No.47 Shipbuilding and Repair Quality Standard

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Part A Shipbuilding and Repair Quality Standard for New Construction

Part B Repair Quality Standard for Existing Ships

PART A - SHIPBUILDING AND REPAIR QUALITY STANDARDS FOR NEW CONSTRUCTION

REFERENCES

1. IACS "Bulk Carriers - Guidelines for Surveys, Assessment and Repair of Hull Structure"
2. TSCF "Guidelines for the inspection and maintenance of double hull tanker structures"
3. TSCF "Guidance manual for the inspection and condition assessment of tanker structures"
4. IACS UR W7 "Hull and machinery steel forgings"
5. IACS UR W8 "Hull and machinery steel castings"
6. IACS UR W11 "Normal and higher strength hull structural steel"
7. IACS UR W13 "Allowable under thickness tolerances of steel plates and wide flats"
8. IACS UR W14 "Steel plates and wide flats with improved through thickness properties"
9. IACS UR W17 "Approval of consummables for welding normal and higher strength hull structural steels"
10. IACS UR Z10.1 "Hull surveys of oil tankers"and Z10.2 "Hull surveys of bulk carriers" Annex I
11. IACS Recommendation No. 12 "Guidelines for surface finish of hot rolled plates and wide flats "
13. IACS Recommendation No. 20 " Guide for inspection of ship hull welds"

1. Scope

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

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 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 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.

1.3 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 recognised national standards.

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

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 skewed 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 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.

2.3 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.

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 recognised 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. Subcontractors are to keep records of welders qualification and, when required, furnish valid approval test certificates.

3.1.2 Welding operators using fully mechanised 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 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 recognised 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 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 recognised 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 consummables, 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 Under Thickness Tolerances

The maximum permissible under thickness tolerance, for hull structural plates and wide flats with thicknesses of 5mm and over, for both normal and high strength steels, is -0.3mm. The thickness is to be measured at random locations whose distance from an edge shall be at least 10mm. Local surface depressions resulting from imperfections and ground areas resulting from the elimination of defects may be disregarded provided the imperfections or grinding are in accordance with the requirements of Section 4.3 "Surface Conditions".

4.3 Surface Conditions

4.3.1 Definitions

Minor Imperfections: pittings, rolled-in scale, indentations, roll marks, scratches and grooves

Defects: Cracks, shells, sand patches, sharp edged seams and minor imperfections not exceeding the limits of table 1 in case that the sum of the influenced area exceeds 5% of the total surface in question

Depth of Imperfections or defects: the depth is to be measured from the surface of the product

4.3.2 Unrepaired Conditions

Minor imperfections, in accordance with the limits described in Table 1, are permissible and may be left unrepaired.

4.3.3 Repairs of Defects

Defects are to be repaired by grinding or welding irrespective of their size and number. Repair by grinding may be carried out over the entire surface up to a depth equal to the under thickness tolerances given in para.4.2.

The sum of the repairs by welding and of the repairs by grinding, reducing the nominal thickness by more than 0.3mm, shall not exceed 2% of the total surface in question.

4.3.4 Repairs by Grinding

For ground areas with a thickness less than the minimum permissible thickness stated in para.4.2, the nominal thickness is not to be reduced by more than 7% or 3mm, whichever is the lesser. Each single ground area is not to exceed $0.25m^2$.

The defects are to be completely removed by grinding. Complete elimination of the defects is to be verified by a magnetic particle or dye penetrant test procedure. The ground areas must have smooth transitions to the surrounding surface.

4.3.5 Repairs by welding

Local defects, which cannot be repaired by grinding, may be repaired by chipping and/or grinding followed by welding in accordance with the qualified procedures approved by the Classification Society concerned.

Any single welded area is not to exceed $0.125m^2$. The weld preparation should not reduce the thickness of the product below 80% of the nominal thickness. Welding is to be completed with one layer of weld bead in excess, which is subsequently to be ground smooth, level with the plate surface. The soundness of the repair is to be verified by ultrasonic, magnetic particle or dye penetrant methods.

Plate Thickness	Surface Area	100%	15%	5%	2%
3 ≤ t < 8mm	N + 0.1	0.2	-	0.4	-
	N	0.2	-	0.3	0.4
	N - 0.1	0.2	-	-	0.4
	N - 0.2	0.1	0.2	-	0.4
	N - 0.3	0.0	0.2	-	0.4
8 ≤ t < 25mm	N + 0.2	0.3	-	0.5	-
	N + 0.1	0.3	-	0.4	0.5
	N	0.3	-	-	0.5
	N - 0.1	0.2	0.3	-	0.5
	N - 0.2	0.1	0.3	-	0.5
	N - 0.3	0.0	0.3	-	0.5
25 ≤ t <40mm	N + 0.3	0.4	-	0.6	-
	N + 0.2	0.4	-	0.5	0.6
	N + 0.1	0.4	-	-	0.6
	N	0.3	0.4	-	0.6
	N - 0.1	0.2	0.4	-	0.6
	N - 0.2	0.1	0.4	-	0.6
	N - 0.3	0.0	0.4	-	0.6
40 ≤ t <80mm	N + 0.5	0.5	-	0.8	-
	N + 0.4	0.5	-	0.7	0.8
	N + 0.3	0.5	-	0.6	0.8
	N + 0.2	0.5	-	-	0.8
	N + 0.1	0.4	0.5	-	0.8
	N	0.3	0.5	-	0.8
	N - 0.1	0.2	0.5	-	0.8
	N - 0.2	0.1	0.5	-	0.8
	N - 0.3	0.0	0.5	-	0.8
80 ≤ t<150mm	N + 0.6	0.6	-	0.9	-
	N + 0.5	0.6	-	0.8	0.9
	N + 0.4	0.6	-	0.7	0.9
	N + 0.3	0.6	-	-	0.9
	N + 0.2	0.5	0.6	-	0.9
	N + 0.1	0.4	0.6	-	0.9
	N	0.3	0.6	-	0.9
	N - 0.1	0.2	0.6	-	0.9
	N - 0.2	0.1	0.6	-	0.9
	N - 0.3	0.0	0.6	-	0.9

N - Nominal Plate Thickness

Table 1 Limits for minor imperfections left unrepaired

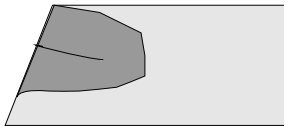
4.3.6 Further Defects

4.3.6.1 Lamination

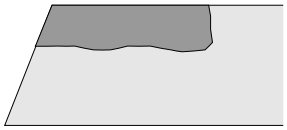
Investigation to be carried out at the steelmill into the cause and extent of the laminations. Severe lamination is to be repaired by a local insert plates. The minimum breadth of the plate to be repaired by insert is to be:

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

Local limited lamination may be repaired 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 repair may be carried out as shown in sketch (b). For limitations see paragraph 4.3.5.



(a)



(b)

4.3.6.2 Weld Spatters

Loose weld spatters are to be removed completely by grinding to clean metal (see Table 9.13) 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. Cutting

5.1 Gas Cutting

The deviation **u** of cut edges (see sketch (a)), from a right angle or from a required slope, and the roughness of the cut edges **R**, is to meet the following requirements:

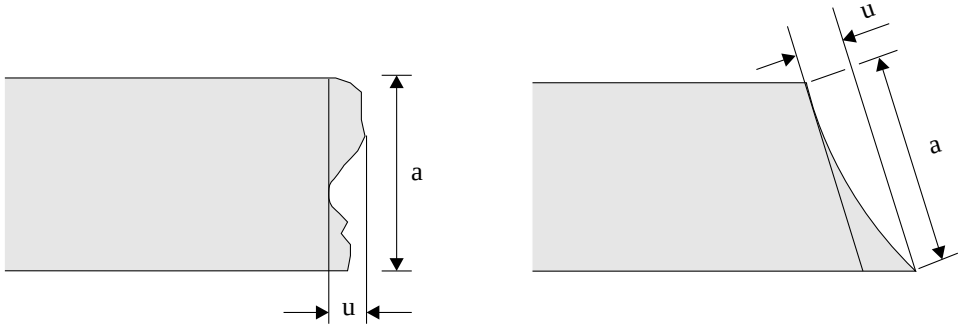
Mechanised Gas Cutting			**Manual Gas Cutting: Free Edges**		
Cut Thickness	**Standard**	**Limit**	**Strength Members**	**Standard**	**Limit**
a≤20mm	u=0.6mm R=100µm	u=1.2mm R=150µm		u=1.5mm R=150µm	u=1.5mm R=300µm
			Others		
a>20mm	u=0.75mm R-100µm	u=1.5mm R=150µm		u=1.5mm R=300µm	u=1.5mm R=500µm

Manual Gas Cutting: Welding Edges

	Standard	Limit
Strength Members	u=1.5mm R=400µm	u=1.5mm R=800µm*
Others	u=1.5mm R=800µm*	u=1.5mm R=1500µm*

Individual non-sharp notches caused by torch failures (scouring) are not to be greater than 3mm in depth. Deeper scores should be removed by grinding.

* Unless the welding procedure needs smaller tolerances.



(a) deviation u from a right angle or from a required slope

5.2 Plasma Arc Cutting

The deviation **u** of the cut edge (see sketch (a)), from a right angle or from a required slope, and the roughness of the cut edge **R**, is to meet the following requirements:

Mechanised Plasma Arc Cutting

Cut Thickness	Standard	Limit
a≤20mm	u=1.0mm R=100µm	u=1.5mm R=150µm
a>20mm	u=0.75mm R=100µm	u=1.5mm R=150µm

The tolerances for manual cutting are to be agreed by the Classification Society concerned.

