or $a > 4$ mm release and adjust Other $a > 0.2t$, or $a > 4$ mm release and adjust	t_1 is lesser plate thickness
Alignment of fillet welds 	Strength member and higher stress member $t_1/3 < a \leq t_1/2$ - generally increase weld throat by 10% $a > t_1/2$ - release and adjust over a minimum of $50a$ Other $a > t_1/2$ - release and adjust over a minimum of $30a$	Alternatively, heel line can be used to check the alignment. Where t_1 is less than t_2 than t_3 should be substituted for t_1 in standard
Alignment of flange of T-longitudinal 	When $0.04b < a \leq 0.08b$, max 8 mm: grind corners to smooth taper over a minimum distance $L = 3a$ When $a > 0.08b$ or 8 mm: release and adjust over a minimum distance $L = 50a$	
Alignment of height of T-bar, L-angle bar or bulb 	When 3 mm $< a \leq 6$ mm: build up by welding When $a > 6$ mm: release and adjust over minimum $L = 50a$ for strength member and $L = 30a$ for other	
Alignment of lap welds 	3 mm $< a \leq 5$ mm: weld leg length to be increased by the same amount as increase in gap in excess of 3 mm $a > 5$ mm: members to be re-aligned	

Table 9.2 – Typical Misalignment Remedial

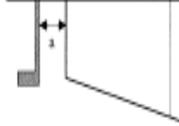
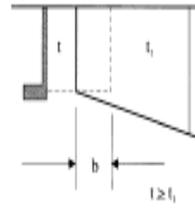
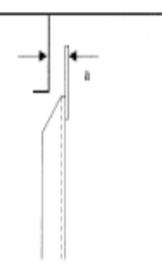
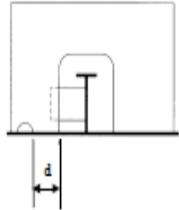
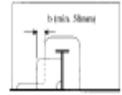
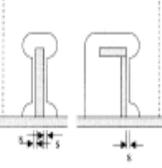
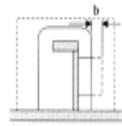
Detail	Remedial Standard	Remarks
Gap between bracket intercostal and stiffener 	When 3 mm $< a \leq 5$ mm: weld leg length to be increased by increase in gap in excess of 3 mm	
	When 5 mm $< a \leq 10$ mm: chamfer 30° to 40° and build up by welding with backing	
	When $a > 10$ mm: increase gap to about 50 mm and fit collar plate  $b = (2t + 25)$ mm, min. 50 mm	
Gap between beam and frame 	3 mm $< a \leq 5$ mm: weld leg length to be increased by the same amount as increase in gap in excess of 3 mm $a > 5$ mm release and adjust	

TABLE 9.3 – Misalignment Remedial

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Detail	Remedial standard	Remarks
<p>Position of scallop</p> 	<p>When $d < 75 \text{ mm}$ web plate to be cut between scallop and slot, and collar plate to be fitted</p>  <p>Or fit small collar over scallop</p>  <p>Or fit collar plate over scallop</p> 	
<p>Gap around stiffener cut-out</p> 	<p>When $3 \text{ mm} < s \leq 5 \text{ mm}$ weld leg length to be increased by the same amount as increase in gap in excess of 2 mm</p>	
	<p>When $5 \text{ mm} < s \leq 10 \text{ mm}$ web to be chamfered and built up by welding</p>	
	<p>When $s > 10 \text{ mm}$ cut off web and fit collar plate of same height as web</p>  <p>$20 \text{ mm} \leq b \leq 50 \text{ mm}$</p>	

Preparation Remedial (Manual Welding and Semi-Automatic Welding)

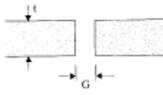
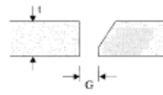
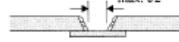
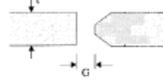
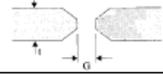
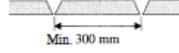
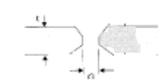
Detail	Remedial standard	Remarks
<p>Square butt</p> 	<p>When $G \leq 10 \text{ mm}$ chamfer to 45° and build up by welding</p> <p>When $G > 10 \text{ mm}$ build up with backing strip, remove, back gouge and seal weld, or, insert plate, min. width 300 mm</p>	
<p>Single bevel butt</p> 	<p>When $5 \text{ mm} < G \leq 1.5t$ (maximum 25 mm) build up gap with welding on one or both edges to maximum of $0.5t$, using backing strip, if necessary.</p> <p>Where a backing strip is used, the backing strip is to be removed, the weld back gouged, and a sealing weld made.</p> 	
<p>Double bevel butt</p> 	<p>Different welding arrangement by using backing material approved by the Classification Society may be accepted on the basis of an appropriate welding procedure specification.</p> <p>When $G > 25 \text{ mm}$ or $1.5t$, whichever is smaller, use insert plate, of minimum width 300 mm</p>	
<p>Double vee butt, uniform bevels</p> 	 <p>Min. 300 mm</p>	
<p>Double vee butt, non-uniform bevel</p> 		

