

# Guidelines for Maintenance of Stainless Steel Wagons



CAMTECH.M/W/SS Wagon-1.1

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**Indian Railways**  
**Centre for Advanced Maintenance Technology**  
( A Directorate of RDSO )

## GUIDELINES FOR MAINTENANCE OF STAINLESS STEEL WAGONS

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## 1.0 INTRODUCTION

Corrosion is perhaps, the single biggest challenge that needs to be surmounted, to attain increased service life of Wagons. Continuous exposure to moisture, air & high temperature, repair practices resulting in localized heating, loading/ unloading practices resulting in damages to the employed surface protection & incorrect/ inadequate surface protection are the main causes of propagation of corrosion.

An effective means of tackling corrosion, is by selecting corrosion-resistant raw material for fabrication of wagons. Such a selection, however, has, to consider, weldability, ease of fabrication, formability & availability of the chosen raw material besides the cost. Based on the above considerations, IR has introduced the use of Ferritic grade Stainless Steel (SS), to IRSM:44 specification, in BOXNHL & BCNHL wagons. Based on the experiences gained, IRSM:44, has also been introduced in rehab of BOXN wagons-BOXNR wagons.

The introduction of SS, has brought forth maintenance issues, related to cutting, welding or straightening of SS, patch repairs, attention to various types of similar and dissimilar joints between stainless steel, carbon steel and corten steel.

To understand, these maintenance issues, it is important to understand the inherent properties of SS & how it is different than the conventional MS, used hither-to in wagon fabrication.

## 2.0 STAINLESS STEEL: THE PECULIARITIES:

The chemistry of Stainless steel differs from carbon steel by the amount of chromium present. The presence of Cr, promotes the development of an invisible, adherent and self-healing chromium-rich oxide surface film. Carbon steel rusts when exposed to air and moisture. This rust, essentially an iron oxide film is active and accelerates corrosion by forming more iron oxide. Stainless steels have sufficient amount of chromium present so that a passive film of chromium oxide forms on initial oxidation, which prevents further corrosion.

The tough chromium-oxide layer, also comes into play, during the repair/ cutting of SS. In conventional carbon steels, during, oxy-cutting the metal is first heated by the flame, and then an excess of oxygen is supplied. This causes an exothermic (heat generation) reaction which generates the heat necessary to melt the oxides formed, which are then removed from the cut by the velocity of the gas jet. In this process a rough surface is produced. Where as, stainless steels having a high level of Chromium (Cr) cannot be cut by simple oxy-cutting methods due to the refractory nature (very high melting point) of the Chrome Oxide which is formed as the top layer. Ferritic stainless steels are generally limited to service temperatures below 750°F (400°C) due to the formation of embrittling phases, which may also precipitate during welding. Primary concerns with welding ferritic grades are maintaining adequate toughness and ductility in the as-welded condition.

### 3.0 MAINTENANCE OF SS WAGONS: AN OVERVIEW

RDSO has introduced SS in the newly designed BOXNHL, BOXNLW, BOXNR & BCNHL wagons.

In constructional design, BOXNHL, BOXNR and BOXNLW wagon are similar to BOXN wagon and BCNHL wagon is similar to BCNA wagon. Hence, the maintenance and Repair procedure of these wagons shall be similar to BOXN/BCNA wagons. The procedure for attending to repairs in BOXN & BCNA is given in the Maintenance manual for Wagons Issued by CAMTECH.

However, since the wagon body and under frame of BOXNHL, BOXNLW, BOXNR & BCNHL wagons are made of higher grade steel i.e. IRSM-44 /IRS M-41 steel/CRF sections, the cutting, straightening, welding / repairing procedures are slightly different than plain carbon steel wagons.