5.3 Laser Beam Cutting

The standard range and the tolerance limits for the deviation from a right angle or from a required slope of the cut edges and the roughness of the cut edges are to be agreed by the Classification Society concerned.

6. Fabrication and fairness

6.1 Flanged longitudinals 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)

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
- Higher tensile steel regions

8. Welding Details

8.1 Typical butt weld plate edge preparation (manual welding) - see Table 8.1 and 8.2
8.2 Typical fillet weld plate edge preparation (manual welding) - see Table 8.3 and 8.4
8.3 Typical butt and fillet weld profile (manual welding) - see Table 8.5
8.4 Lap, plug and slot welding - see Table 8.6
8.5 Distance between welds - see Table 8.7
8.6 Automatic welding - see Table 8.8

9. Repair

9.1 Typical misalignment repair - see Tables 9.1 to 9.3
9.2 Typical butt weld plate edge preparation repair (manual welding) - see Table 9.4 and 9.5
9.3 Typical fillet weld plate edge preparation repair (manual welding) - see Tables 9.6 to 9.8
9.4 Typical fillet and butt weld profile repair (manual welding) - see Table 9.9
9.5 Distance between welds repair - see Table 9.10
9.6 Erroneous hole repair - see Table 9.11
9.7 Repair by insert plate - see Table 9.12
9.8 Weld surface repair - see Table 9.13

TABLE 6.1 - FLANGED LONGITUDINALS AND BRACKETS

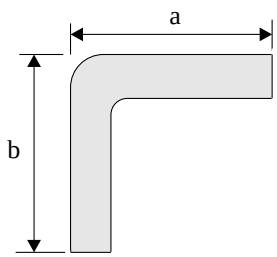
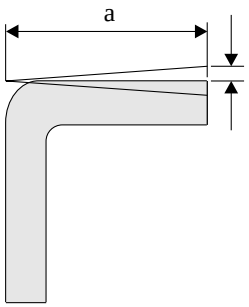
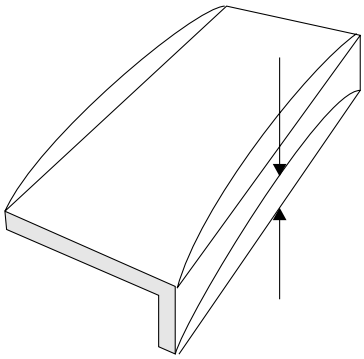
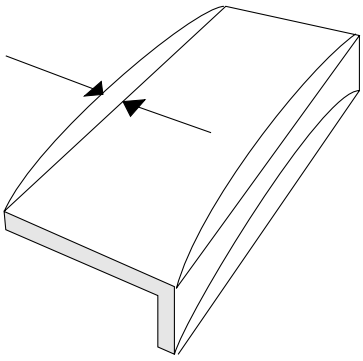
Detail	Standard	Limit	Remarks
Breadth of flange  compared to correct size	± 3 mm	± 5 mm	
Angle between flange and web  compared to template	± 3 mm	± 5 mm	per 100 mm of a
Straightness in plane of flange and web  	± 10 mm	± 25 mm	per 10 m

TABLE 6.2 - BUILT UP SECTIONS

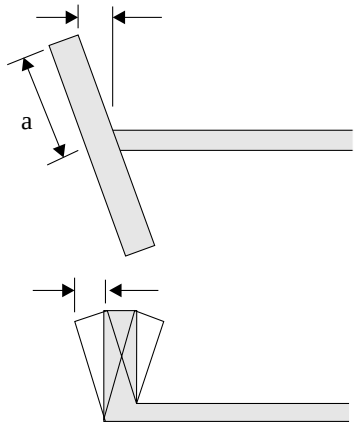
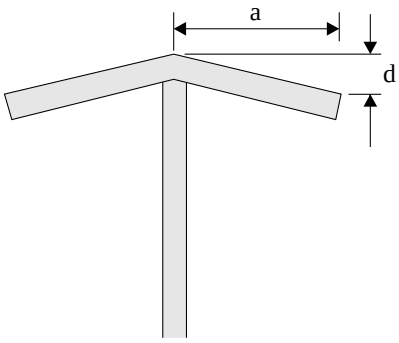
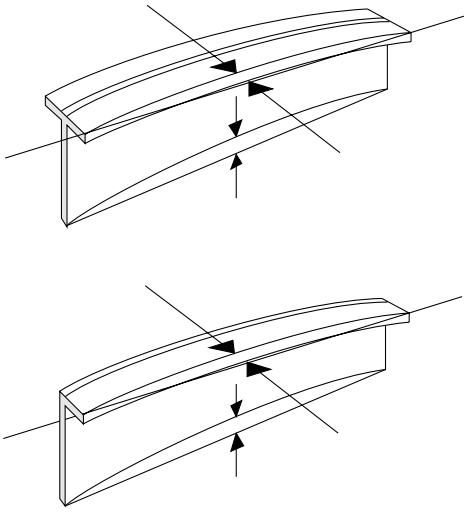
Detail	Standard	Limit	Remarks
Frames and longitudinal 	± 1.5 mm	± 3 mm	per 100 mm of a
Distortion of face plate 	d ≤ 3 + a/100 mm	d ≤ 5 + a/100 mm	
Distortion of girder and transverse at upper edge and flange 	±5 mm	±8 mm	per span between primary members

TABLE 6.3 - CORRUGATED BULKHEADS

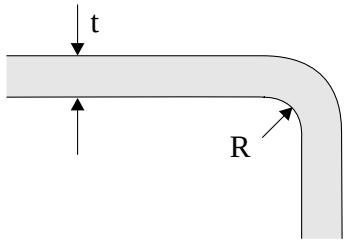
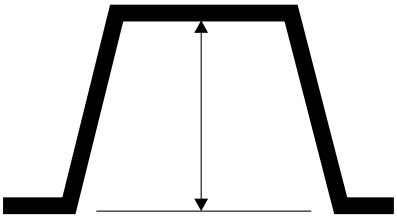
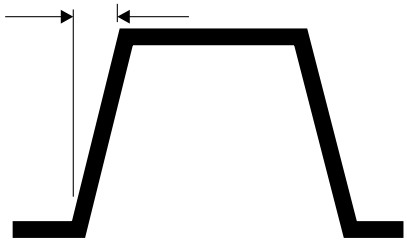
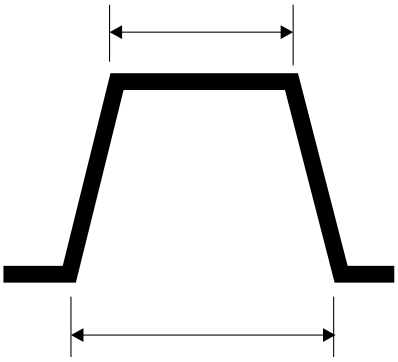
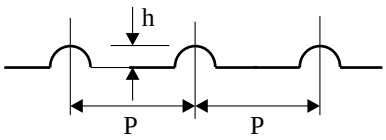
Detail	Standard	Limit	Remarks
Mechanical bending 	R ≥ 3t mm		Material to be suitable for cold flanging (forming) and welding in way of radius
Depth of corrugation 	± 3 mm	± 6 mm	
Breadth of corugation web 	± 3 mm	± 6 mm	
Breadth of corrugation 	± 3 mm	± 6 mm	
Pitch and depth of swedged corrugated bulkhead compared with correct value 	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 P : ± 9 mm P : ± 3 mm	

TABLE 6.4 - PILLARS, BRACKETS AND STIFFENERS

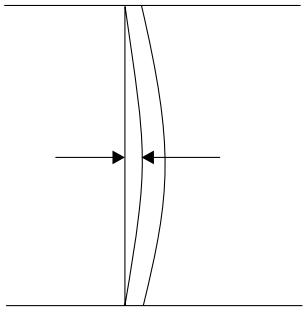
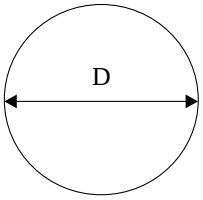
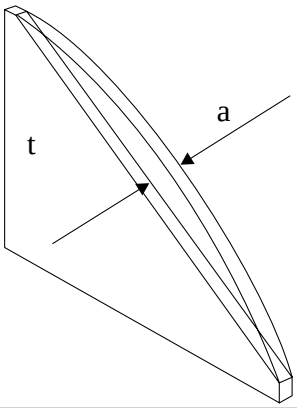
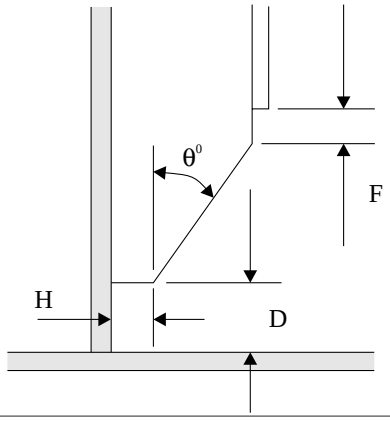
Detail	Standard	Limit	Remarks
Pillar (between decks) 	4 mm	6 mm	
Cylindrical structure diameter (pillars, masts, posts, etc.) 	± D/200 mm max. + 5 mm	± D/150 mm max. 7.5 mm	
Tripping bracket and small stiffener, distortion at the part of free edge 	a ≤ t/2 mm	max. 8mm	
Snipe end of secondary face plates and stiffeners 	$\theta^0 = 30^0$ H = 15 mm D = 25 mm F = 15 mm	+ 5 mm - 5 mm + 10 mm - 5 mm ± 5 mm	

