




R&D CENTER
BEML LIMITED
BANGALORE

DRCA No.	3RS-DM/CB/M/B102/A1
DOC. No.	GR/TD/3896
DATE	15.12.2017
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WELDING SPECIFICATION

REFERENCE ONLY


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1. GENERAL

1.1. Introduction

This specification defines the minimum requirements applicable for welding of stainless steel and mild steel. This specification is formulated to cover all joints associated with the product. The parts of the carbody structure are joined mainly by welding. **MIG, MAG, TIG**, and **resistance (spot)** welding processes are adopted.

The **MIG** process is used to join the following parts:

- Component parts of under frame/carbody bolster and Center sill of under frame.
- Center sill and End sill of under frame
- Cross beam of each end block.
- Underframe/carbody bolster and side sill of under frame
- Side post and Side Cantrails
- Between Roof frames
- Between End frames
- Etc [Equipment Mounting brackets].

The **MAG** process is used to join the following parts:

- Bogie frame structure


The **TIG** process is used to join the following parts:

- Between Roof panels.
- Side panel and Side frame

The **resistance / spot** welding process is used to join the following parts;

- Cross beam and Side sill of under frame
- Side sill of under frame and Side panel
- Between Side posts
- Side frame and Side panel
- Roof panel and Roof frame
- Rain gutter and Side panel
- Between Roof frames
- Between End frames
- Between Roof panels
- Between Keystone plates in under frame, etc

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1.2. Purpose

The purpose of this document is to guide about welding of carbody structure including the carbody equipment-mounting bracket.

1.3. Definitions

Definitions given in **ISO 2553** and **ISO 4063** will be applied together with other connected specifications.

Welding symbols will be as shown in **ISO 2553** Symbolic representation of welds.

Welding processes applied will be as per **ISO 4063**.

Special conditions will be fully explained by adding notes or details.

If necessary, full and complete information regarding welding technique, process etc. will be clearly shown on the drawing.

Any special requirements will be noted on the drawings or in the specifications.

1.3.1. Manufacturer

Manufacturer of parts to the project refers normally to one specific manufacturing unit within the company. A manufacturing unit on another site or place may be considered as a separate manufacturing unit. The quality control of manufacturing parts of sub-contracts will be done in accordance with BEML quality procedure.


1.3.2. Manual Welder

A person who performs the welding and who manipulates the electrode holder, welding gun or operates welding equipment with partly mechanized relative movement between the electrode holder, welding gun and the work-piece.

1.3.3. Welding Operator

Operator for fully mechanized and fully automatic welding processes.

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2. WELDING MATERIAL

REFERENCE ONLY

2.1. Preparation of Base Metal

Surfaces and edges to be welded will be smooth, uniform and free from fins, tears, cracks and other discontinuities which would adversely affect the quality or strength of the weld.

Surfaces to be welded and surfaces adjacent to a weld will also be free from loose or thick scale, slag, rust, moisture, grease and other foreign material that would prevent proper welding or produce objectionable fumes.

The inner surfaces of closed sections of under frame/carbody bolster and lifting pad, before covering with top plate, will be primer coated.

2.1.1. Edge Preparation and Fitting

If preparation or cutting of the material is necessary, it will be done by laser cutting, shearing, chipping, grinding, machining, plasma cutting, gas cutting and carbon arc gouging.

In cases where the edge preparation is performed with any other method than grinding or machining, the cut surface will be ground in order to remove oxide scale, rust, etc.

All surfaces and edges, that are going to be welded, will be even and free from cracks, spatter, oxide scale and other defects, that may have influence on the quality or the

strength of the weld.

The groove or the edge and the surrounding material will be clean and free from moisture, oil, fat, oxide scale, etc. or primer.

Grinding of the welded-on layer will be performed in order to ensure a smooth and even edge.

2.2. Base Metal

2.2.1. The base metal of Stainless Steel

The stainless steel used as base metal for Car body will be in accordance with specification mentioned in **Table 1**.


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Table 1: The Stainless steel Base Metal

SL No.	Description	JIS	
		Material	Standard
1.	Cold Rolled Stainless Steel Plates and Sheets	SUS 301L -LT	JIS G 4305:2012 / Amendment 1:2015.
		SUS 301L -DLT	
		SUS 301L -ST	
		SUS 301L -HT	
		SUS 304L	
2		AISI 304L	

2.2.2. The base metal of Mild Steel

The mild steel used as base metal for Car body and Bogie will be in accordance with specification mentioned in **Table 2**.