TABLE 9.4 – Typical Butt Weld Plate Edge

TABLE 9.5 – Typical Butt Weld Plate Edge

Preparation Remedial (Manual Welding and Semi-Automatic Welding)

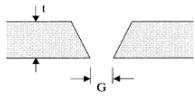
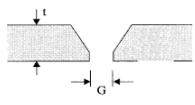
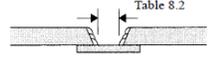
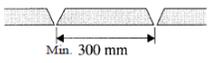
Detail	Remedial Standard	Remarks
<p>Single vee butt, one side welding</p> 	<p>When $5 \text{ mm} < G \leq 1.5t$ (maximum 25 mm), build up gap with welding on one or both edges, to "Limit" gap size preferably to "Standard" gap size as described in Table 8.2.</p> <p>Where a backing strip is used, the backing strip is to be removed, the weld back gouged, and a sealing weld made.</p> <p>Different welding arrangement by using backing material approved by the Classification Society may be accepted on the basis of an appropriate welding procedure specification.</p>	
<p>Single vee butt</p> 	<p>Limits see Table 8.2</p>  <p>When $G > 25 \text{ mm}$ or $1.5t$, whichever is smaller, use insert plate of minimum width 300 mm.</p> 	

TABLE 9.6 – Typical Fillet Weld Plate Edge Preparation Remedial (Manual Welding and Semi-Automatic Welding)

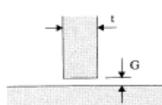
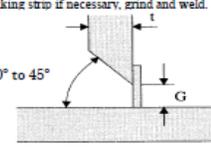
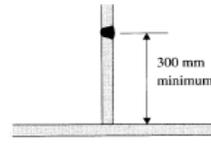
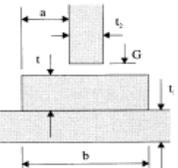
Detail	Remedial standard	Remarks
<p>Tee Filler</p> 	<p>$3 \text{ mm} < G \leq 5 \text{ mm}$ – leg length increased to Rule leg + (G-2)</p> <p>$5 \text{ mm} < G \leq 16 \text{ mm}$ or $G \leq 1.5t$ - chamfer by 30° to 45°, build up with welding, on one side, with backing strip if necessary, grind and weld.</p>  <p>30° to 45°</p> <p>$G > 16 \text{ mm}$ or $G > 1.5t$ use insert plate of minimum width 300 mm</p> 	
<p>Liner treatment</p> 	<p>$t_2 \leq t \leq t_1$ $G \leq 2 \text{ mm}$ $a = 5 \text{ mm}$ + fillet leg length</p>	<p>Not to be used in cargo area or areas of tensile stress through the thickness of the liner</p>

TABLE 9.7 – Typical Fillet Weld Plate Edge

Preparation Remedial (Manual Welding and Semi-Automatic Welding)

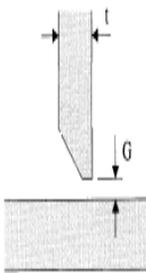
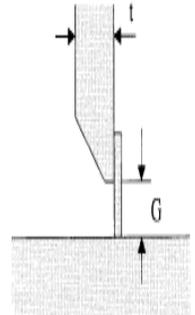
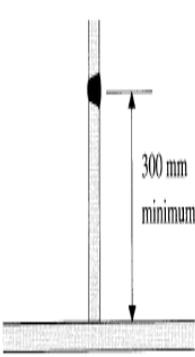
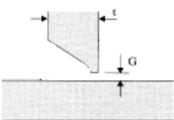
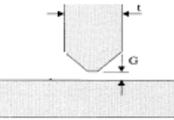
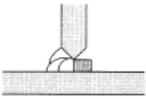
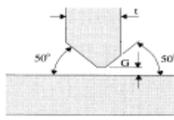
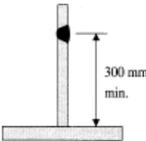
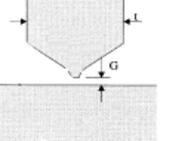
Detail	Remedial standard	Remarks
<p>Single bevel tee</p> 	<p>$3 \text{ mm} < G \leq 5 \text{ mm}$ build up weld</p> <p>$5 \text{ mm} < G \leq 16 \text{ mm}$ - build up with welding, with backing strip if necessary, remove backing strip if used, back gouge and back weld.</p> 	
	<p>$G > 16 \text{ mm}$ new plate to be inserted of minimum width 300 mm</p> 	

TABLE 9.8 – Typical Fillet Weld Plate Edge Preparation Remedial (Manual Welding and

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استاندارد کیفی تعمیرات و ساخت کشتی
شماره: ۳۲/۹۳/۰۰۳۹
تاریخ: ۱۳۹۳/۰۷/۱۹

Semi-Automatic Welding)

Detail	Remedial standard	Remarks
Single 'J' bevel tee 	as single bevel tee	
Double bevel tee symmetrical 	When $5 \text{ mm} < G \leq 16 \text{ mm}$ build up with welding using ceramic or other approved backing bar, remove, back gouge and back weld. 	
Double bevel tee asymmetrical 	When $G > 16 \text{ mm}$ -insert plate of minimum height 300 mm to be fitted. 	
Double 'J' bevel symmetrical 		