TABLE 6.5 - MAXIMUM HEATING TEMPERATURE ON SURFACE FOR LINE HEATING FOR PLATE FORMING

Item		Standard	Limit	Remarks
Conventional Process AH32-EH32 & AH36-EH36	Water cooling just after heating	under 650°C		
TCMP type AH32-EH32 & 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:

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

TABLE 6.6 - BLOCK ASSEMBLY

Item	Standard	Limit	Remarks
Flat Plate Assembly			
Length and Breadth	±2.5mm	±5mm	
Distortion	±10mm	±20mm	
Squareness	±5mm	±10mm	
Deviation of interior members from plate	5mm	10mm	
Curved plate assembly			
Length and Breadth	±2.5mm	±5mm	Measured along
Distortion	±10mm	±20mm	the girth
Squareness	±10mm	±15mm	
Deviation of interior members from plate	5mm	10mm	
Flat cubic assembly			
Length and Breadth	±2.5m	±5mm	
Distortion	±10mm	±20mm	
Squareness	±5mm	±10mm	
Deviation of interior members from plate	5mm	10mm	
Twist	±10mm	±20mm	
Deviation between upper and lower plate	±5mm	±10mm	
Curved cubic assembly			
Length and Breadth	±2.5mm	±5mm	measured along
Distortion	±10mm	±20mm	with girth
Squareness	±10mm	±15mm	
Deviation of interior members from plate	5mm	10mm	
Twist	±15mm	±25mm	
Deviation between upper and lower plate	±7mm	±15mm	

TABLE 6.7 - SPECIAL SUB-ASSEMBLY

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

TABLE 6.8 - SHAPE

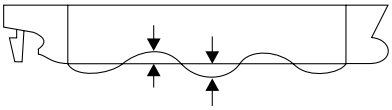
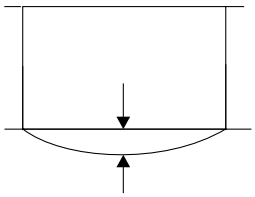
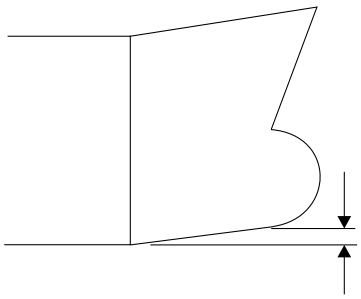
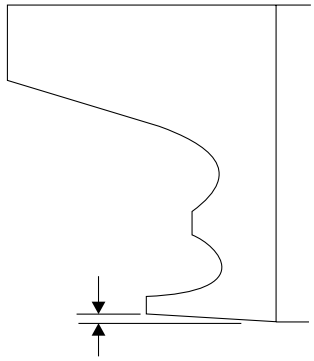
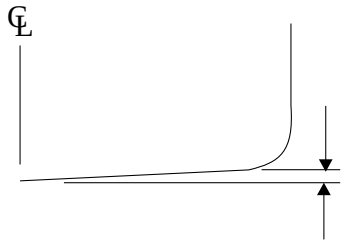
Detail	Standard	Limit	Remarks
Deformation for the whole length 	± 50 mm		per 100 m against the line of keel sighting
Deformation for the distance between two adjacent bulkheads 	± 15 mm		
Cocking-up of fore body 	± 30 mm		
Cocking-up of aft-body 	± 20 mm		
Rise of floor amidships 	± 15 mm		

TABLE 6.9 - SHAPE

Item	Standard	Limit	Remarks
Length between perpendiculars	±50 per 100m		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 stern may be substituted for the fore perpendicular in the measurement of the length.
Length between aft edge of boss and main engine	±25mm		
Moulded breadth at midship	±15mm		Applied to ships of 15 metre breadth and above. Measured on the upper deck.
Moulded depth at midship	±10mm		Applied to ships of 10 metre depth and above.

TABLE 6.10 - FAIRNESS OF PLATING BETWEEN FRAMES

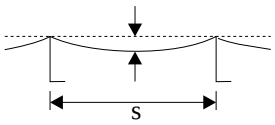
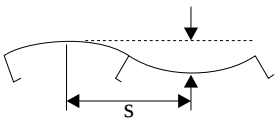
Item		Standard	Limit	Remarks
Shell plate	Parallel part (side & bottom shell)	4mm	8mm	
	Fore and aft part	5mm		
Tank top plate		4mm		
Bulkhead	Longl. bulkhead Trans. bulkhead Swash bulkhead	6mm		
Strength deck	Parallel part	4mm		
	Fore and aft part	6mm	9mm	
	Covered part	7mm	9mm	
Second deck	Bare part	6mm	8mm	
	Covered part	7mm	9mm	
Forecastle deck poop deck	Bare part	4mm	8mm	
	Covered part	6mm	9mm	$300 < s < 1000$
Super structure deck	Bare part	4mm	6mm	
	Covered part	7mm	9mm	
House wall	Outside wall	4mm	6mm	
	Inside wall	6mm	8mm	
	Covered part	7mm	9mm	
Interior member (web of girder, etc)		5mm	7mm	
Floor and girder in double bottom		5mm	7mm	

TABLE 6.11 - FAIRNESS OF PLATING WITH FRAMES

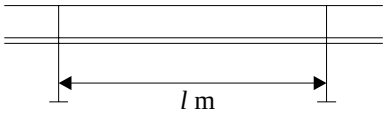
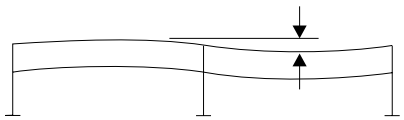
Item		Standard	Limit	Remarks
Shell plate	Parallel part	±2 /1000mm	±3 /1000mm	To be measured between on trans. space (min. *l*=3m)
	Fore and aft part	±3 /1000mm	±4 /1000mm	
Strength deck (excluding cross deck) and top plate of double bottom	-	±3 /1000mm	±4 /1000mm	
Bulkhead	-	±4 /1000mm	±5 /1000mm	
Others	-	±5 /1000mm	±6 /1000mm	
 *l* = span of frame (minimum *l* = 3 m) 				

TABLE 7.1 - ALIGNMENT

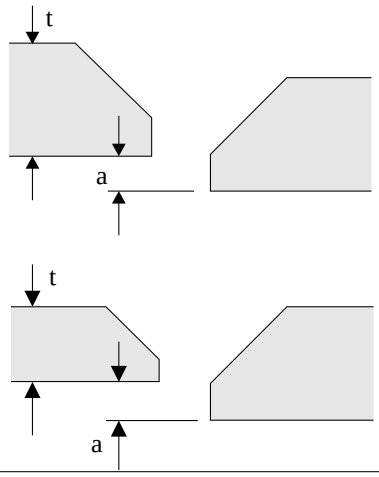
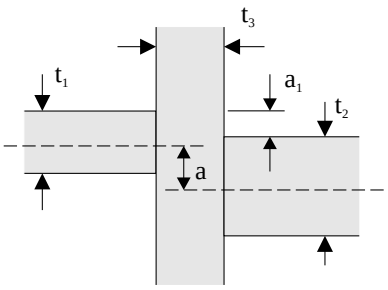
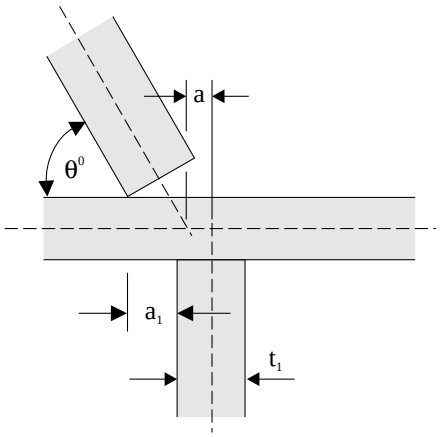
Detail	Standard	Limit	Remarks
Alignment of butt welds 	a ≤ 0.15t strength a ≤ 0.2t other	a ≤ 3.0 mm	
Alignment of fillet welds  $t_1 < t_2$	a) strength and higher tensile $a \leq t_1/3$ measured on the median $a_1 \leq (5t_1 - 3t_2)/6$ measured on the heel line b) other $a \leq t_1/2$ measured on the median $a_1 \leq (2t_1 - t_2)/2$ measured on the heel line		Where t_3 is less than t_1, then t_3 should be subsituted for t_1 in the standard
Alignment of fillet welds 	a) strength and higher tensile steel $a \leq t_1/3$ measured on the median b) other $a_1 \leq t_1/2$ measured on the heel line		