Before elaborating on repair details, **it is important to understand that the SS wagon structural members, body panels & other components that form part of the wagon structure, when corroded/damaged, should necessarily be repaired or replaced with similar grade of steel only.**

### 4.0 FACILITIES REQUIRED FOR MAINTENANCE OF STAINLESS STEEL WAGONS:-

Reiterated below, for guidance, are recommended facilities (by CAMTECH) for effective maintenance of SS wagons:

S.No.	Item/Description	Freight Yard (maintaining 3 rakes/day)	Sick line (5 wagon/day)	ROH Depot./ POH workshops (200 wagons/month)
1.	MIG/MAG Welding sets (400 Amp.)	02 Nos.	02 Nos.	03 Nos.
2.	DC Arc Welding Rectifier (600 Amp.)	02 Nos.	02 Nos.	03 Nos.
3.	Portable Air plasma cutting machine (Max. capacity 16 mm)	02 Nos.	02 Nos.	03 Nos.
4.	Consumables for Air Plasma M/C i.e. Torch tip, catalyst etc.	As per Requirement		

S.No.	Item/Description	Freight Yard (maintaining 3 rakes/day)	Sick line (5 wagon/day)	ROH Depot./ POH workshops (200 wagons/month)
5.	Welding electrodes For IRS M-44 to IRS M-41 etc.	As per Requirement		
6.	Lock bolts of various sizes ( 3/8" to 7/8")	As per Requirement		
7.	Lock bolting Equipment	02 sets	02 sets	03 sets.
8.	Portable grinding Machine (only dedicated grinding wheels & disc should be used.)	03	03	05
9.	Stainless steel wire brushes	As per Requirement		
10	IRS M44 & IRS M41 plates/sheets & CRF sections as per wagon design drawing.	As per Requirement		

**Note:** The class of welding electrodes for different combinations of materials shall be as per RDSO specification No. G-72 latest revision.

## 4.1 Specification / Major Parameters

### 4.1.1 Lock Bolts Installation Equipment (Make: Huck/ Avdel)

- Hydraulic Power unit, suitable for 3/8" to 7/8" Lock Bolts.  
(Huck Model HK 432 – 2 or equivalent)
- Hand held units for 3/8", 1/2", 5/8", 3/4", and 7/8" Lock bolts.
- Nose assembly suitable for Hand held units for 3/8", 1/2", 5/8", 3/4", and 7/8"
- Set of Hydraulic hoses, 10 m long (Suitable for Lock Bolts equipment)
- Spares for 2 years normal maintenance
- Set of operator / maintenance tools.

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- Commissioning & prove out of the Lock Bolts equipment at consignee's premises.
- Warranty: 24 months from the date of commissioning.

#### **4.1.2 Air Plasma Arc Cutting Machine**

- Type : Air Plasma Arc Cutting Machine
- Capacity : Stainless Steel upto 16 mm.
- Concomitant Accessories : Air Filter, Regulator, Power/ earthing cable, torch-set , 5 sets of consumable electrodes, nozzles & caps.
- Commissioning and prove-out of the machine at consignee's premises.
- Spares for 2 years normal maintenance
- Set of operator / maintenance tools.
- Commissioning & prove out of the Air Plasma Arc Cutting Machine at consignee's premises.
- Warranty: 24 months from the date of commissioning.

#### **4.1.3 DC Arc welding Rectifier (600 Amps)**

- Type : DC Arc welding rectifiers,  
Fully thyristorised
- Input power supply : 415 +/- 10% AC 3 phase
- Rating @ 60% duty cycle : 40 KVA.
- Open circuit voltage : 100V DC
- Welding current range : 10- 600 Amps.DC
- Max. continuous hand welding Current (100% duty cycle) : 470 Amps.
- Class of insulation : 'H'
- Winding material : Copper winding
- Type of cooling : Forced Air cooled.
- Concomitant Accessories : Power source with power cable, welding cable copper (95mm<sup>2</sup>) 10 m length, electrode holder suitable for 600A capacity, Earthing clamp
- Commissioning and prove-out of the DC Arc welding rectifiers at consignee's premises.
- Warranty: 24 months from the date of commissioning.