Semi-Automatic Welding)

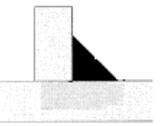
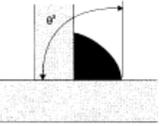
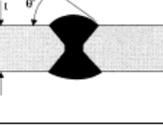
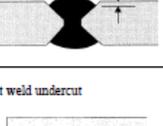
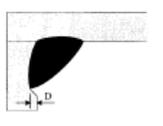
Detail	Remedial standard	Remarks
Fillet weld leg length 	Increase leg or throat by welding over	Minimum short bead to be referred Table 9.14
Fillet weld toe angle 	$\theta > 90^\circ$ grinding, and welding, where necessary, to make $\theta \leq 90^\circ$	
Butt weld toe angle 	$\theta > 90^\circ$ grinding, and welding, where necessary, to make $\theta \leq 90^\circ$	
Butt weld undercut 	For strength member, where $0.5 < D \leq 1 \text{ mm}$, and for other, where $0.8 < D \leq 1 \text{ mm}$, undercut to be ground smooth (localized only) or to be filled by welding Where $D > 1 \text{ mm}$ undercut to be filled by welding	
Fillet weld undercut 	Where $0.8 < D \leq 1 \text{ mm}$ undercut to be ground smooth (localized only) or to be filled by welding Where $D > 1 \text{ mm}$ undercut to be filled by welding	

TABLE 9.10 – Distance Between Welds Remedial

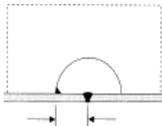
Detail	Remedial standard	Remarks
Scallops over weld seams 	Hole to be cut and ground smooth to obtain distance	

TABLE 9.9 – Typical Fillet and Butt Weld Profile Remedial (Manual Welding and

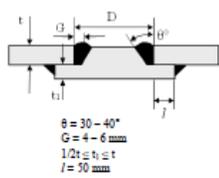
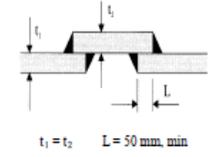
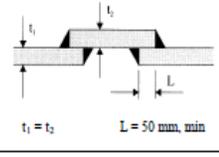
TABLE 9.11 – Erroneous Hole Remedial

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Detail	Remedial standard	Remarks
Holes made erroneously $D < 200$ mm	<p>Strength member open hole to minimum 75 mm dia., fit and weld spigot piece</p>  <p>Or open hole to over 300 mm and fit insert plate</p> <p>Other open hole to over 300 mm and fit insert plate Or fit lap plate</p>  <p>$t_1 = t_2$ $L = 50$ mm, min</p>	<p>Fillet weld to be made after butt weld</p> <p>The fitting of spigot pieces in areas of high stress concentration or fatigue is to be approved by the Classification Society.</p>
Holes made erroneously $D \geq 200$ mm	<p>Strength member open hole and fit insert plate</p> <p>Other open hole to over 300 mm and fit insert plate Or fit lap plate</p>  <p>$t_1 = t_2$ $L = 50$ mm, min</p>	

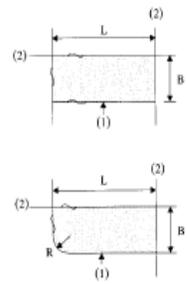
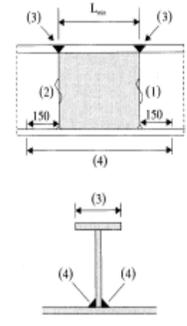
Detail	Remedial standard	Remarks
Remedial by insert plate	 <p>$L = 300$ mm minimum $B = 300$ mm minimum $R = 5t$ 100mm minimum</p> <p>(1) seam with insert piece is to be welded first</p> <p>(2) original seam is to be released and welded over for a minimum of 100 mm.</p>	
Remedial of built section by insert plate	 <p>$L_{min} \geq 300$ mm</p> <p>Welding sequence (1) → (2) → (3) → (4)</p> <p>Web butt weld scallop to be filled during final pass (4)</p>	

TABLE 9.12 – Remedial by Insert Plate

TABLE 9.13 – Weld Surface Remedial

Detail	Remedial standard	Remarks
Short bead for remedying scar (scratch)	<p>a) HT steel, Cast steel, TMCP type HT steel ($C_{eq} > 0.36\%$) and Low temp steel ($C_{eq} > 0.36\%$) Length of short bead ≥ 50 mm</p> <p>b) Grade E of mild steel Length of short bead ≥ 30 mm</p> <p>c) TMCP type HT steel ($C_{eq} \leq 0.36\%$) and Low temp steel ($C_{eq} \leq 0.36\%$) Length of short bead ≥ 10 mm</p>	Preheating is necessary at $100 \pm 25^\circ\text{C}$
Remedying weld bead	<p>a) HT steel, Cast steel, TMCP type HT steel ($C_{eq} > 0.36\%$) and Low temp steel ($C_{eq} > 0.36\%$) Length of short bead ≥ 50 mm</p> <p>b) Grade E of mild steel Length of short bead ≥ 30 mm</p> <p>c) TMCP type HT steel ($C_{eq} \leq 0.36\%$) and Low temp steel ($C_{eq} \leq 0.36\%$) Length of short bead ≥ 30 mm</p>	
<p>NOTE:</p> <p>1. When short bead is made erroneously, remove the bead by grinding.</p> <p>2. $C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} (\%)$</p>		