TABLE 7.2 - ALIGNMENT

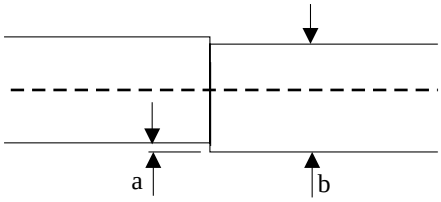
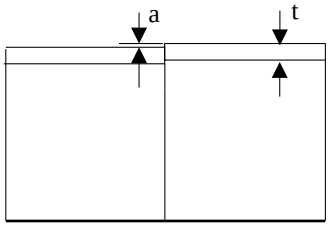
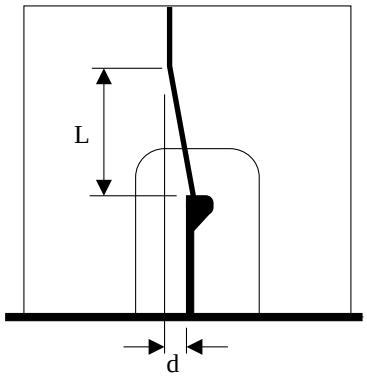
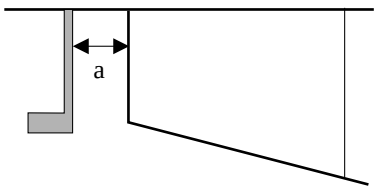
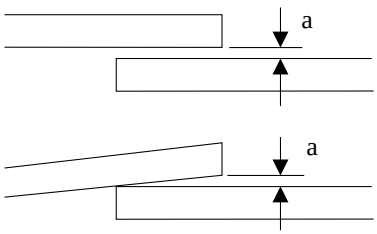
Detail	Standard	Limit	Remarks
Alignment of flange of T-longitudinal 	a ≤ 0.04b strength	a = 8.0 mm	
Alignment of height of T-bar, L-angle bar or bulb 	Primary members a ≤ 0.15t Secondary members a ≤ 0.20t	3.0 mm	
Alignment of panel stiffener 	d ≤ L/50		
Gap between bracket/intercostal and stiffener 	a ≤ 2.0 mm	3 mm	
Alignment of lap welds 	a ≤ 2.0 mm		

TABLE 7.3 - ALIGNMENT

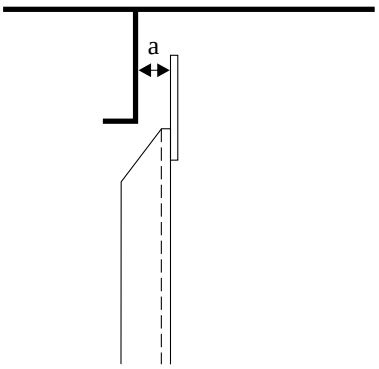
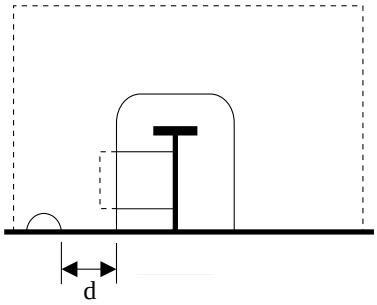
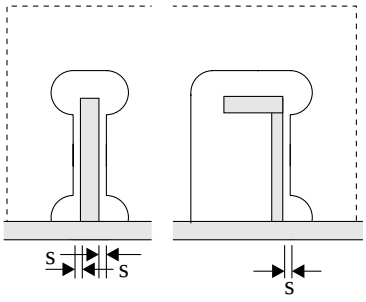
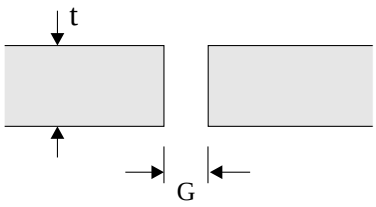
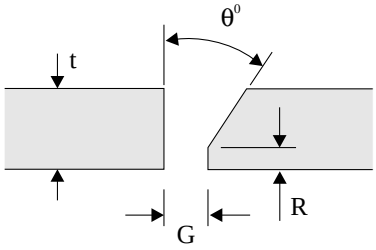
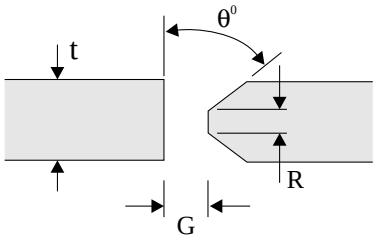
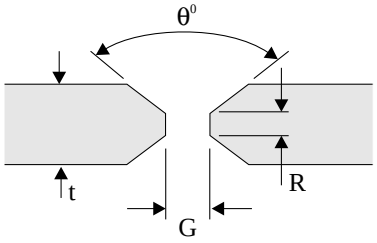
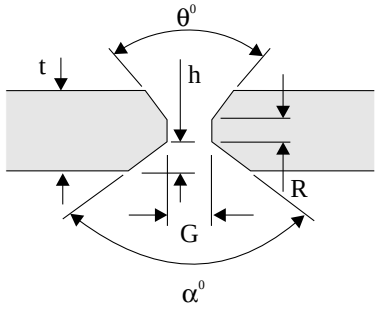
Detail	Standard	Limit	Remarks
Gap between beam and frame 	a ≤ 2.0 mm		
Position of scallop 	d ≥ 75 mm		
Gap around stiffener cut-out 	s ≤ 2.0 mm		

TABLE 8.1 -TYPICAL BUTT WELD PLATE EDGE PREPARATION (MANUAL WELDING)

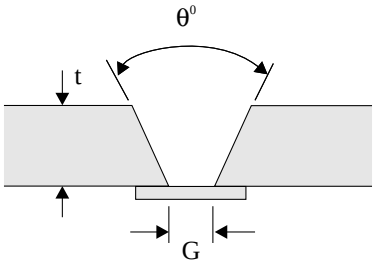
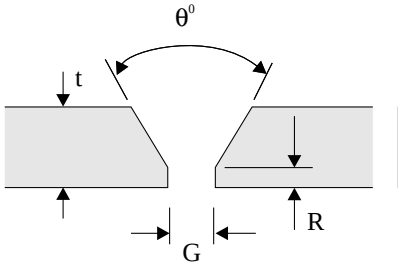
Detail	Standard	Limit	Remarks
Square butt 	$t \leq 5$ mm $G = 3$ mm		see Note 1
Single bevel butt 	$t > 5$ mm $G \leq 3$ mm $R \leq 3$ mm $\theta = 50^0 - 70^0$		see Note 1
Double bevel butt 	$t > 19$ mm $G \leq 3$ mm $R \leq 3$ mm $\theta = 50^0 - 70^0$		see Note 1
Double vee butt, uniform bevels 	$G \leq 3$ mm $R \leq 3$ mm $\theta = 50^0 - 70^0$		see Note1
Double vee butt, non-uniform bevel 	$G \leq 3$ mm $R \leq 3$ mm $6 \leq h \leq t/3$ mm $\theta = 50^0$ $\alpha = 90^0$		see Note 1

NOTE 1

Different plate edge preparation may be accepted or approved by the Classification Society on the basis of an appropiate welding procedure specification.

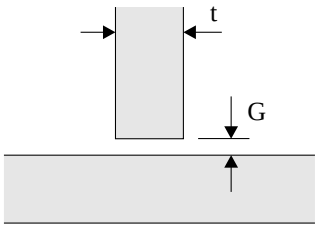
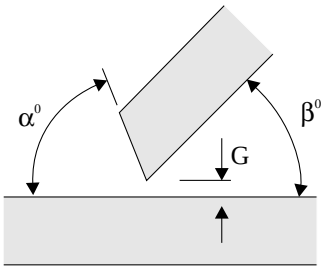
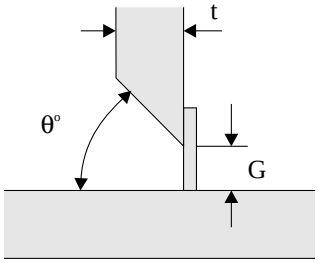
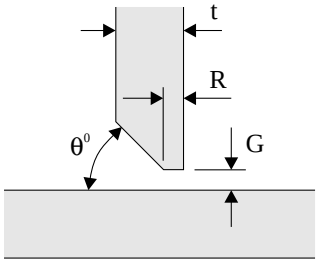
For welding procedures other that manual welding, see paragraph 3.2 Qualification of weld procedures

TABLE 8.2 - TYPICAL BUTT WELD PLATE EDGE PREPARATION (MANUAL WELDING)

Detail	Standard	Limit	Remarks
Single vee butt, one side welding with backing strip (temporary or permanent) 	G = 3 - 9 mm θ = 30^0 - 45^0		see Note 1
Single vee butt 	G ≤ 3 mm θ = 50^0 - 70^0 R ≤ 3 mm		see Note 1

NOTE 1
Different plate edge preparation may be accepted or approved by the Classification Society on the basis of an appropiate welding procedure specification.
For welding procedures other that manual welding, see paragraph 3.2 Qualification of weld procedures

TABLE 8.3 - TYPICAL FILLET WELD PLATE EDGE PREPARATION (MANUAL WELDING)