Table 2: The Mild steel Base metal

SL. No.	Description	JIS	
		Material	Standard
1	Hot-Rolled Atmospheric Corrosion Resisting Steels for Welded Structure	SMA 490 BW	JIS G 3114:2016

The **SMA 490 BW** is used for the bogie frame and the following parts of the Underframe:

- Pad and bracket of jacking
- Center sill assembly
- Underframe/carbody bolster Assembly
- Bracket of leveling valve
- Tapping pad for center pivot of Underframe/carbody bolster
- Bracket for Anti-roll bar of Underframe/carbody bolster

3. WELDING PROCESS


REFERENCE ONLY

3.1. General Requirements

Welding standards will be as per EN, DIN or European Railways Authorities standards / Equivalent applicable for rolling stock manufacturing as per ERTS 18.9.

3.2. Welding Consumable

All welding consumables (Electrodes, Filler Rods, Wires, and Shielding Gases etc.) will conform to relevant specifications.

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Consumables will be stored, dried and used in accordance with the manufacturer's instructions.

3.2.1. Filler Metal Requirements

The Filler metal for welding will be selected considering the requirements of the product, regarding the mechanical characteristics of the parent material with the lowest demands of yield stress and impact strength as well as taking into consideration the welding position, weld appearance and welding method.

The filler metal will be kept clean, free from oil, fat, dirt, rust and other pollution. Unidentified, damaged or rusty filler metals will be removed from the manufacturing premises.

The qualification tests for the welding rod will be as per the respective welding rod specification standards.

REFERENCE ONLY

3.2.2. Filler Metal for Stainless Steel

The filler metal for stainless steel to be applied in this specification is shown in the **Table 3**, **Table 4** and **Table 5**.

Table 3: The Filler Metal for Stainless Steel

Item	Standard	Equivalent	Description	Remarks
Welding Rod	AWS A5.4-06	JIS Z 3221	Stainless Steel Covered Electrodes	SMAW
Welding Wire	AWS A5.9M-2012	JIS Z 3324	Stainless Steel Welding Rods & Wires	MIG W/D
Electrodes	AWS A5.12-2009	JIS Z 3233	Tungsten Electrodes for TIG Arc welding	TIG W/D
Spot Welding Electrodes	JIS Z 3234-1999	-	Copper Alloys for Resistance Welding Electrode	SPOT W/D
Welding Gas	IS 309-1992 IS 5760 -1998	JIS K 1101 JIS K 1105	Oxygen Argon	TIG & MIG W/D

Table 4: Application of Covered Arc Electrodes

Base Metal	Base Metal			Standard	Equivalent
	SUS 304L	SUS 301L	MILD STEEL		
SUS 304L	E308 or E308L	E308 or E308L	E309	AWS A5.4 -06	JIS Z 3221
SUS 301L	-	E308L	E309		


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Table 5: Application of Wire Electrodes

Base Metal	Base Metal			Standard	Equivalent
	SUS 304L	SUS 301L	MILD STEEL		
SUS 304L	ER306 or ER308L	ER308 or ER308L	ER309	AWS A5.9-2012	JIS Z 3321
SUS 301L	-	ER308L	ER309		

3.2.3. The Filler Metal of mild Steel

The filler metals of mild steel to be applied in this specification are shown in the Table 6.

Table 6: The filler metal to be applied


Item	Standard	Equivalent	Description	Remarks
Welding Rod	AWS A5.1 E7016	JIS Z 3211	Covered Electrodes for Mild Steel.	
	AWS A5.1 E7018	JIS Z 3212	Covered Electrodes for high strength steel.	
	AWS A5.5	JIS Z 3214	Covered Electrodes for Atmospheric Corrosion resisting steel.	
	AWS A5.18	JIS Z 3312	Solid wires for MAG welding of mild steel and high strength steel.	
	AWS A5.20	JIS Z 3313	Arc welding flux cored wires for mild steel & high strength steel.	
	AWS A5.28	JIS Z 3315	Solid wires for CO2 gas shield arc welding of atmospheric corrosion resisting steel.	
Welding Flux			Decide as per welding wire & base	
Welding Gas	IS: 309-1992	JIS K 1101	Oxygen	
	IS: 5760 -1998	JIS K 1105	Argon	
	IS: 307-1966	JIS K 1106	Liquid Carbon Dioxide	

3.3. Welding Process Control

REFERENCE ONLY

3.3.1. General

Welding will be under the control of a suitable experienced and qualified welding engineer. Where subcontract undertakes welding, the firm will deploy only certified welders for welding and submit the certificates of welders to BEML.