#### **4.1.4 Makes of Equipment**

##### **Welding Sets and consumables**

1. ESAB India Ltd.
2. L&T Limited (welding product business)
3. Miller
4. Lincoln

##### **Portable Air Plasma cutting machine**

1. L&T Limited (welding product business)
2. ESAB India Ltd.

##### **Huck/Lock Bolts Equipment**

1. Huck/Alcoa
2. Avdel

##### **Portable grinding machine**

1. Bosch
2. Hitachi
3. CP Tools Ltd.

## 5.0 MAINTENANCE ACTIVITIES IN SS WAGONS

The maintenance of wagons mainly consist of the activities of Inspection, cutting, straightening, replacement, welding and finally painting. Brief details of these activities, with particular attention to be given for SS wagons, are enumerated below:

### 5.1 Inspection of Under frame and Body

The under frame members & body should be thoroughly inspected for locating cracks, bent/damaged, corroded members. A component that warrants repair should be repaired as per the defined procedure, in the wagon maintenance manual. In case a component/ sub-assembly/ structure is found to be corroded & is judged to be beyond repair, the same should be replaced. Essentially, the repair/ replacement should be done on condition basis.

*During Inspection of wagons, special/ particular attention should be paid to the below detailed vulnerable members and locations:*

- Sole bar, side wall stanchions, and floor plates.
- Head stock, corner angle and end stanchions.
- Top copings, and corner joints.
- Door locking brackets and hinges.
- Puncturing/damages of side/end sheets.
- Centre pivots, and center sill.
- Cracks in center sill, sole bar and cross members etc.
- Breakage/Failure of lock bolts.

### 5.2 Cutting of IRSM-44:

The IRSM-44 steel panels/plates/CRF sections shall be cut either by shearing machine or by plasma cutting machine but not by oxy-cutting.

*The guidelines for cutting of IRS M-44 are subdivided into the following sections:-*

#### a. Guillotining

- i) The guillotine is normally used for cutting steel up to 16 mm thick. The maximum capacity of the guillotine (used for mild steel shearing) should be downgraded by 30-40% for cutting IRS:M44 because of IRS:M44's greater shear strength, e.g. if maximum shear capacity is 16mm(mild steel) then the maximum shearing capacity will be 11mm for IRS:M44.
- ii) "Shear breaks" on the cut edge can be prevented by using well sharpened, correctly aligned and set blades especially for plates heavier than 8mm.
- iii) Burnish and burr heights increase with increasing blade dullness and blade gap and rollover tends to be excessive. This needs to be taken note of & suitable corrective/preventive action taken.



- iv) Shear break or splitting should not be confused with laminations as the former is a result of the shearing process parameters, while the latter is a material defect. Shear break is caused by excessive cutting speeds, blade clearance etc.

***The following guillotine clearance settings are given for guidance:-***

Plate Thickness (mm)	3	6	10
Clearance Settings (mm)	0.1	0.15	0.25

- v) The most suitable shear blades for cutting IRS:M44 and stainless steel are made of high carbon-high chromium tool steel. The blades must be kept sharp- a good test is to cut a piece of paper.
- vi) Good practice is to wipe the blade and hold down pads free of adherent mild steel particles prior to cutting IRS:M44. This will avoid mild steel contamination.
- vii) Where possible, shearing speeds should be reduced by up to 20%. This will prevent shear break of thick plates.

#### **b. Plasma cutting**

Due to high chromium content of IRS:M44 it cannot be cut with the conventional oxy-acetylene torch. Portable plasma cutting equipment with inbuilt liquid tank are also available which can be used for repair work.

- i) Plasma cutting and profiling of IRS:M44 is the fastest and most economic thermal cutting method available. Fast cutting speeds together with a clean smooth surface finish can be achieved. Due to the fast cutting speeds, the heat affected zone is very narrow, minimizing the effect on the properties of the material. Thin plates can be stack-cut. Any discoloration of the cut edge can easily be removed by grinding or by using a stainless steel wire brush. If no subsequent welding is undertaken, edge discoloration must be removed, followed by passivation.