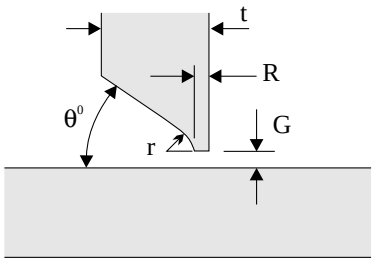
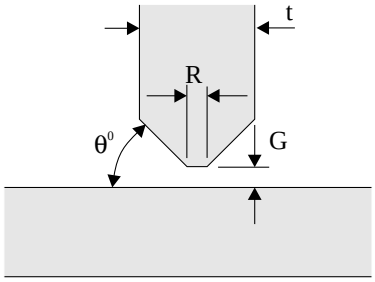
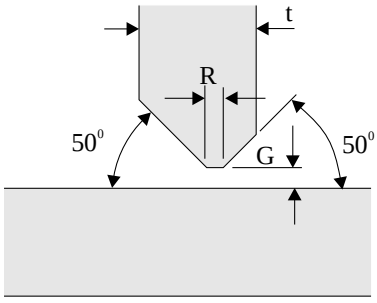
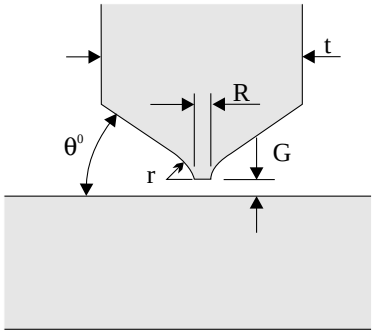
Detail	Standard	Limit	Remarks
Tee Fillet 	G ≤ 2 mm		see Note 1
Small angle fillet 	α = 50⁰ - 70⁰ β = 70⁰ - 90⁰ G ≤ 2 mm		see Note 1
Single bevel tee with permanent backing 	G ≤ 4 - 6 mm θ° = 30° - 45⁰		Not normally for strength members also see Note 1
Single bevel tee 	G ≤ 3 mm R ≤ 3 mm θ = 50⁰		see Note 1

NOTE 1

Different plate edge preparation may be accepted or approved by the Classification Society on the basis of an appropiate welding procedure specification.

For welding procedures other that manual welding, see paragraph 3.2 Qualification of weld procedures

TABLE 8.4 - TYPICAL FILLET WELD PLATE EDGE PREPARATION (MANUAL WELDING)

Detail	Standard	Limit	Remarks
Single 'J' tee 	G = 2.5 - 4 mm r = 12 - 15 mm R = 3mm $\theta \geq 35^0$		see Note 1
Double bevel tee symmetrical 	t > 19 mm G ≤ 3 mm R ≤ 3 mm $\theta = 50^0$		see Note 1
Double bevel tee assymetrical 	t > 19 mm G ≤ 3 mm R ≤ 3 mm		see Note1
Double J bevel symmetrical 	G = 2.5 - 4 mm R ≤ 3 mm r = 12 - 15 mm $\theta \geq 35^0$		see Note 1

NOTE 1

Different plate edge preparation may be accepted or approved by the Classification Society on the basis of an appropiate welding procedure specification.

For welding procedures other that manual welding, see paragraph 3.2 Qualification of weld procedures

TABLE 8.5 -TYPICAL BUTT AND FILLET WELD PROFILE (MANUAL WELDING)

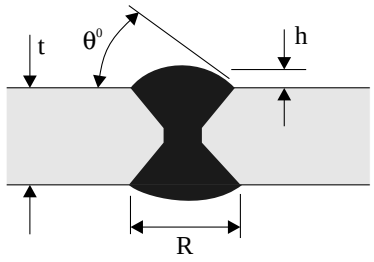
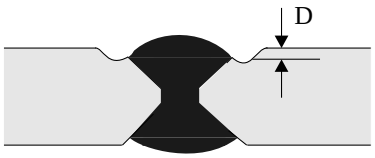
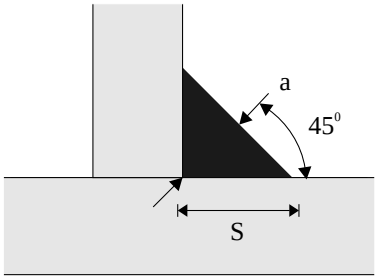
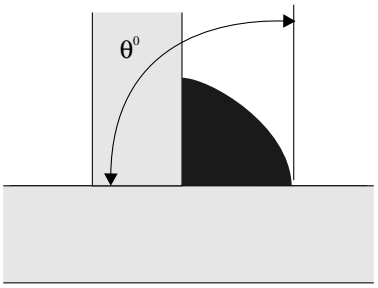
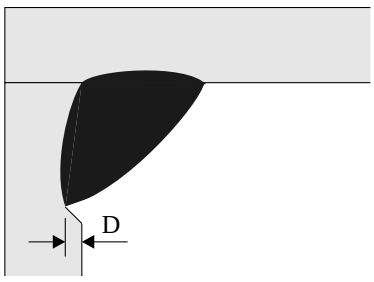
Detail	Standard	Limit	Remarks
Butt weld toe angle 	$\theta \leq 60^{\circ}$ $h \leq 0.2R$	maximum h 6 mm	
Butt weld undercut 	D = 0 mm	0.5 mm	
Fillet weld leg length 	s = leg length a = throat depth	$s \geq 0.9s_d$ $a \geq 0.9a_d$ over short weld lengths	s_d = design s a_d = design a
Fillet weld toe angle 		$\theta \leq 90^{0}$	in areas of stress concentration and fatigue, the Class Society may require a lesser angle
Fillet weld undercut 	D = 0 mm	0.5 mm	

TABLE 8.6 -TYPICAL LAP, PLUG AND SLOT WELDING (MANUAL WELDING)

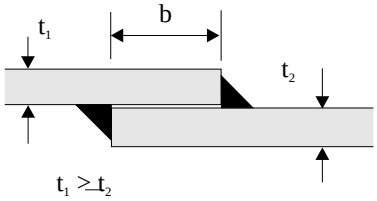
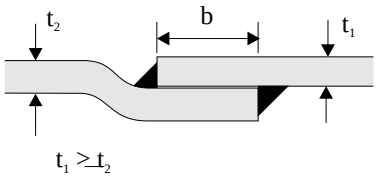
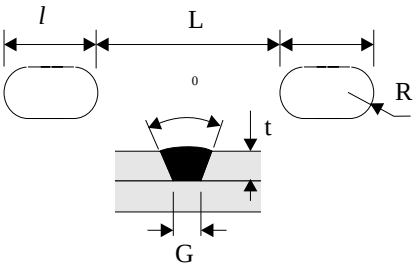
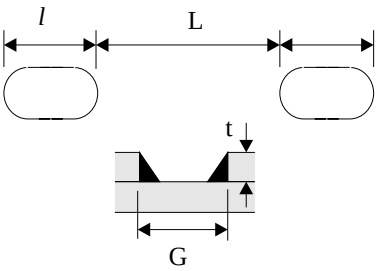
<table>
<tr><th>Detail</th><th>Standard</th><th>Limit</th><th>Remarks</th></tr>
<tr><td>Fillet weld in lap joint
 
</td><td>b = 2t2 + 25</td><td></td><td rowspan="2">location of lap joint to be approved by the Classification Society</td></tr>
<tr><td>Fillet weld in joggled lap joint
 
</td><td>b ≥ 2t2 + 25 mm</td><td></td></tr>
<tr><td>Plug welding
 
</td><td colspan="2"><table><tr><th></th><th>t ≤ 12 mm</th><th>12 < t ≤ 25 mm</th></tr><tr><td>l</td><td>60 mm</td><td>80 mm</td></tr><tr><td>R</td><td>6 mm</td><td>0.5t mm</td></tr><tr><td></td><td>40°-50°</td><td>30°</td></tr><tr><td>G</td><td>12mm</td><td>t mm</td></tr><tr><td>L</td><td colspan="2">> 2l</td></tr></table></td><td></td></tr>
<tr><td>Slot welding
 
</td><td colspan="2"><table><tr><th></th><th>t ≤ 12 mm</th><th>t > 12mm</th></tr><tr><td>G</td><td>20 mm</td><td>2t</td></tr><tr><td>l</td><td>80 mm</td><td>100 mm</td></tr><tr><td>L</td><td colspan="2">2l - 3l max. 250 mm</td></tr></table></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

TABLE 8.7 - DISTANCE BETWEEN WELDS

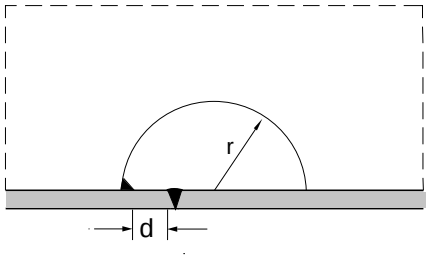
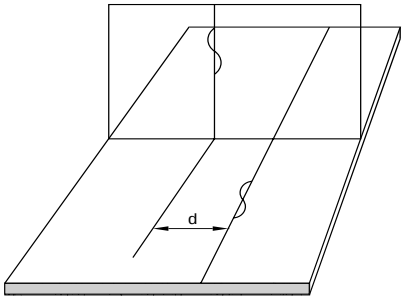
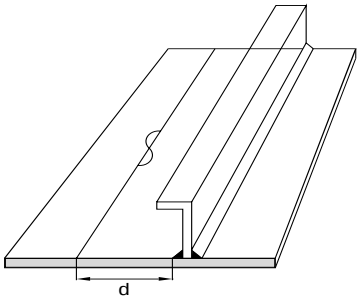
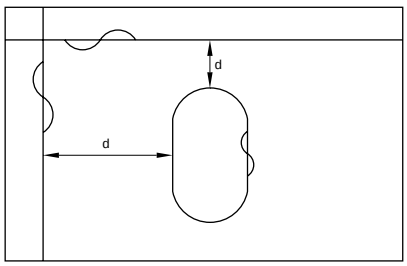
Detail	Standard	Limit	Remarks
Scallops over weld seams 	for r ≥ 30 mm d ≥ 5 mm		The “d” is to be measured from the toe of the fillet weld to the toe of the butt weld.
Distance between two butt welds 	d ≥ 0 mm		
Distance between butt weld and fillet weld 	d ≥ 10 mm		
Distance between butt welds 	for cut-outs d ≥ 30 mm		
	for margin plates d ≥ 300 mm	150 mm	