Detail	Remedial standard	Remarks
Short bead for remedying scar (scratch)	a) HT steel, Cast steel, TMCP type HT steel (Ceq > 0.36%) and Low temp steel (Ceq > 0.36%) Length of short bead ≥ 50 mm b) Grade E of mild steel Length of short bead ≥ 30 mm c) TMCP type HT steel (Ceq ≤ 0.36%) and Low temp steel (Ceq ≤ 0.36%) Length of short bead ≥ 10 mm	Preheating is necessary at 100 ± 25°C
Remedying weld bead	a) HT steel, Cast steel, TMCP type HT steel (Ceq > 0.36%) and Low temp steel (Ceq > 0.36%) Length of short bead ≥ 50 mm b) Grade E of mild steel Length of short bead ≥ 30 mm c) TMCP type HT steel (Ceq ≤ 0.36%) and Low temp steel (Ceq ≤ 0.36%) Length of short bead ≥ 30 mm	
NOTE: 1. When short bead is made erroneously, remove the bead by grinding. 2. $C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$ (%)		

PART B – SHIPBUILDING AND REPAIR QUALITY STANDARD FOR EXISTING SHIP

1. SCOPE

1.1) This standard provides guidance on quality of repair of hull structures. The standard covers permanent repairs of existing ships.

Whereas the standard generally applies to

- Conventional ship types,
- Parts of hull covered by the rules of the Classification Society,
- 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 Classification Society.

The standard does generally not apply to repair of

- Special types of ships as e.g. gas tankers

- Structures fabricated from stainless steel or other, special types or grades of steel

1.2) The standard covers typical repair methods and gives guidance on quality standard on the most important aspects of such repairs. 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 design. A more stringent standard may however be required for critical and highly stressed areas of the hull, and is to be agreed with the Classification Society in each case. In assessing the criticality of hull structure and structural components, reference is made to ref. 1, 2 and 3.

1.3) Restoration of structure to the original standard may not constitute durable repairs of damages originating from insufficient strength or inadequate detail design. In such cases strengthening or improvements beyond the original design may be required. Such improvements are not covered by this standard; however it is referred to ref. 1, 2 and 3.

2. GENERAL REQUIREMENTS FOR REPAIRS AND REPAIRERS

2.1) In general, when hull structure covered by classification is to be subjected to repairs, the work is to be carried out under the supervision of the Surveyor to the Classification Society. Such repairs are to be agreed prior to commencement of the work.

2.2) Repairs are to be carried out by workshops, repair yards or personnel who have demonstrated their capability to carry out hull repairs of adequate quality in accordance with the Classification Society's requirements and this standard.

2.3) Repairs are to be carried out under working conditions that facilitate sound repairs. 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.

2.4) 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 Classification Society, see Section 3. Welding operations are to be carried out under proper supervision of the repair yard.

2.5) Where repairs to hull which affect or may affect classification are intended to be carried out during a voyage, complete repair procedure including the extent and sequence of repair is to be submitted to and agreed upon by the Surveyor to the Classification Society reasonably in advance of the repairs. See Ref. 8.

3. QUALIFICATION OF PERSONEL

3.1) Qualification of welders

3.1.1) Welders are to be qualified in accordance with the procedures of the Classification Society or to a recognized national or international standard, e.g. EN 287, ISO 9606, ASME Section IX, ANSI/AWS D1.1. Recognition of other standards is subject to submission to the Classification Society for evaluation. Repair yards and workshops are to keep records of welder's qualification and, when required, furnish valid approval test certificates.

3.1.2) Welding operators using fully mechanized or fully automatic processes need generally not pass approval testing, provided that 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 Classification Society for inspection when requested.

3.2) Qualification of welding procedures

Welding procedures are to be qualified in accordance with the procedures of the Classification Society or a recognized national or international standard, e.g. EN288, ISO 9956, ASME Section IX, ANSI/AWS D1.1. Recognition of other standards is subject to submission to the Classification Society for evaluation. 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.

3.3) Qualification of NDE operators

3.3.1) Personnel performing nondestructive examination for the purpose of assessing quality of welds in connection with repairs covered by this standard, are to be qualified in accordance with the Classification Society rules or to a recognized international or national qualification scheme. Records of operators and their current certificates are to be kept and made available to the Surveyor for inspection.

4. MATERIALS

4.1) General requirements for materials

4.1.1) The requirements for materials used in repairs are in general the same as the requirements for materials specified in the Classification Society's rules for new constructions, (ref. 5).

4.1.2) Replacement material is in general to be of the same grade as the original approved material. Alternatively, material grades complying with recognized national or international standards may be accepted by the Classification Societies provided such standards give equivalence to the requirements of the original grade or are agreed by the Classification Society. For assessment of equivalency between steel grades, the general requirements and guidelines in Section 4.2 apply.