#### **ii) Cutting Gases**

At present, there are many makes of portable plasma cutting machines which are able to cut up to 16mm thick plate. These portable units make use of compressed air (300 – 500 KPa) rather than mixed plasma gases. These machines are light, (weighing not more than an oxy-acetylene set) economical and efficient. Consumable items are the torch tip and the catalyst.

For gauges in excess of 16mm, heavier mixed gas plasma cutting machines will have to be used. Oxygen – free nitrogen is the most economical cutting gas. Other gases which can be used include mixtures of argon and hydrogen or nitrogen and hydrogen. The secondary shielding gas can be one of numerous gases such as welding grade carbon dioxide which is inexpensive. Argon or argon-hydrogen mixtures are often used where a better, cleaner cut is required.

**c. Abrasive Cut – off Wheels**

Abrasive disc cutting can be used for limited lengths of cut. Only dedicated discs should be used and suitable control of the storage of these must be exercised. Use can be made of water soluble oil for cooling/lubrication.

Aluminum oxide discs of the vitrified or resinoid bonded types are suitable. Zirconia silicon carbide discs are not recommended.

**d. Arc-Air Gouging**

Arc-Air gouging is a suitable method of cutting provided the recommended settings are adhered to in order to produce acceptable cuts. All cut edges must be ground back (using dedicated grinding discs) to a depth of approximately 2mm to remove the heat affected zone before further fabrication. Areas not subsequently welded must be de-scaled and passivated.

**e. Powder Cutting**

Ferrite powder injected into an oxy-acetylene flame can be used to cut IRS:M44, but the unsightly edges produced must be ground back approximately 2-4 mm using dedicated discs before further fabrication, to ensure that the plane edge is of an acceptable quality. Areas not subsequently welded must be de-scaled and passivated.

**f. Slitting**

After cutting on conventional slitting equipment, edge must be deburred. Slitting knives should be cleaned of all mild steel or other metal contamination before IRS:M44 is processed. Close control of blade clearance will ensure good edges. Blade clearances are as for guillotine settings.

**g. Cold Sawing**

Cold sawing is suitable provided a high feed rate is maintained to produce an acceptable cut. Cutting and cooling fluids (water soluble oil type) should be used for cutting thicker gauges.

High speed wavy tooth blades are recommended with up to 13 teeth/cm for light gauge material. The number of teeth per centimeter should be reduced as the gauge increases.

**h. Blanking and Punching**

These operations can be successfully carried out provided that tools and equipment used have sufficient strength and rigidity to account for the higher proof strength of IRS:M44. Clearance between the punch and the die is normally held to 5% of the metal thickness on a side i.e. 10% overall. Punches must be kept sharp, and where possible, the speed of operation should be reduced.

## i. **Drilling**

High speed drills should be used on IRS:M44. It is advisable to have the web of the drill thinned as much as possible (up to 1/8 the drilling diameter) to eliminate excessive drilling temperatures caused by the friction generated at the bottom of the hole.

The included angle of the cutting edge should be  $\pm 120^\circ$ . The drills should be as short as possible to improve rigidity. A suitable cutting compound (sulphurized or chlorinated oil) should be used for drilling deep holes. Cooling of the drill cutting edge can be effected using a light water-soluble oil which will extend drill life. Drills should be backed out at regular intervals to relieve chip congestion.

### **5.3 Straightening of IRSM-44:**

The wagon members which are bent/deformed can be straightened up to a certain extent. It is notable that IRS:M44 requires, greater bending capacity to straighten the steel members owing to its higher yield strength. As an approximation, the maximum capacity of the bending is reduced by 40% for bending IRS:M44 compared to mild steel. Also, IRS:M44 generally exhibits greater spring back than mild steel during bending. This should, hence, be compensated for, by slight over-bending, e.g. 5% on a  $90^\circ$  bend.

Use of hydraulically/ manually operated Tie screw pulling and hammering is recommended for bending /straightening wagon members. The members which are more than 5mm thick and are distorted/bend can be heated locally upto  $150^\circ\text{C}$  and straightened by hammering/pulling. However, heating of stainless steel members beyond  $150^\circ\text{C}$  should be avoided in view of change in chemistry of steel.