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3.3.1.1 Protection from the weather:

Surfaces to be welded will be dry.

In any case, no welding will be carried out on parent metal below 0° C.

3.3.1.2 Pre-Heat Temperature:

The preheating temperature is the temperature of the parent metal immediately before welding commences.

The welding is carried out inside the factory. It will not have any outdoor welding.

With the exception of tack welding and the allowed procedures, the heating should be performed along the whole groove, that is to be welded (in order to avoid deformation of certain parts it might be advisable to use multi-stage welding) and to be maintained until the whole joint is welded.

When gas heating is used, it is convenient to measure the temperature on the opposite side of the edge than that which is pre-heated

3.3.1.3 Grinding of Plate Edge

The exposed edge of the welded joint (termination) and the adjacent parent material will be dressed smooth by machining or grinding. The marks produced by machining or grinding will lie parallel to the plate surface.

REFERENCE ONLY

3.3.2. Butt Welded Joints

The details of all butt welds, form of joints, angle between fusion faces and gap between parts will be arranged to permit the use of a satisfactory welding procedure and the combination of weld detail and welding procedure will be such that the resultant joint will comply with the requirements of the design.

Where there is access, the reverse side of the joint will be back-gouged to sound weld metal and sealing run deposited. Back gouging into sound weld metal may require confirmation by the appropriate NDT (Non-Destructive Test) method.

Where the access to the reverse side of the joint does not allow back gouging but access for welding, then sealing run will be deposited.

The shape and dimension of the butt welded joint in manual Arc welding will be as shown in **Table 7.**



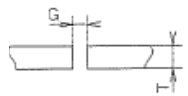

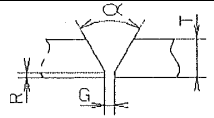

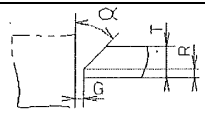
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Table 7: The shape and dimension of the butt-welding in manual Arc Welding

Weld Type	Symbol	Base Metal Thickness T (mm)	Intersection angle α (°)	Root gap G (mm)	Root Face R (mm)	Figure
I Type		≤ 12	-	≤ 2	-	
		> 12		≤ 3		
V Type		≤ 12	60	≤ 2	2	
		> 12	60	≤ 3	2	
Type (Bevel Weld)		≤ 12	45	≤ 2	1	
		> 12	45	≤ 3	2	

3.3.3. Fillet Welded Joints

REFERENCE ONLY

The effective area will be the effective weld length multiplied by the effective throat.

Stress in a fillet welds will be considered as applied to this effective area for any direction of applied load.

The effective length of a fillet weld will be the overall length of the full-size fillet, including end returns. No reduction in effective length will be made for either the start or crater of the weld if the weld is full size throughout its length.

The minimum effective length of a fillet weld will be at least four times the nominal size or the size of the weld will be considered not to exceed one-fourth its effective length.

When the butt welding is carried out together with fillet welding, the joint condition should follow the butt welding.

In case of welding a different thickness of base metal, it should be based on the thinner part.

The detail of partial joint of penetration fillet weld will be as shown in **Table 8**.



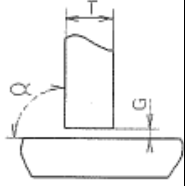

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Table 8: The detail of partial joint penetration fillet weld

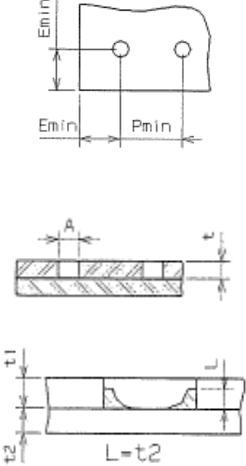
Weld Type	Symbol	Base Metal Thickness T (mm)	Intersection angle α (°)	Root Gap G (mm)	Root Face R (mm)	Figure
Single Side		3 ~ 6	60 ~ 120	2 below	-	
Double Side		5 ~ 12				

3.3.4. Plug Welded Joints

REFERENCE ONLY


The depth of filling of plug welds will be equal to the thickness of the base material.
The size of plug weld will be as shown in **Table 9**.