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4.1.3) Higher tensile steel is not to be replaced by steel of a lesser strength unless specially approved by the Classification Society.

4.1.4) Normal and higher strength hull structural steels are to be manufactured at works approved by the Classification Society for the type and grade being supplied.

4.1.5) Materials used in repairs are to be certified by the Classification Society applying the procedures and requirements in the rules for new constructions. In special cases, and normally limited to small quantities, materials may be accepted on the basis of alternative procedures for verification of the material's properties. Such procedures are subject to agreement by the Classification Society in each separate case.

4.2) Equivalency of material grades

4.2.1) Assessment of equivalency between material grades should at least include the following aspects;

- Heat treatment/delivery condition
- Chemical composition
- Mechanical properties
- Tolerances

4.2.2) When assessing the equivalence between grades of normal or higher strength hull structural steels up to and including grade E40 in thickness limited to 50 mm, the general requirements in Table 4.1 apply.

4.2.3) Guidance on selection of steel grades to certain recognized standards equivalent to hull structural steel grades specified in Classification Societies' rules is given in Table 4.2

to assessment of equivalency between normal or higher strength hull structural steel grades

Items to be considered	Requirements	Comments
Chemical composition	- C; equal or lower - P and S; equal or lower - Mn; approximately the same but not exceeding 1.6% - Fine grain elements; in same amount - Detoxidation practice	The sum of the elements, e.g. Cu, Ni, Cr and Mo should not exceed 0.8%
Mechanical properties	- Tensile strength; equal or higher - Yield strength; equal or higher - Elongation; equal or higher - Impact energy; equal or higher at same or lower temperature, where applicable	Actual yield strength should not exceed Classification Society Rule minimum requirements by more than 80 N/mm ²
Condition of supply	Same or better	Heat treatment in increasing order; - as rolled (AR) - controlled rolled (CR) - normalised (N) - thermo-mechanically rolled (TM) ¹⁾ - quenched and tempered (QT) ¹⁾ ¹⁾ TM- and QT-steels are not suitable for hot forming
Tolerances	- Same or stricter	Permissible under thickness tolerances; - plates: 0.3 mm - sections: according to recognised standards

Table 4.2 - Guidance on steel grades comparable to the normal and high strength hull structural steel grades given in Classification Society rules

Steel grades according to Classification Societies' rules (ref. 5)						Comparable steel grades			
Grade	Yield stress R _{el} min. N/mm ²	Tensile strength R _m N/mm ²	Elongation A ₅ min. %	Average impact energy Temp. J, min.		ISO 630-80 4950/2/3/ 1981	EN EN 10025-93 EN 10113-93	ASTM A 131	JIS G 3106
				°C	L T				
A	235	400-502	22	+20	-	Fe 360B	S235JRG2	A	SM41B
B				0	27 20	Fe 360C	S235J0	B	SM41B
D				-20	27 20	Fe 360D	S235J2G3	D	(SM41C)
E				-40	27 20	-	S275NLM	E	-
E 27				-40	27 20	-	S275NLM	-	-
A 27	265	400-530	22	0	-	Fe 430C	S275J0G3	-	-
D 27				-20	27 20	Fe 430D	S275NM	-	-
E 27				-40	-	-	S275NLM	-	-
A 32	315	440-590	22	0	-	-	-	AH32	SM50B
D 32				-20	31 22	-	-	DH32	(SM50C)
E 32				-40	-	-	-	EH32	-
A 36	355	490-620	21	0	-	Fe 510C	S355NM	AH36	SM53B
D 36				-20	34 24	Fe 510D	S355NM	DH36	(SM53C)
E 36				-40	-	E355E	S355NLM	EH36	-
A 40	390	510-650	20	0	-	E390CC	S420NM	AH40	(SM58)
D 40				-20	41 27	E390DD	S420NM	DH40	-
E 40				-40	-	E390E	S420NLM	EH40	-

Note:

In selecting comparable steels from this table, attention should be given to the requirements of Table 4.1 and the dimension requirements of the product with respect to Classification Society rules.

WELDING

5.1) Correlation of welding consumables with hull structural steels

5.1.1) For the different hull structural steel grades welding consumables are to be selected in accordance with IACS UR W17 (see Ref.6).

5.2) General requirements to preheating and drying out

5.2.1) The need for preheating is to be determined based on the chemical composition of the materials, welding process and procedure and degree of joint restraint.

5.2.2) A minimum preheat of 50° C is to be applied when ambient temperature is below 0° C. Dryness of the welding zone is in all cases to be ensured.

5.2.3) Guidance on recommended minimum preheating temperature for higher strength steel is given in Table 5.1. For automatic welding processes utilizing higher heat input e.g. submerged arc welding, the temperatures may be reduced by 50° C. For re-welding or repair of welds, the stipulated values are to be increased by 25° C.