TABLE 8.8 - AUTOMATIC ARC WELDING

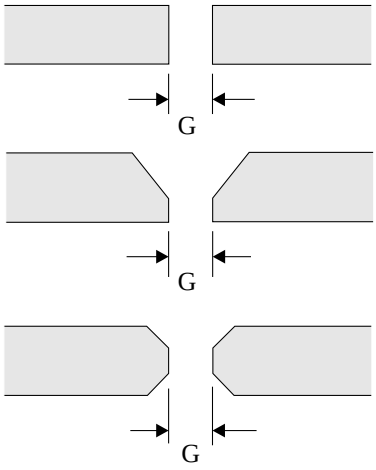
Detail	Standard	Limit	Remarks
Submerged Arc Welding (SAW) 	0 ≤ G ≤ 0.8 mm	G ≤ 5 mm	Edge preparation as per Tables 8.1 and 8.2 SAW may follow WPS approved by the Classification Society see Note 1

TABLE 9.1 - TYPICAL MISALIGNMENT REPAIR

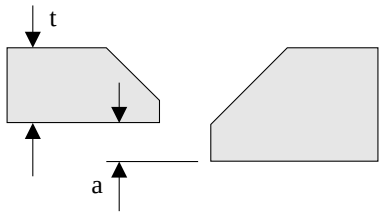
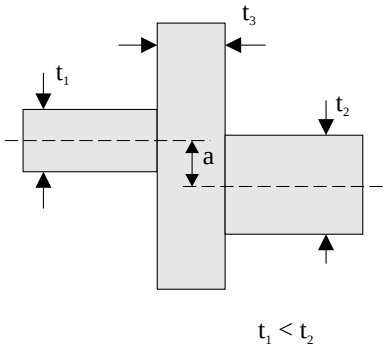
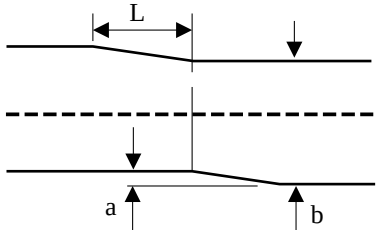
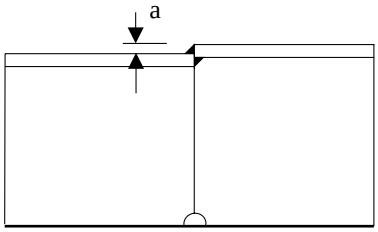
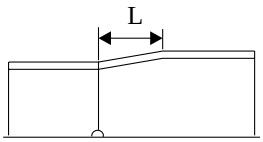
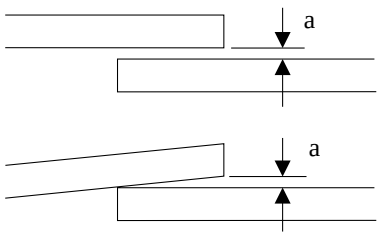
Detail	Repair standard	Remarks
Alignment of butt joints 	Strength members $a > 0.15t_1$ or $a > 3$ mm release and adjust Others $a > 0.2t_1$ or $a > 3$ mm release and adjust	
Alignment of fillet welds  $t_1 < t_2$	a) strength and higher tensile steel $t_1/3 < a \leq t_1/2$ - generally increase weld throat by 10% $a > t_1/2$ - release and adjust over a minimum of 50a b) Other $a > t_1/2$ - release and adjust over a minimum of 30a	Where t_3 is less than t_1, then 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 minimum L=50a	
Alignment of height of T-bar, L-angle bar or bulb 	When 3 mm < a ≤ 6 mm building up by welding When a > 6 mm release and adjust over minimum L=50a for primary structure and L=30a elsewhere 	
Alignment of lap welds 	2 mm < a ≤ 5 mm weld leg length to be increased by the same amount as increase in gap a > 5 mm members to be re-aligned	

TABLE 9.2 - TYPICAL MISALIGNMENT REPAIR

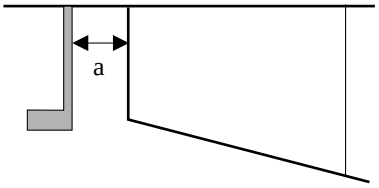
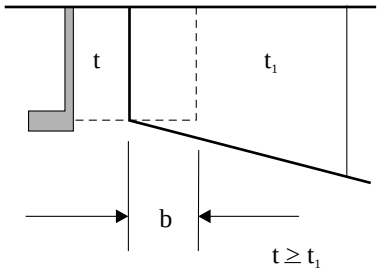
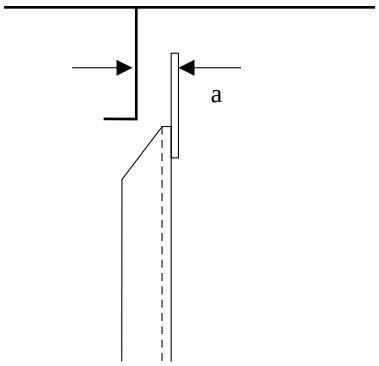
Detail	Repair standard	Remarks
Gap between bracket/intercostal and stiffener 	When 2 mm < a ≤ 5 mm weld leg length to be increased by increase in gap	
	When 5 mm < a ≤ 10 mm chamfer 30^0 - 40^0 and build up with welding	
	When a > 10 mm increase gap to 50mm and fit collar plate  b = (2t + 25) mm, min. 50 mm	
Gap between beam and frame 	a > 2 mm - release and adjust	

TABLE 9.3 - MISALIGNMENT REPAIR

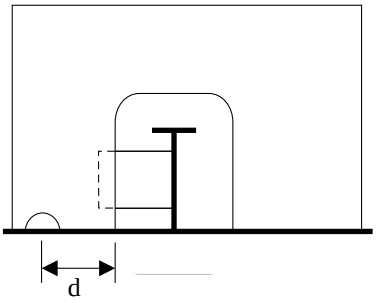
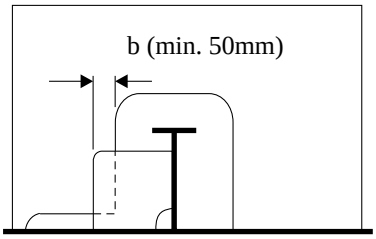
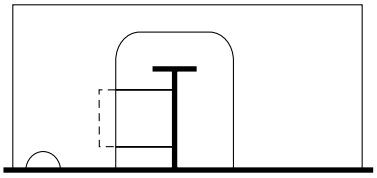
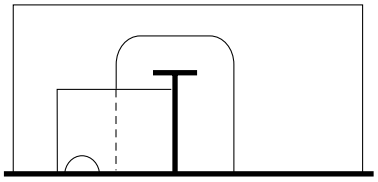
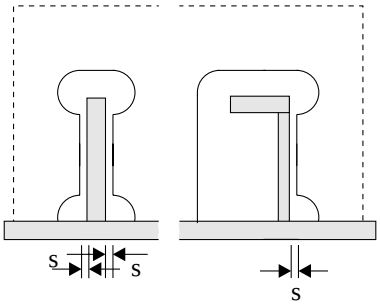
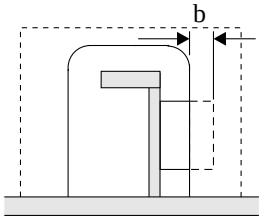
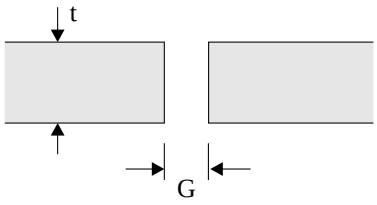
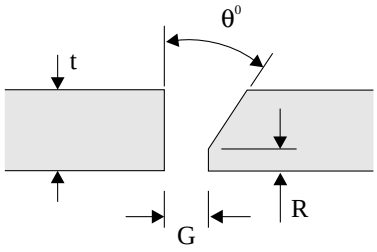
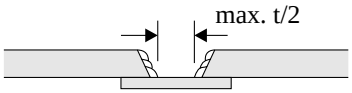
Detail	Repair standard	Remarks
Position of scallop  	When d < 75 mm, web plate to be cut between scallop and slot, and collar plate to be fitted  OR fit smal collar over scallop  OR fit collar plate over scallop 	
Gap around stiffener cut-out  	When 2 mm < s ≤ 5 mm weld leg length to be increased as much as increase in gap opening over 2 mm When 5 mm < s ≤ 10 mm nib to be chamfered and built up by welding When s > 10 mm cut off nib and fit collar plate with same height as nib  20 mm ≤ b ≤ 50 mm	

TABLE 9.4 - TYPICAL BUTT WELD PLATE EDGE PREPARATION REPAIR (MANUAL WELDING)

<table>
<tr><th>Detail</th><th>Repair standard</th><th>Remarks</th></tr>
<tr><td>Square butt
 
</td><td>When G ≤ 10 mm
chamfer to 45^0 and build up by welding
When G > 10 mm
build up with backing strip; remove, back gouge and seal weld;
or, insert plate, min. width 300 mm</td><td></td></tr>
<tr><td>Single bevel butt
 