Table 9: The size of recommended plug weld (JIS E 4049-1990)

Base metal thickness t (mm)	Hole size A (mm)	Edge to hole center distance E min. (mm)	Min. pitch P min. (mm)	Figure
1.0	8.0*	9.5	22	
1.2	9.5*	12.5	25	
1.5	11*	16	28	
2.0	14*	19	35	
2.5	16*	22	41	
3.0	19 ~ 22 †	25	51	
3.5	20 ~ 24 †	27	58	
4.0	21 ~ 25 †	28	64	
4.5	22 ~ 32 †	30	73	
5.0	22 ~ 32 †	32	82	
6.0	22 ~ 32 †	32	82	

* - The depth of filling of plug welds will be equal to the thickness (T) of the base material.

† - If the type of plug welds is fillet weld, the size will exceed the thickness of the thinner part.

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3.3.5. Allowable stress Arc Welded Joints

The allowable stress in Arc welded joints will be as shown in **Table 10**.

Table 10: The allowable stress of Arc welded joints (JIS E 4049-1990)

Welded Joints	Allowable Stress
Groove welded Joints	Allowable stress of base metal to be welded
Other than groove welded joints	Allowable shear stress of base metal to be welded

3.3.6. The Allowable Stress of Base Metal

The allowable stress of base metal will be as shown in the **Table 11**.

Table 11: The Allowable Stress of Base metal (JIS E 4049-1990) & (JIS G 3114-2004)


Symbol	Strength, (N/mm ²)		Remarks
	Yield Stress	Tensile Stress	
SUS301L -LT -DLT -ST -HT	215 min 345 min 410 min 685 min	550 min 690 min 760 min 930 min	JIS E 4049-1990
SUS304L	175 min	480 min	
SMA 490BW	335 ~ 365	490 ~ 610	JIS G 3114-2004

3.3.7. Spot Welded Joints

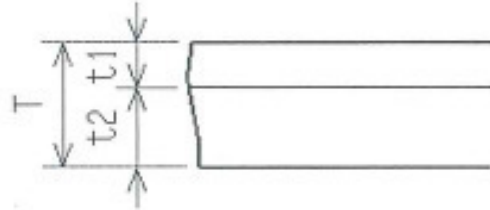
Regular inspection/monitoring of the welding parameters such as current, pressure and time will be performed. All measuring instruments used for such checks will form part of a recognized calibration system.

The detail of spot welded joint will be as shown in **Table 12**.

REFERENCE ONLY

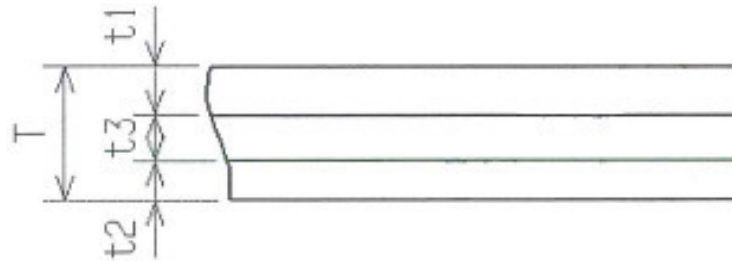
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- In case of 2 sheets spot welding:



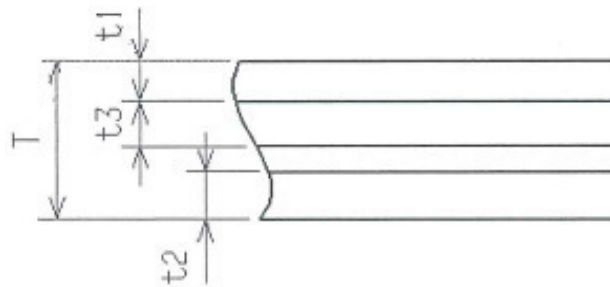
Here, $T \leq 5t_1$ ($t_1 < t_2$)

- In case of 3~4 sheets spot welding




$\leq 3t_1$ ($t_1 < t_2 < t_3$)

Here, t_3



Here, $t_3 \geq 1/2 \times t_1$ ($t_3 < t_1 < t_2$)

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3.3.8. Allowable stress in Spot Welded Joints

The allowable stress in spot welded joints will be as shown in *Table 13*.