Table 5.1 - Preheating temperature

Carbon equivalent ¹⁾	Recommended minimum preheat temperature (° C)		
	t _{comb} ≤ 50 mm ²⁾	50 mm < t _{comb} ≤ 70 mm ²⁾	t _{comb} > 70 mm ²⁾
Ceq ≤ 0.39	-	50	
Ceq ≤ 0.41	-	75	
Ceq ≤ 0.43	-	50	100
Ceq ≤ 0.45	50	100	125
Ceq ≤ 0.47	100	125	150
Ceq ≤ 0.50	125	150	175

5.3) Dry welding on hull plating below the waterline of vessels afloat

5.3.1) Welding on hull plating below the waterline of vessels afloat is acceptable only on normal and

higher strength steels with specified yield strength not exceeding 355 MPa and only for local repairs. Welding involving other high strength steels or more extensive repairs against water backing is subject to special consideration and approval by the Classification Society of the welding procedure.

5.3.2) Low-hydrogen electrodes or welding processes are to be used when welding on hull plating against water backing. Coated low-hydrogen electrodes used for manual metal arc welding should be properly conditioned to ensure a minimum of moisture content.

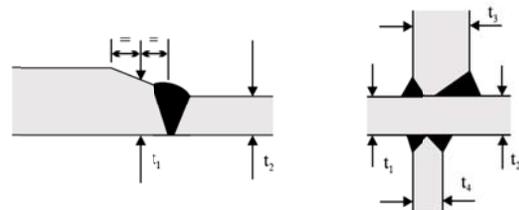
5.3.3) In order to ensure dryness and to reduce the cooling rate, the structure is to be preheated by a torch or similar prior to welding, to a temperature of minimum 5° C or as specified in the welding procedure.

Notes:

1)

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

2) Combined thickness t_{comb} = t₁+t₂+t₃+t₄, see figure



6. REPAIR QUALITY STANDARD

6.1) Welding, general

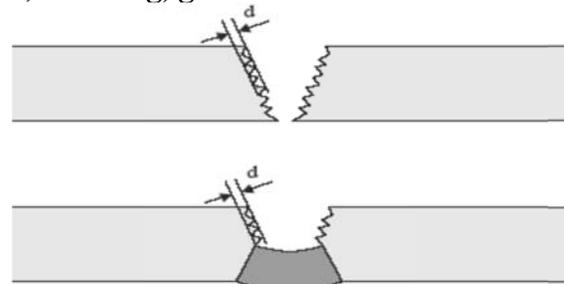


Fig 6.1 - Groove roughness

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استاندارد کیفی تعمیرات و ساخت کشتی

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Item	Standard	Limit	Remarks
Material Grade	Same as original or higher		See Section 4
Welding Consumables	IACS UR W17 (ref. 6)	Approval according to equivalent international standard	
Groove / Roughness	See note and Fig 6.1	$d < 1.5 \text{ mm}$	Grind smooth
Pre-Heating	See Table 5.1	Steel temperature not lower than 5°C	
Welding with water on the outside	See Section 5.3	Acceptable for normal and high strength steels	- Moisture to be removed by a heating torch
Alignment	As for new construction		
Weld Finish	IACS Recommendation 20 (ref. 10)		
NDE	IACS Recommendation 20 (ref. 10)	At random with extent to be agreed with attending surveyors	

Note:

Slag, grease, loose mill scale, rust and paint, other than primer, to be removed.

6.2) Renewal of plates

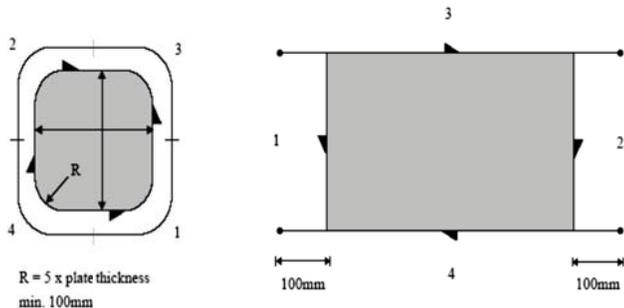


Fig 6.2 - Welding sequence for inserts

Item	Standard	Limit	Remarks
Size Insert	Min. 300 x 300 mm R = 5 x thickness Circular inserts: $D_{min} = 200 \text{ mm}$	Min. 200 x 200 mm Min R = 100 mm	
Material Grade	Same as original or higher		See Section 4.
Edge Preparation	As for new construction		In case of non compliance increase the amount of NDE
Welding Sequence	See Fig 6.2 Weld sequence is 1 → 2 → 3 → 4		For primary members sequence 1 and 2 transverse to the main stress direction
Alignment	As for new construction		
Weld Finish	IACS Recommendation 20 (ref. 10)		
NDE	IACS Recommendation 20 (ref. 10)		

6.3) Doublers on plating

Local doublers are normally only allowed as temporary repairs, except as original compensation for openings, within the main hull structure.