If members are badly distorted/ bent and straightening is not possible, the members should be replaced with similar grade of materials, instead of attempting major repairs by heating/ straightening.

It is also recommended that in case severe bending of thicker plate sections, needs to be done, such bending operations should be carried out before welding operations, so as to avoid the possibility of heat affected zone cracking.

Edge cracks can be avoided by placing the cut face on the outside radius of the bend and the sheared face on the inside. This type of cracking can also be prevented by grinding the outside radius point of bending into a rounded profile. Thus, eliminates the natural stress concentration point.

### **5.4 Replacement**

Heavily damaged members should be replaced with similar grade of steel with new members.

## 6.0 Welding

IRS:M44 has good weldability in most applications, provided the recommended procedures are adopted. The quality and integrity of welds are crucial features of any fabrication and, when weld quality standards are demanding, it is recommended that recognized welding procedure testing be carried out and that experienced certified welders be used.

IRS:M44 is designed to have good weldability. However, it is susceptible to grain growth in the “heat – affected zone”. The extent of grain growth is minimized by virtue of IRS:M44’s chemical composition and is not critical for general engineering applications. However, it is important that correct welding techniques for IRS:M44 be followed in order to minimize the heat input which will influence the extent of grain growth. A welding procedure should be adopted which limits the heat input per pass to a maximum of 1.0 KJ/mm. In any event, the heat input should always be kept to the minimum required to achieve good weld integrity.

All welding fumes are hazardous to health. Every effort should be made to ensure that welders are not exposed to fumes. This can be achieved by having good ventilation in buildings, the use of fume extractors placed alongside welding bays and welders not bending directly over the fumes.

### a. Welding Processes

Both Manual Metal Arc (MMA) and Gas Metal Arc Welding (MIG/MAG) welding processes can be used on IRS:M44. Tungsten Inert Gas (TIG) welding is usually used to weld the thinner plate thickness e.g. 1.0 – 3.0 mm. The use of combined processes, e.g. TIG root followed by MIG/MAG filler and cap is considered as a means of improving both quality and productivity and shall preferably be employed.

The Submerged Arc Welding (SAW) process should be used with great care keeping in view the high heat input and slow cooling rate associated with the process which can cause excessive loss of toughness in the heat-affected zone.

### b. Weld repairs

The removal of weld metal or portions of the base metal may be undertaken by machining, grinding, chipping or gouging. It should be performed in such a manner that the remaining weld metal or base metal is not nicked or undercut. Unacceptable portions of the weld (e.g. weld beads) should be removed without substantial removal of the base metal. It is recommended that a smaller electrode than that used to make the original weld be used to make up for any over grinding, undercut etc. The surfaces should be cleaned thoroughly before welding. Careful attention must be exercised to avoid/ reduce distortion.

### c. Post weld cleaning

All welding processes give rise to a zone of discolouration in the weld areas. This discolouration consists of a layer of thermally-formed oxides and particles from the

protective flux. In corrosive atmospheres or environments an electro-chemical cell can be set up between this oxide layer and the underlying metal which can promote localized corrosion.

To prevent such corrosion it is necessary to remove all traces of discolouration from the weld area.

In abrasive applications the weld discolouration will be removed by wear mechanisms and post-weld cleaning may not be necessary.

In IRS:M44 which is used in contact with aqueous solutions, it is essential that post weld cleaning and passivation be undertaken, so that adequate service life can be ensured.