Table 13: The allowable load of Spot welded joints (JIS E 4049-1990)

Thickness (mm)	Base Metal		
	SUS 304L (Units N)	SUS 301L, (Units N)	
		DLT, ST	HT
0.4	540	735	930
0.5	735	1030	1325
0.6	980	1325	1665
0.8	1420	1960	2500
1.0	1960	2695	3435
1.2	2550	3180	4415
1.5	3480	4755	6030
2.0	5200	7110	9070
2.5	7060	9710	12355
3.0	9120	12555	15985
3.5	11825	15595	19810
4.0	13680	18780	23930
4.5	16130	22165	28195
5.0	18680	25695	32655

NOTE

- When the thicknesses for 2 plates to be welded differ, the thinner one will represent the plate thickness. In case where 3 or more plates are subjected to welding, the thinner of the outside two plates will represent the plate thickness.
- In the case of combination of different kinds of base metals or different temper rolled materials, the lower value among their allowable tensile/ compression shear stresses will be adopted.


REFERENCE ONLY

3.3.9. Shielded Metal Arc Welding (SMAW)

Technique for shield metal Arc welding will be in accordance with latest edition of AWS (Equivalent JIS standard - Z3211) recommended practice for manual Arc welding.

The shield metal Arc welding is not applied in normal condition.

This welding will be applied repair and modification etc in the area of not to supply the welding gas.

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3.3.10. CO₂ Arc Welding

Technique for CO₂ Arc welding will be in accordance with the latest edition of AWS (Equivalent JIS standard - Z3312) recommended practice for semi-automatic Arc welding. CO₂ Arc welding will not be used for stainless steel, but only for mild steel.

4. WELDING PROCEDURES

REFERENCE ONLY

4.1. Welding Procedure Specification (WPS)

Welding procedure specifications will be formulated to cover all joints associated with the product.

Welding must be performed according to an approved and qualified welding procedure. The procedure must give distinct instructions how to perform the weld.

Welding procedure specifications must be present at the premises of the Manual Welders.

The Manual Welder must follow the welding procedure specifications for the weld in question.

Where welding is carried out by sub-contract all welding procedure specifications will be submitted to the main supplier for examination and endorsement prior to the commencement of welding.

4.2. Fulfillment of Requirements


A welding procedure is approved if imperfections in the test specimen are within stated limits except for the type reinforcement of weld, convex fillet weld, throat thickness and excessive reinforcement.

Welding procedure approval must be performed under conditions that simulate the worse case conditions under which production will be performed.

The conditions under which the welding procedure approval is performed are to be approved by the Main Supplier.

The orientation of the test plates when impact strength specimens are to be cut out is to be such that the main rolling direction of the plate is parallel to the weld. The impact strength testing of the heat affected zone (HAZ) will then be performed transverse to the rolling direction (transverse test).

For specimens with a thickness of more than 40 mm and where radiographic testing is inconvenient, ultrasonic testing is to be used with two probes at different angles.

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5. WELDING WORMANSHIP

5.1. Tack Welding

Tack welds made to hold parts properly until the final welds are made.

Tack welds, which are incorporated into final weld, will be made with electrodes meeting the requirements of the final welds and will be cleaned thoroughly.

Tack welds not incorporated into final welds will be removed. except those that are required for holding the parts in position for further processes.

5.2. Weld Profiles

REFERENCE ONLY

5.2.1. The Weld Profiles of Groove welds

Groove welds will preferably be made with slight or minimum excess except as may be otherwise agreed. In case of butt and corner joints, the excess will not exceed 2 mm in height and will have gradual transition to the plane of the base metal surfaces.

See Table 14. They will be free of the discontinuities shown for butt joints in Figure 1.

Table 14. Bead width and dimensions of the butt welding.

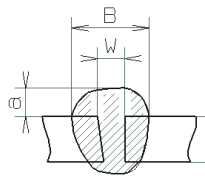
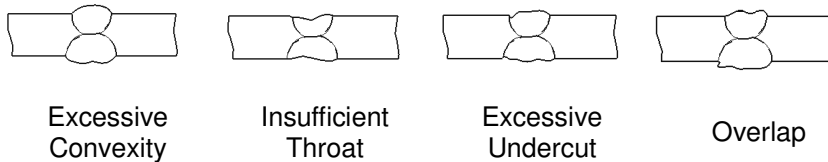

Groove	Plate Thickness	Bead (B)	Excess(a)	Shape
Without Groove	2.3 Below 3.2 4.5 6.0	5-7 6-8 7-9 8-10	≤ 2	
With Groove	Including All Plate Thickness	+2 (W+2) -0	≤ 2	

Figure 1. Unacceptable weld profiles of groove joint.



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5.2.2. The Weld Profiles of Fillet welds

The faces of fillet welds may be slightly convex, flat, or slightly concave as shown in Figure 2(A) and (B) with none of the unacceptable profiles in Figure 3.