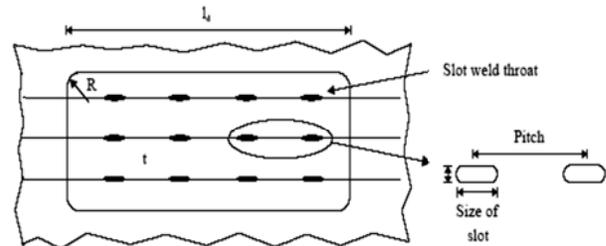


Fig 6.3 - Doublers on plates

Item	Standard	Limit	Remarks
Existing Plating		General: $t \geq 5 \text{ mm}$	For areas where existing plating is less than 5 mm plating a permanent repair by insert is to be carried out.
Extent / Size	Rounded off corners.	min 300 x 300 mm $R \geq 50 \text{ mm}$	
Thickness of Doubler (td)	$td \leq tp$ (tp = original thickness of existing plating)	$td > tp/3$	
Material Grade	Same as original plate		See Section 4
Edge Preparation	As for [newbuilding] new construction		Doublers welded on primary strength members: (Le: leg length) when $t > Le + 5 \text{ mm}$, the edge to be tapered (1:4)
Welding	As for [newbuilding] new construction		Welding sequence similar to insert plates.
Weld Size (throat thickness)	Circumferential and in slots: $0.6 \times td$		
Slot Welding	Normal size of slot: $(80-100) \times 2 \text{ td}$ Distance from doubler edge and between slots: $d \leq 15 \text{ td}$	Max pitch between slots 200 mm $d_{max} = 500 \text{ mm}$	For doubler extended over several supporting elements, see Figure 6.3
NDE	IACS Recommendation 20 (ref. 10)		

6.4) Renewal of internals/stiffeners

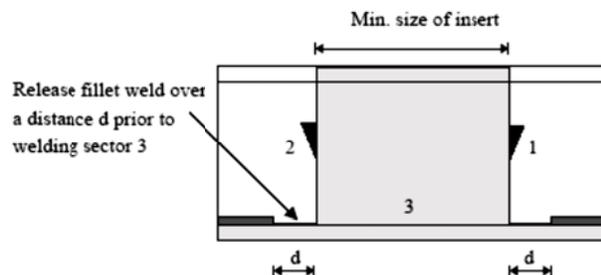


Fig 6.4 - Welding sequence for inserts of stiffeners

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Item	Standard	Limit	Remarks
Size Insert	Min. 300 mm	Min. 200 mm	
Material Grade	Same as original or higher		See Section 4.
Edge Preparation	As for new construction. Fillet weld stiffener web / plate to be released over min. $d = 150$ mm		
Welding Sequence	See Fig 6.4 Welding sequence is 1 → 2 → 3		
Alignment	As for new construction		
Weld Finish	IACS Recommendation 20 (ref. 10)		
NDE	IACS Recommendation 20 (ref. 10)		

6.5) Renewal of internals/stiffeners – transitions inverted angle/bulb profile

The application of the transition is allowed for secondary structural elements.

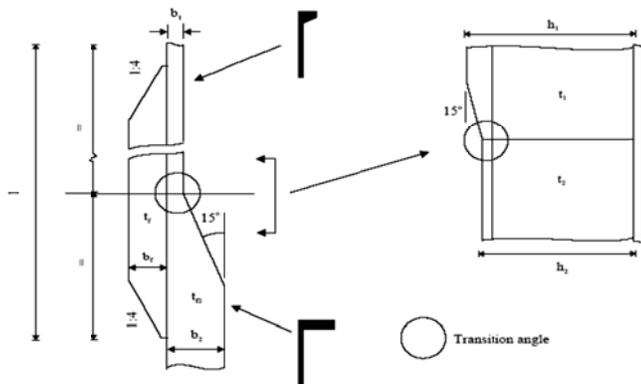


Fig 6.5 - Transition between inverted angle and bulb profile

Item	Standard	Limit	Remarks
$(h_1 - h_2)$	$\leq 0.25 \times b_1$		
$ t_1 - t_2 $	2 mm		Without tapering transition.
Transition Angle	15 degrees		At any arbitrary section
Flanges	$t_f = t_2$ $b_f = b_2$		
Length of Flatbar	$4 \times h_1$		
Material			See Section 4.

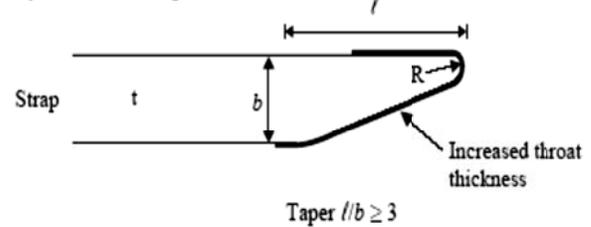
6.6) Application of Doubling Straps

In certain instances, doubling straps are used as a means to strengthen and reinforce primary structure. Where this has been agreed and approved, particular attention should be paid to:

- The end termination points of the straps, so that toe support is such that no isolated hard point occurs.
- In the case of application of symmetrical or asymmetrical-ended straps, the corners at the end of the tapering should be properly rounded.

- any butts between lengths of doubling straps, so that there is adequate separation of the butt weld from the primary structure below during welding, and so that a high quality root run under controlled circumstances is completed prior to completing the remainder of the weld. Ultrasonic testing should be carried out on completion to verify full penetration.