#### **d. Mechanical cleaning**

- i. **Wire brushing:** It is often possible to remove a substantial amount of discolouration and detritus from weld areas by vigorous brushing with stainless steel wire brushes. Brushes must not previously have been used on materials other than IRS:M44 itself.
- ii. **Grinding:** Dressing of welds and removal of discolouration can be carried out by grinding. Only dedicated grinding wheels and discs should be used. The presence of iron, iron oxides and other undesirable materials in the grinding medium will adversely affect IRS:M44's appearance and corrosion resistance.
- iii. **Flapper wheel abrasives:** These are often used for cleaning weldments, aluminium oxide abrasives being the preferred medium.
- iv. **Abrasive blast cleaning:** The abrasive should be stainless steel shot, copper slag (angrit) or alumina, free of metallic iron, iron oxides or chlorides. A surface cleanliness equivalent to Sa 2 ½ ( as per Swedish standard SIS 05 5900) is recommended.

### **6.1 QUALITY REQUIREMENTS OF WELDING –**

The following points are to be considered before and after assembly of the wagons:-

- i) Ensure that under frame is well cleaned and rust free.
- ii) Repair of under frame should be carried out as per Specification.

- iii) After repairing the under frame, its alignment, squareness and tolerances should be checked and maintained as described in Specification G-72 Rev.-3 (with Amendment no. 2 of Jan'08).
- iv) (a) Ensure that Electrodes and other consumable items used for different combinations of welded materials should be as detailed in G-72, Rev.-3 (with Amendment no. 2 of Jan'08),  
(b) Before body assembly with underframe, be sure that the sealant are provided as detailed in Specification.
- v) All the welds shall be visually inspected. Any cracks, porosity, blow holes shall be repaired.
- vi) Precautions must be taken by welder to control moisture content, where high humidity exists. The electrodes shall be taken out from the drying oven as per the requirement of work, i.e. electrodes should not be taken out for work in bulk.
- vii) All the welding operations should be carried out on manipulator/fixture to ensure good quality down hand welding.
- viii) The existing holes of rivets at head stock location should be plugged before drilling the new one for end stanchions.
- ix) Ensure that painting of under frame is carried out as explained in para 11.2 of G-72, Rev.-3 (with Amendment no. 2 of Jan'08).
- x) Ensure that brake rigging, including hand brake, and empty load device are according to RDSO drawings.
- xi) Existing hand brake wheel ( Ø610) Drg No. W/BG-6226 to be replaced with lesser dia and wheel (Ø356) as per Drg. No. W/BG-1100.
- xii) Maintain the “A” and “E” dimension in brake rigging arrangement.
- xiii) Ensure that the gap between the wheel flange to brake block is as per standard practice.
- xiv) After assembly brake rigging shall be checked as per Drawing No.- WD-80007-S-9.

**Note:** These instructions for upgraded rehabilitation from BOXN to BOXNR have been given for ready reference. For complete details, please refer to RDSO's document : Guidelines and technical requirement for upgraded rehabilitation of BOXN wagons to BOXNR (with stainless steel body), WD-14-BOXNR-2008)

## 6.2 Welding Procedure:-

The main differences between welding stainless steel and mild steel are owing to differences in properties of SS in terms of coefficient of linear expansion, thermal conductivity, ductility etc. This affects the work hardening and shock absorption properties.

For stainless steel welding various welding processes can be used such as MIG, TIG, MMAW, Resistance welding and laser welding. However, the following issues, need to be considered in case of SS repairs:

## 6.3 General Precautions in Welding of Stainless Steel

- i. Since Stainless steel has high coefficient of thermal expansion and less heat conductivity, it is advised to use low welding currents in the recommended range and smaller gauge electrode to minimize heat input and reduce distortions.
- ii. Surface to be welded must be clean, dry and free from dirt, oxide film, oil, grease, paints etc.
- iii. Electrodes should be re-dried before use.
- iv. Always maintain short arc to minimize the loss of alloying elements.
- v. Avoid weaving and make stringer beads.
- vi. After finishing welding, lift electrode slowly and fill the crater before breaking the arc. This will avoid crater cracks.
- vii. Use stainless steel wire brush for cleaning welds.
- viii. Use electrode preferably with DC (+).
- ix. Every bead should be properly cleaned before further welding on it.
- x. Welding should be preferably carried out in flat position.
- xi. Correct electrode size, recommended current, arc length, travel speed and electrode angle must be followed.
- xii. Any defect like crack, blowhole etc. must be properly gouged out and re-welded.
- xiii. Do not strike arc adjacent to the weld.
- xiv. Tack the welded area correctly to ensure proper gap.
- xv. Proper welding sequence must be followed to reduce internal stresses and hence reduce warpage of structure.
- xvi. Always weld towards the free ends.