Figure 2. Weld profiles of fillet joint.

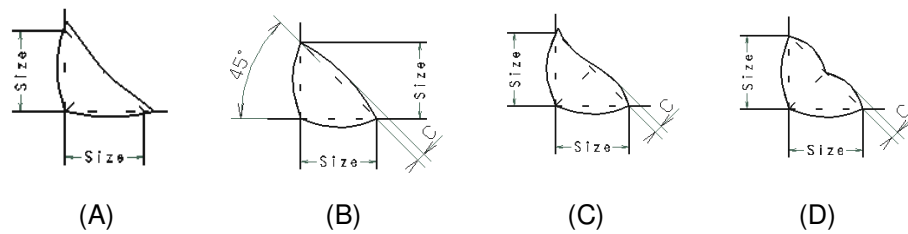
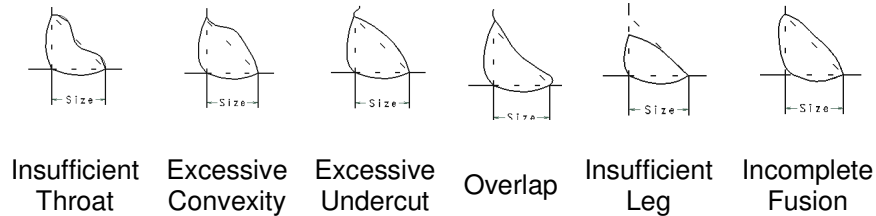


Figure 3. Unacceptable fillet weld profiles

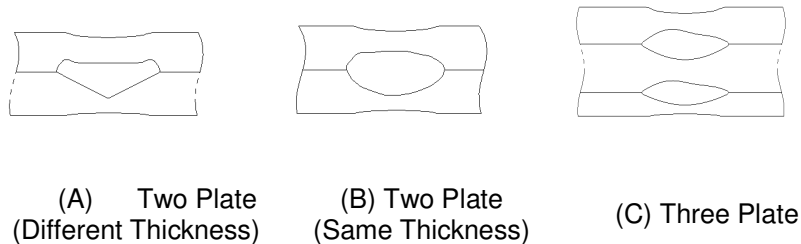
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5.2.3. The Weld Profiles of Spot welds

The faces of spot welds are shown in the Figure 4 (A) , (B) and (C).

Figure 4. Weld profiles of spot weld joint.



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5.3. Repairs

5.3.1. General Requirements

The removal of weld metal or portions of the base metal may be done by machining, grinding, chipping or air carbon arc gouging. It will be done in such a manner that the remaining weld metal or base metal is not nicked or undercut.

Unacceptable portions of the weld will be removed without substantial removal of the base metal.

Additional weld metal to compensate for any deficiency in size will be deposited using an electrode preferably smaller than that used for making the original welds.

The surfaces will be cleaned thoroughly before welding.

These procedures are to contain details about methods for removal, preparation of welding area, etc. The Main Supplier may in certain circumstances demand that the repair procedure is approved according to the same routines as welding procedures for welding and testing.

5.3.2. Repair Preparation

REFERENCE ONLY

Defects that are detected and found unacceptable and which are to be repaired, will be removed by means of machining, grinding or carbon arc grooving.

After thermal cutting the repair area has to be ground free from slag and carburized material. The groove or the repair area will be even and without notches, and in addition the area will be free from oil, rust, fat and other contaminants.

The repair area is to be examined by magnet particle testing or penetrating liquid to guarantee the removal of all defects prior to repair welding.

NDT (Non-Destructive Testing) will be done after the removal of weld and after repair. NDT is to be performed by qualified operators.

5.3.3. Repair Working


The manufacturer is to do his utmost to reduce the stresses originating from the welding in the area.

All repair work is to be performed by qualified Manual Welders.

The repaired area will be checked and examined according to the requirements for the original weld.

If at a further check more defects are found, the weld must be re-examined once again.

The repair of welds will not be required more than 2 times for stainless steel and 3 times for mild steel. Then the repair job will be approved by BMRCL or BMRCL's Representative.

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The Main Supplier has to be informed in writing before further repair is performed.

Non-destructive testing (NDT) will be done after the removal of weld and after repair.