Asymmetrical arrangement



Symmetrical arrangement

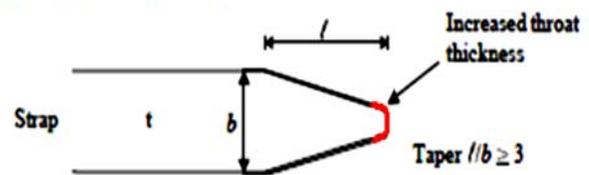


Fig 6.6 - Application of Doubling Straps

Item	Standard	Limit	Remarks
Tapering	$l/b > 3$		Special consideration to be drawn to design of strap terminations in fatigue sensitive areas.
Radius	$0.1 \times b$	min 30 mm	
Material			See paragraph 2.0 General requirement to materials.
Weld Size			Depending on number and function of straps. Throat thickness to be increased 15 % toward ends.
Welding	Welding sequence from middle towards the free ends		See sketch. For welding of lengths > 1000 mm step welding to be applied.

6.7) Welding of pitting corrosion

Notes:

Shallow pits may be filled by applying coating or pit filler. Pits can be defined as shallow when their depth is less than 1/3 of the original plate thickness.

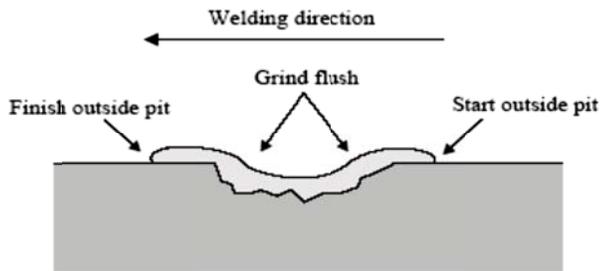


Fig 6.7 - Welding of pits

Item	Standard	Limit	Remarks
Extent / Depth	Pits / grooves are to be welded flush with the original surface.	If deep pits or grooves are clustered together or remaining thickness is less than 6 mm, the plates should be renewed.	See also IACS Recommendation 12 (ref. 9)
Cleaning	Heavy rust to be removed		
Pre-Heating	See Table 5.1	Required when ambient temperature < 5°C	Always use propane torch or similar to remove any moisture
Welding Sequence	Reverse direction for each layer		See also IACS Recommendation 12 (ref. 9)
Weld Finish	IACS Recommendation 20 (ref. 10)		
NDE	IACS Recommendation 20 (ref. 10)	Min. 10% extent	Preferably MPI

Reference is made to TSCF Guidelines, Ref. 2 & 3.

6.8) Welding repairs for cracks

In the event that a crack is considered weldable, either as a temporary or permanent repair, the following techniques should be adopted as far as practicable. Run-on and run-off plates should be adopted at all free edges.

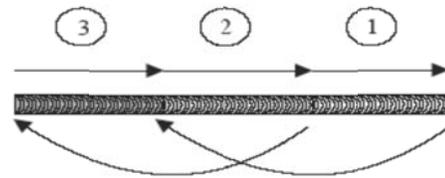


Fig 6.8.a - Step back technique

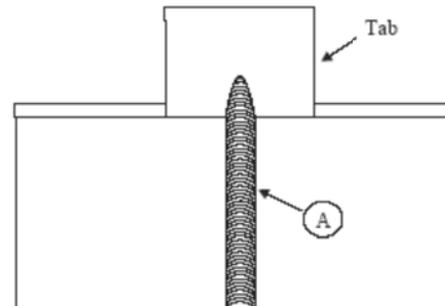


Fig 6.8.b - End crack termination

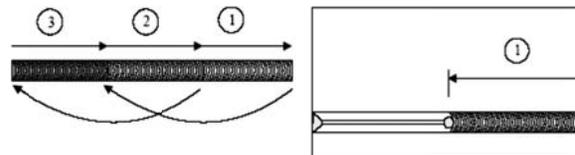


Fig 6.8.c - Welding sequence for cracks with length less than 300 mm

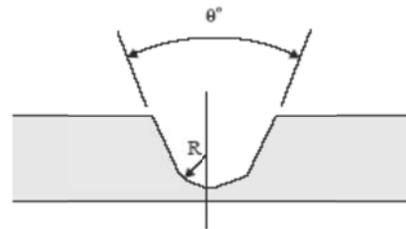


Fig 6.8.d - Groove preparation (U-groove left and V-groove right)

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تاریخ: ۱۳۹۳/۰۷/۱۹

Item	Standard	Limit	Remarks
Groove Preparation	$\theta = 45-60^\circ$ $r = 5 \text{ mm}$		For through plate cracks as for newbuilding. Also see Fig 6.8.d
Termination	Termination to have slope 1:3		For cracks ending on edges weld to be terminated on a tab see Fig 6.8.b
Extent	On plate max. 400 mm length. Vee out 50 mm past end of crack	On plate max 500 mm. Linear crack, not branched	
Welding Sequence	See Fig 6.8.c for sequence and direction	For cracks longer than 300 mm step-back technique should be used Fig 6.8.a	Always use low hydrogen welding consumables
Weld Finish	IACS Recommendation 20 (ref. 10)		
NDE	IACS Recommendation 20 (ref. 10)	100 % MP or PE of groove	100 % surface crack detection + UE or RE for butt joints