</td><td rowspan="4">When 3 mm < G ≤ 3t/2 mm (maximum 25mm)
build up gap with welding on one or both sides of preparation, with possible use of backing strip as necessary, to maximum t/2.
where a backing strip is used, the backing strip is to be removed, the weld back gouged, and a sealing weld made
 

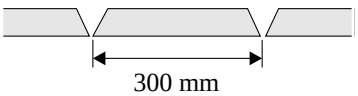
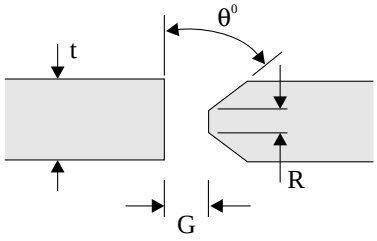
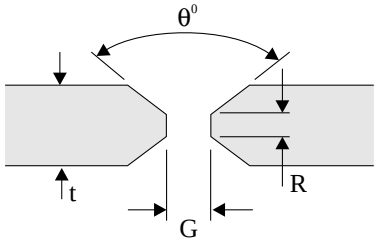
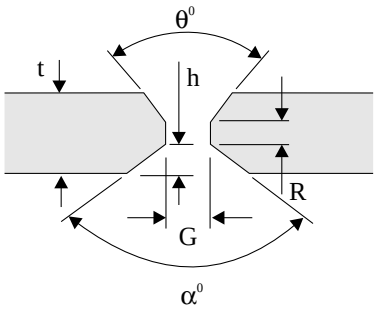
When G > 25 mm or 3t/2
an insert plate, of minimum width 300mm, to welded in place
 
</td><td rowspan="4"></td></tr>
<tr><td>Double bevel butt
 
</td></tr>
<tr><td>Double vee butt, uniform bevels
 
</td></tr>
<tr><td>Double vee butt, non-uniform bevel
 
</td></tr>
</table>

TABLE 9.5 - TYPICAL BUTT WELD PLATE EDGE PREPARATION REPAIR (MANUAL WELDING)

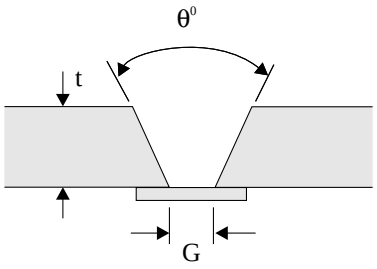
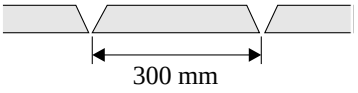
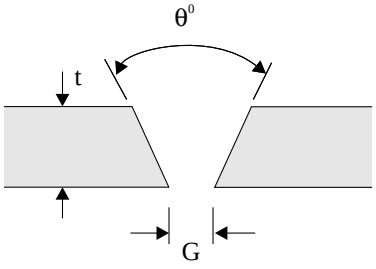
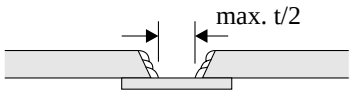
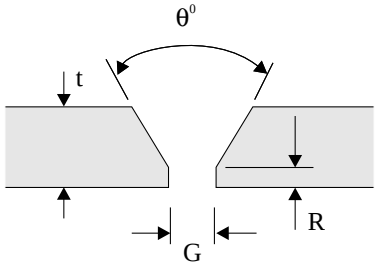
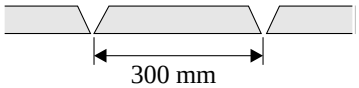
Detail	Repair Standard	Remarks
Single vee butt, one side welding with backing strip 	When G ≤ 25 mm or G ≤ t/2 build up edge preparation on one or both sides, grind edge preparation, weld with backing strip, remove backing strip, back gouge, and back weld  When G > 25 mm insert plate, min. width 300mm 	
Single vee butt, one side welding 	When 3 mm < G ≤ 3t/2 mm (maximum 25mm) build up gap with welding on one or both sides of preparation, with possible use of backing strip as necessary, to maximum t/2. Where a backing strip is used, the backing strip is to be removed, the weld back gouged, and a sealing weld made 	
Single vee butt 	When G > 25 mm or t/2 an insert plate, of minimum width 300mm, to welded in place 	

TABLE 9.6 - TYPICAL FILLET WELD PLATE EDGE PREPARATION REPAIR (MANUAL WELDING)

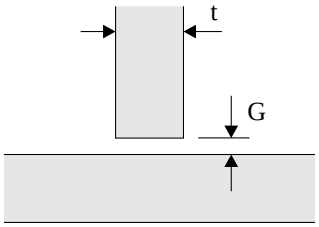
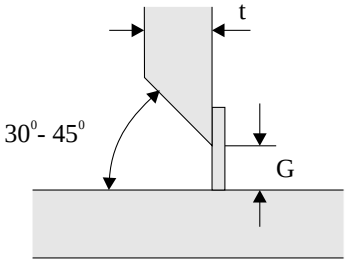
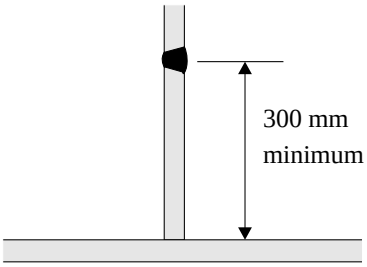
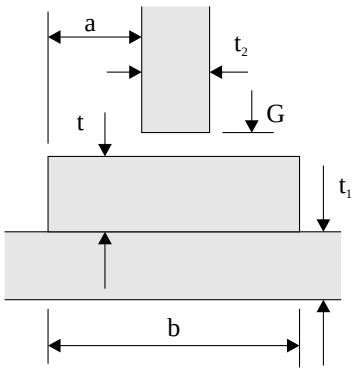
Detail	Repair standard	Remarks
Tee Fillet 	2 mm < G ≤ 5 mm - leg length increased to Rule leg + (G - 2)	
	5 mm < G ≤ 16 mm - chamfer to 30^0 to 45^0, build up with welding, on one side, with or without backing strip, grind and weld 	
	G > 16 mm or G > 1.5t - new plate to be inserted (min. 300mm) 	
Liner treatment 	$t_2 \le t \le t_1$ G ≤ 2 mm a = 5 mm + fillet leg length	Not to be used in cargo area or areas of tensile stress perpendicular to liner

TABLE 9.7 - TYPICAL FILLET WELD PLATE EDGE PREPARATION REPAIR (MANUAL WELDING)

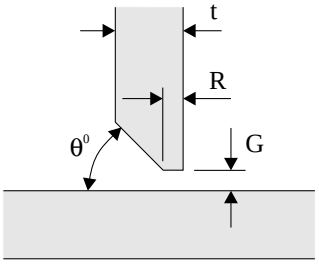
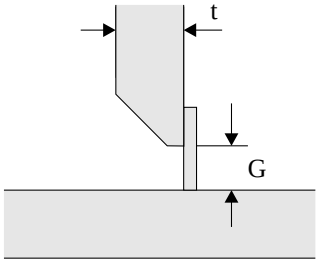
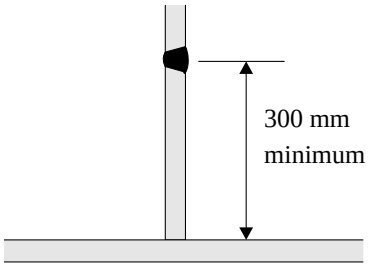
Detail	Repair standard	Remarks
Single bevel tee 	3 mm < G ≤ 5 mm build up weld	
	5 mm < G ≤ 16 mm - build up with welding, with or without backing strip, remove backing strip if used, back gouge and back weld 	
	G > 16 mm - new plate to be inserted of minimum width 300mm 	

TABLE 9.8 -TYPICAL FILLET WELD PLATE EDGE PREPARATION REPAIR (MANUAL WELDING)

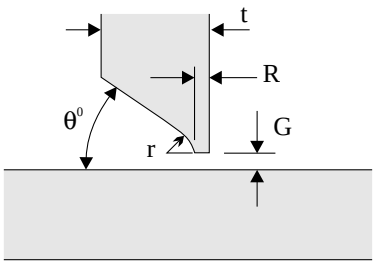
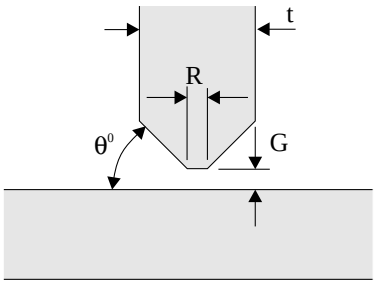
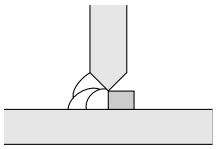
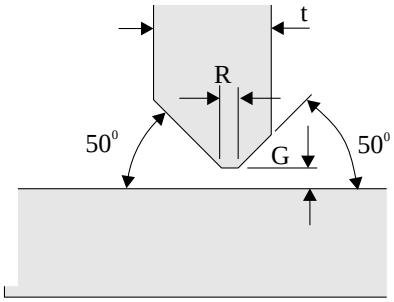
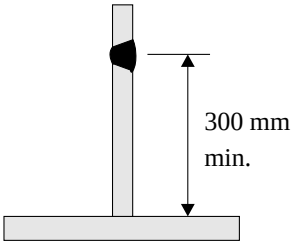
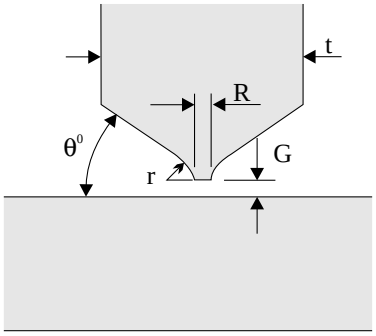
Detail	Repair standard	Remarks
Single 'J' tee 	as single bevel tee	
Double bevel tee symmetrical 	When 3 mm < G ≤ 16 mm build up with welding using ceramic or other approved backing bar, remove, back gouge and back weld 	
Double bevel tee assymetrical 	When G > 16 mm - insert plate of minimum height 300mm to be fitted 	
Double J bevel symmetrical 		