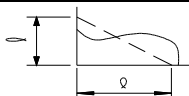
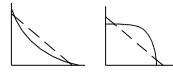
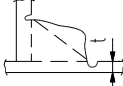


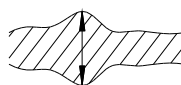
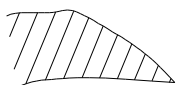
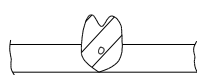
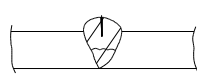
The repair work of spot welding defects is as following:


REFERENCE ONLY


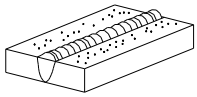
- Reinforce with Plug welding
- Reinforce with manual arc welding
- Reinforce with another spot welding

The NDT of spot welding will carry out the visual inspection. See *Table 15*.

Table 15. The extent of allowance and repair method of the flaw

Flaw	Shape	Extent of Allowance	Repair
Fillet Welding, Lack of Leg Length		Standard Scale * 30□0%	Adding Bead
Fillet Welding Bead Shape Badness		Surface Flat	Adding Bead and Grinding
Undercut		The Depth is over 0.05 to 0.5mm	Filled With Bead
Overlap		Not Permissible	Re-Welding
Roughness of Bead Surface		Allowance, $\Delta h = 2.5\text{mm}$ Below	Welding after Removing
Uneven Bead Width		Allowance, Less Than 5mm	Welding after Removing
Bead Badness		Concavity Part is not Permissible	Re-Welding
Blow-Hole Pit		Critical Welding Zone : Not Permissible etc : Dia. 1mm Below	Welding after Removing
Crack and Penetration Lack		Not Permissible	

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Built-up Height		Below 2mm	Grinding
Slag Adherence		Invisible	Completely Removing

5.3.4. Allowable Stress of the Welding after Repair Working

The allowable stress of the Arc welding after repair working will be applied in accordance with section 3.3.5.

The allowable stress of the spot welding after repair working will be applied in accordance with section 3.3.8.

5.4. Approval of Welder

REFERENCE ONLY

5.4.1. Manual Welders

The Manufacturer is responsible for the approval of all Manual Welders, including tack welders and Welding Operations according to BS EN 287-2006.

The approval test may be performed either on tubes or plates. The approval test should be on seamless tubes, since this will give the widest range of approval.

It is necessary to wait for at least 24 to 48 hours after the welding of the approval tests for the visual examination and other tests.

Manual welder, who has not passed the approval test, must be trained further before a renewed test is allowed.

5.4.2. Welding Operators

Welding Operators who only perform work with automatic welding equipment do not need to pass welder approval according to BS EN 287-2006..


The entire spot weld will be tested with reference to the welding equipment and welder (JIS Z 3140).

6. INSPECTION AND TESTING OF WELDING

6.1. Welding Inspection

The Inspection Plan will identify stages at which welding inspection will be carried out.

Inspection stages will be points in the manufacture of the product where it is considered necessary that weld inspection be carried out prior to continuing manufacture.

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All weld preparations and fit-ups will be inspected and verified prior to welding and will conform to the requirements of the welding procedure specification (WPS).

All welds will be subject to visual inspection (100%).

Details of all weld inspections will be recorded in the form of stage inspection sheets or defect report sheets.

All welding machines will be calibrated. Records will be maintained and be available for examination by The Main supplier representative or its client.

The welding inspection, checking and monitoring will be carried out by the welding inspector and engineer periodically for the welding quality, welding equipment, welding consumables, WPS, welder, weld operator and welding test.

6.2. Inspection for Spot Weld

All weld surfaces will be subject to visual inspection.

Weld surface will be free from crack.

Weld surface will be free from pit exceeding 1.5 mm in diameter.

6.3. Spot Weld Test


REFERENCE ONLY

6.3.1. Grade of Weld

Weld grade will be classified as shown in *Table 16* according to the mechanical properties and evenness of one side outer surface.

Table 16. Grade of Weld (JIS Z 3140)

Grade of weld	Mechanical properties and evenness	Remarks
Grade A	Weld requiring partial strength	
Grade B	Weld requiring strength	
Grade C	Weld other than Grade A and Grade B	
Grade AF	Weld requiring properties of Grade A together with evenness of surface	
Grade BF	Weld requiring properties of Grade B together with evenness of surface	
Grade CF	Weld requiring properties of Grade C together with evenness of surface	

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The weld grade of spot welding will be applied only A and AF.

6.3.2. Test Method and Acceptance Criteria

6.3.2.1. Appearance Test

Appearance test will be made for presence of cracks and pits on weld surface by visual examination.

- Acceptance Criteria

Crack - Weld surface will be free from crack.

Pit - Weld surface will be free from pit exceeding 1.5 mm in diameter.