#### 6.4 Weldability issues:

- Grain growth in the HAZ and loss of toughness.
- Reducing the heat input is critical and no preheats should be given.
- Oxides formed during welding in the weld zone do not protect it from subsequent corrosion.
- Proper protection of the weld zone from atmosphere and subsequent cleaning after welding are important.
- Stringer beads to reduce the heat input.
- Maintaining interpass temperature below certain temperature (in multipass weld).  
Also, allow weld to cool between the passes and using copper chills.

#### 6.5 Preparation prior to Welding:

The following points should be considered before welding of IRSM:44 components.

- i. The area about 15 mm from each side of the weld zone should be properly be cleaned.
- ii. The weld area should be free from dust, dirt, grease, oil, paints etc. Any non-corrosive and suitable organic solvent (Kerosene oil, Benzene etc.) can be used for removing grease, oil & paints.
- iii. Only Stainless steel wire brushes should be used to remove tenacious layer of chromium oxide for better strength of joint.
- iv. No edge preparation is required, unless specifically mentioned in the drg, when welding up to thickness 3/16" (5 mm approx.). For higher thickness between 3/16" & 1/2" (5-12mm approx.) bevel preparation is necessary.

#### 6.6 Precautions During Welding:

- i. The welding parameter in the machine should be set as per recommendations of manufacturer.
- ii. If welding is carried out by MMAW process, connect the electrode with positive terminal of welding equipment (DC+) when welding with DC.
- iii. Use 70 OCV (min) transformers while welding with AC.
- iv. Keep the welding current on lower side (as possible) of the range as recommended by the manufacturer of the consumables.



- v. Maintain as short an arc length as possible to minimise the loss of alloying elements during welding.
- vi. Put stringer beads. Weaving should not be more than two times of the diameter of electrode used.,
- vii. Use small diameter electrode according to thickness of base metal to minimise heat input& ensure minimal distortion.
- viii. Each run should be property de-slaged by using stainless steel brushes and chisels.
- ix. Preheating of job is not required.
- x. For cutting of stainless steels plasma cutting or machine cutting shall be used. Manual metal arc cutting may also be used in case when plasma arc cutting or machine facility is not available.

### 6.7 Precautions After Welding:

- i) The weld reinforcement of stainless steel welds must be grounded.
- ii) The stainless steels are susceptible to corrosion if the surface is rough. To avoid the corrosion, surface should be made smooth & polished. It is therefore, necessary to finish the stainless steel joint by grinding & subsequent polishing using fine grinder.
- iii) Post- weld cleaning should be undertaken on all weld areas (weld material and HAZ),arc strikes and points where cleats, lugs etc..have been welded.

### 6.8 Electrodes For Welding:

The welding electrodes to be used for repairs of IRSM:44 material are indicated below:

S. No	Material to be welded	Electrodes / filler wire to be used
1.	IRS M-44 to IRS M-44	<p>MMAW electrodes approved under classM1 as per IRS M-28-02 shall be used.</p> <p>MMAW electrodes of diameter 2.5 mm/4.0 mm shall be used depending upon the thickness of the plate.</p> <p>Re-dry the electrodes before use to about 150°C for atleast one hour or as recommended by manufacturers.</p> <p>MIG/MAG welding filler wires approved under class VI as per IRS M46-03 shall be used. The diameter of the wire shall preferably be 1.2 mm/0.8 mm.</p>

S. No	Material to be welded	Electrodes / filler wire to be used
2.	IRS M-44 to IRS M-41	As per G-72 Rev-3 or latest.
3.	IRS M-41 to IRS M-41	

**Note:**

1. The edge preparation should be done as per IS: 9595 for both “V” butt as well as fillet joints.
2. Electrodes and filler wires should be procured from any RDSO approved sources and the parameters like current, voltage, etc. should be as per IS code and manufacturers recommendations.
3. For other combination of materials welding Refer RDSO specification No.G-72 Rev-3 or latest appendix-III.
4. **Welders` Qualification:** Welders deputed to carry out welding work on wagons and wagon components should be only those tested and certified as adequately skilled for welding work on stainless steel wagons and its components.