TABLE 9.9 - TYPICALFILLET AND BUTT WELD PROFILE REPAIR (MANUAL WELDING)

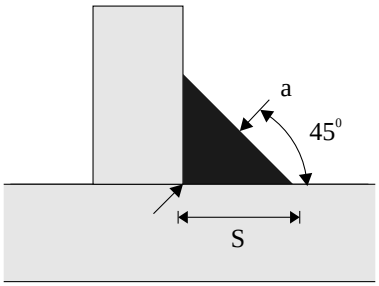
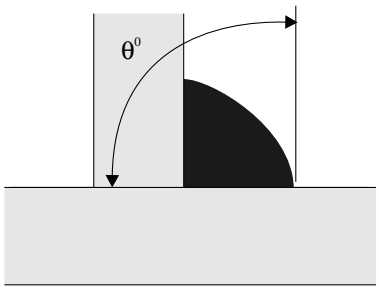
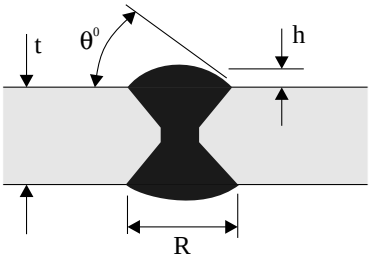
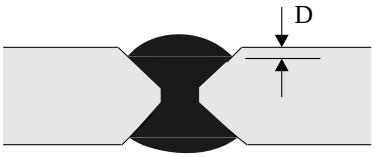
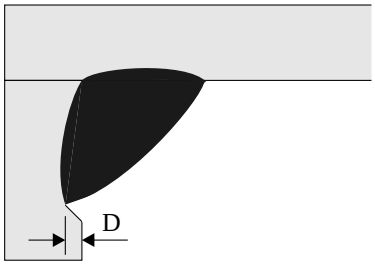
Detail	Repair standard	Remarks
Fillet weld leg length 	Increase leg or throat by welding over	
Fillet weld toe angle 	$\theta > 90^0$ grinding, and welding, where necessary, to make $\theta < 90^0$	Short beads, less than 50 mm, to be avoided in higher tensile steel
Butt weld toe angle 	$\theta > 90^0$ grinding, and welding, where necessary, to make $\theta < 90^0$	Microgrooves of ground edge to be parallel to main stress direction
Butt weld undercut 	Where $0.5 < D \leq 1$ mm undercut to be ground smooth (localised only) Where $D > 1$ mm undercut to be filled by welding	
Fillet weld undercut 		

TABLE 9.10 - DISTANCE BETWEEN WELDS REPAIR

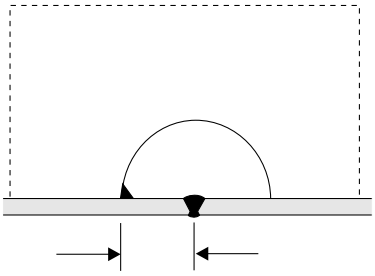
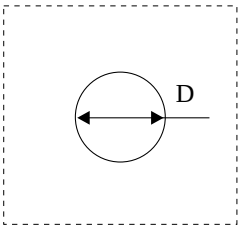
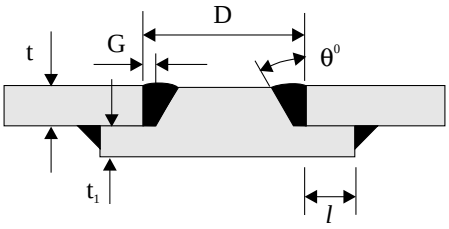
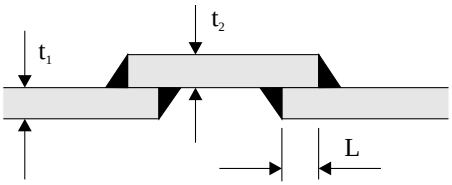
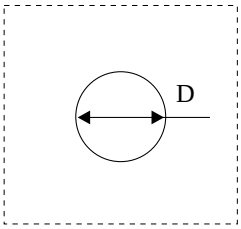
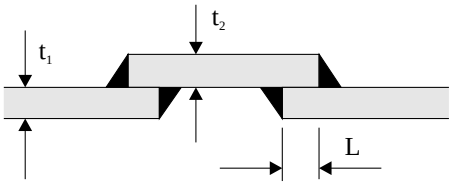
Detail	Repair standard	Remarks
Scallops over weld seams 	Hole to be cut and ground smooth to obtain distance	

TABLE 9.11 - ERRONEOUS HOLE REPAIR

<table>
<tr><th>Detail</th><th>Repair standard</th><th>Remarks</th></tr>
<tr><td rowspan="2">Holes made erroneously D < 200 mm
 
</td><td>Strength members
open hole to minimum 75 mm dia.,
fit and weld spigot piece
 

θ = 30⁰ - 40⁰
G = 4 - 6 mm
1/2 t ≺ t1 ≺ t
l = 50 mm
OR
open hole to over 300 mm and fit
insert plate</td><td rowspan="2">Fillet weld to be made
after butt weld

The fiting of spigot pieces
in areas of high stress
concentration or fatigue
is to be approved by the
Classification Society</td></tr>
<tr><td>Other members
open hole to over 300 mm and fit
insert plate
OR fit lap plate
 

t1 = t2 L = 50 mm, min</td></tr>
<tr><td rowspan="2">Holes made erroneously D > 200 mm
 
</td><td>Strength members
open hole to over 300 mm and fit
insert plate</td><td rowspan="2"></td></tr>
<tr><td>Other members
open hole to over 300 mm and fit
insert plate
OR fit lap plate
 

t1 = t2 L = 50 mm, min</td></tr>
</table>

TABLE 9.12 - REPAIR BY INSERT PLATE

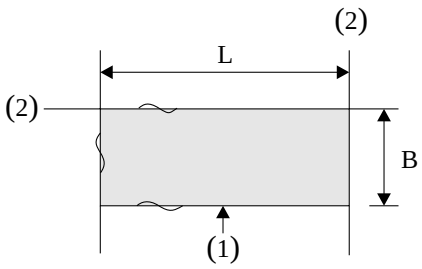
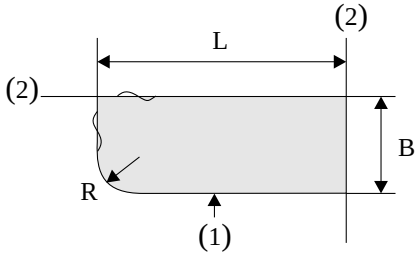
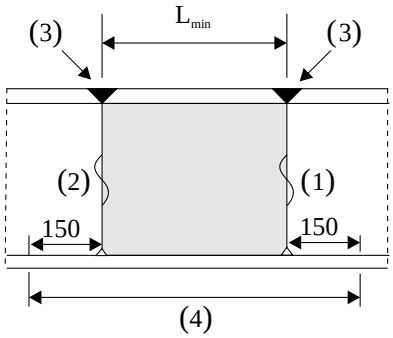
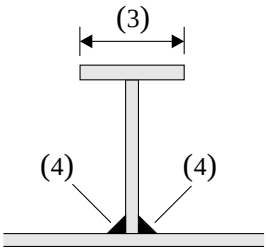
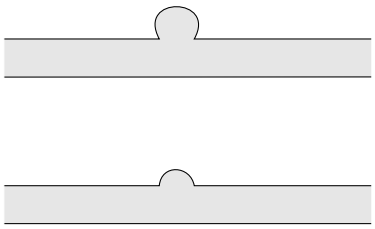
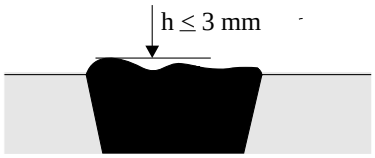
Detail	Repair standard	Remarks
Repair by insert plate   	L = 300 mm minimum B = 300 mm minimum R = 5t mm 100 mm minimum (1) seam with insert piece is to be welded first (2) original seam is to be released and welded over for a minimum of 100 mm	
Repair of built section by insert plate   	$L_{min} \geq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

TABLE 9.13 - WELD SURFACE REPAIR

Detail	Repair standard	Remarks
Weld spatter 	1. Remove spatter observed before blasting with scraper or chipping hammer, etc. 2. For spatter observed after blasting: a) Remove with a chipping hammer, scraper, etc. b) For spatter not easily removed with a chipping hammer, scraper, etc., grind the sharp angle of spatter to make it obtuse	In principal, no grinding is applied to weld surface
Irregularity of manual weld 	When the surface irregularity exceeds 3mm, apply grinding until the irregularity becomes less than 3mm	This repair standard is applicable to fillet welds also
Arc strike	Remove the hardened zone by grinding	