6.3.2.2. Evenness Test

For Grade AF, Grade BF and Grade CF, indentation of the weld surface on the side of which evenness has been specified will be checked.

- Measuring Method for Indentation

Height difference between the point like the center of the dent and the sheet surface at a point of about dent diameter distance from the center of the dent will be measured with a dial gauge.

- Acceptance Criteria

REFERENCE ONLY

For Grade AF, Grade BF and Grade CF, the indentation on weld surface at the side of which evenness has been specified will not exceed 10% of sheet thickness of the side or 0.15 mm, whichever is greater.

6.3.3. Section & Tensile Shear Test

Test method and Acceptance Criteria will be in accordance with JIS Z 3140.


Nugget diameter and penetration will be measured by the section test method described in JIS Z 3139.

6.4. Inspection Arc Welding

We will follow ISO 5817 (2014) for the inspection of Arc welding.

6.5. Arc Welding Test

We will follow BS EN 288-3 for the Arc welding test.

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6.6. NDT (Non-Destructive Testing)


We will perform the NDT inspection according to document “Welding Inspection Specification”.

The NDT of spot welding will carry out the visual inspection.

7. Applicable Standards

REFERENCE ONLY

SL No.	ERTS Standard	Equivalent Standard	Title
1	-	ISO 2553-1992	Welded, brazed and soldered joints-symbolic representation on drawings.
2	-	ISO 4063-1998	Welding and allied processes-Nomenclature of processes and reference numbers.
3	-	ISO 5817-2014	Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections
4	DIN 6700 (1 to 6) or EN 287-1, EN 287-2 & EN 288-9	BS EN 287-2006	Approval testing of welders for fusion welding.
5	AWS/ EN 288-3	BS EN 288-3-1992	Specifications and Approval of welding procedures for metallic materials- Welding procedure tests for the arc welding of steels.
6	EN 1011-1, EN 1011-2	ISO 5817-2014	Arc/Welded joints in steel/Acceptability criteria of welds Imperfections/amendments.
7	EN 1011-1, EN 1011-2	JIS G 3114-2016	Hot-Rolled Atmospheric Corrosion Resisting Steels for welded structure.
8	-	JIS Z 3139-1978	Method of Macro Test for Section of Spot Welded Joint.
9	-	JIS Z 3140-1989	Method of Inspection for Spot Weld.
10	-	JIS Z 3141-1996	Method of Test for Seam Welded joints.
11	-	JIS Z 3234-1999	Copper Alloys for Resistance Welding Electrode.


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12	-	JIS E 4049-1990	Welded joints of Stainless Steel for railway rolling Stock-Design Method.
13	-	JIS G 4305-2012 / Amendment 1:2015	Cold-rolled stainless steel plate, sheet and strip
14	-	I.S. 309-2005	Compressed Oxygen gas - Specification.
15		I.S. 1261	Code of Practice for seam welding in mild steel
16	-	I.S.5760-1998	Argon, Compressed and liquid - Specification.
17	-	AWS A5.18-2005	Specification for Carbon steel electrodes and rods for Gas shielded Arc Welding.
18	-	AWS A5.4-2006	Specification for stainless steel electrodes for Shielded Metal Arc Welding.
19	-	AWS A5.9-2012	Specification for bare stainless steel welding electrodes and rods.
20	-	AWS A5.12-2009	Specification for Tungsten and Tungsten alloy electrodes for arc welding and cutting.
21	-	AWS D1.6-2007	Structural welding codes-Stainless Steel.

8. Abbreviations

ERTS	: Employer's Requirement Technical Specification
ISO	: International Organization for Standardization
JIS	: Japanese Industrial Standard
IS	: Indian Standard
BS	: British Standard
EN	: European Standard
MIG	: Metal Inert Gas
MAG	: Metal Active Gas
TIG	: Tungsten Inert Gas
SMAW	: Shielded Metal Arc Welding

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SUS : Steel Use Stainless
 SMA : Shape Memory Alloy
 AWS : American Welding Society
 ER : Electric Rod (Filler Material)
 W/D : Welding
 LT : Low Tensile
 DLT : Deadlite Tensile
 ST : Special Tensile
 HT : High Tensile
 NDT : Non destructive Test
 MPT : Magnetic particle Test
 LPT : Liquid Penetrate Test
 DPT :Dye Penetrate Test
 RT : Radiographic Test
 PQR : Product Quality Report
 PFDR : Pre-final Design review

REFERENCE ONLY