**6.9 Welding between dissimilar metals:**

During welding of dissimilar metals, the following general guidelines shall be helpful:

- i. Minimum heat input should be provided to joint, so that diffusion can be restricted and dilution is minimised. To achieve this low welding current, small diameter electrodes shall be preferred.
- ii. Proper filler materials compatible with both the steels, being joined are to be used.
- iii. Dilution must be reduced to as low as possible. Dilution depends on the welding process, process variables and penetration. Hence, proper welding process shall be used with proper setting of process variables (Current, Voltage, Travel speed, Polarity etc.).
- iv. When using gas metal arc welding (MIG/MAG) reduced current density is to be employed, so that only dip transfer of metal occurs.
- v. The problem of dilution and formation of inter-metallic phases can be minimised by buttering one or both joint faces with a layer of compatible material.

## 7.0 SURFACE PREPARATION & PAINTING

- i. The surface preparation and painting for underframe of the wagon shall be as per standard specification No.G-72 read with latest amendments.

### ii. Surface preparation of the wagon body

Degreasing with petroleum hydrocarbon solvent to IS:1745-1978 (low aromatic grade 145/205) or any other degreaser (applicable for both SS,MS and corten steel).

### iii. PAINTING OF WAGON BODY

Wherever the wagon is repaired it must be dressed to smooth surface and proper protective coating i.e. paints to be applied as recommended.

#### For stainless steel

As specified in the relevant drgs/ specifications or General Standard Specification No. G-72 (Rev.3) read with latest amendments.

- iv. The painting of bogies, couplers and air brake equipment shall be done as given in Para 11.2.5 of General Standard Specification No. G-72 (Rev.3) read with latest amendments.

## 8.0 PRECAUTIONS TO BE TAKEN IN WORK AREA

- a. It should not be contaminated by contact with mild steel or alloy steel during the fabrication process.
- b. All sources of carbon contamination should be eliminated e.g. varnish, paint, wax marking pencils, etc.
- c. Identification markings, usually written on the plate, must be removed from the weld area.
- d. When carbon steel lifting lugs are used for handling heavy components, IRS:M44 pads should be used between the lugs and the component. (This prevents dilution of the IRS:M44 and carbon pick up, both of which cause deterioration in the mechanical and corrosion properties of the steel)
- e. Oil or greases deposits on, or near a weld joint should be removed using suitable degreasing agents as otherwise they can cause weld related problems.
- f. Prevent carry over of mild steel grinding swarf onto IRS:M44 as otherwise it can cause significant discolouration and under some conditions, loss of corrosion resistance.
- g. Before using guillotines, bending brakes etc, the equipment should be wiped clean of any adhering mild steel particles.

Most of these potential contamination problems can be avoided if separate work areas for IRS:M44 exist, remote from those used for mild steel.

## **9.0 PRECAUTIONS TO BE TAKEN IN STORAGE**

- a. IRS:M44 should be stored in a dry area, separate from carbon steels.
- b. The storage racks used should be made of IRS:M44 or wood.
- c. Prevent accumulation of dirt, dust and greasy deposits on the IRS:M44's surface as otherwise it will prevent oxygen from ensuring the integrity of the protective film beneath the deposit and localized staining can take place after lengthy shielding from the air.
- d. Grinding tools, stainless steel wire brushes and other tools and equipments used for IRS:M44 should be stored separately to avoid mild steel contamination.
- e. Marking inks free of chlorides, lead and sulphur should only be used.