



केवल कार्यालयीन उपयोग हेतु
(For Official Use Only)

भारत सरकार GOVERNMENT OF INDIA
रेल मंत्रालय MINISTRY OF RAILWAYS



SELECTION OF WELDING ELECTRODES

END USER: WELDERS AND CONCERNED SSE/JES

CAMTECH/ E/17-18/EP-3/Welding Electrodes/1.0

Draft

अअसा सं RDS
रेल अग्रदूत Transforming Railways



**Indian Railways
Centre for Advanced Maintenance Technology**

Maharajpur, GWALIOR - 474 005

SELECTION OF WELDING ELECTRODES

QUALITY POLICY

"To develop safe, modern and cost effective Railway Technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs and Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the railways".

CONTENTS

1.0	INTRODUCTION	01
1.1	FACTORS WHILE SELECTING ELECTRODE	01
1.1.1	Identify base metals	01
1.1.2	Weld Geometry (Joint Fit-up)	02
1.1.3	Welding Positions	04
1.1.2	Other Factors	06
1.2	CLASSIFICATION OF ELECTRODES	07
1.2.1	Mild steel electrodes	07
1.2.2	Welding Electrode Sizes	09
1.2.3	Indian Railways Specifications	09
1.3	SUMMARY OF MMAW ELECTRODES	10
1.4	CLASSIFICATION OF WELDING ELECTRODES	12
	<i>(As per IRSM 28-2012)</i>	
1.5	GAS WELDING RODS	32
1.6	USAGE AND STORAGE OF ELECTRODES	33
1.6.1	Usage and Storage of Electrodes	33
1.6.2	Storage of Electrodes	34
1.6.3	Drying Electrodes	35
	REMEMBER	36
	IS SPECIFICATIONS	37
	REFERENCES	38

1.0 INTRODUCTION

Welding is a skill that takes much practice to master, and selecting the correct electrode for the job can be equally challenging. Electrodes are available in a wide range of types, each of which provide different mechanical properties and operates with a specific type of welding power source.

The selection of a correct type of welding electrode for specific application is a very important consideration in metal arc welding. Metal welding electrodes are used for various applications on the Indian Railway such as in the construction and repairs of rolling stock, structures, bridges, permanent way etc.

1.1 FACTORS WHILE SELECTING ELECTRODE

Factors we should consider when selecting an electrode include base **metal type, joint fit-up and welding positions**.

1.1.1 Identify base metals

The first step in choosing an electrode is to determine our base metal composition. Our goal is to match (or closely match) the electrode composition to the base metal type, which will help to ensure a strong weld.

If we are in doubt about the composition of base metal, ask our self following questions:

Q. What does the metal look like?

If we are working with a broken part or component, check for a coarse and grainy internal surface, which usually means the base material is a cast metal.

Q. Is the metal magnetic?

If the base metal is magnetic, chances are good that the base metal is carbon steel or alloy steel. If the base metal is not magnetic, the material could be manganese steel, 300 series austenitic stainless steel or a non-ferrous alloy such as aluminium, brass, copper or titanium.

Q. What kind of sparks does the metal give off when touched by a grinder?

As a rule of thumb, more flare in the sparks indicates a higher carbon.

Q. Does a chisel “bite” into the base metal or bounce off?

A chisel will bite into a softer metal, such as mild steel or aluminium, and bounce off of harder metals, such as high carbon steel, chrome-moly or cast iron.

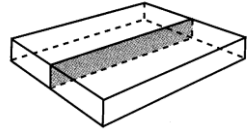
1.1.2 Weld Geometry (Joint Fit-up)

It is a joint configuration. It tells how two or more pieces of metal/component can be weld together.

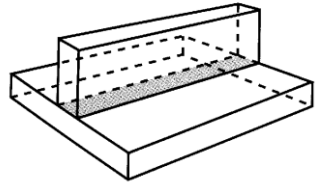
Five types of joints have been referred by the American Welding Society: butt, corner, edge, lap, and tee.

(i) Butt joint

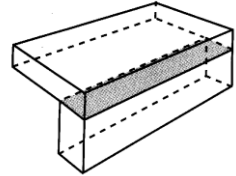
A joint between two members aligned approximately in the same plane (face to face)

**(ii) T-joint (fillet joint)**

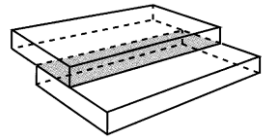
A joint between two members located approximately at right angles to each other in the form of a T.

**(iii) Corner joint**

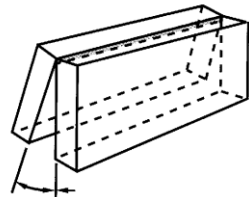
A joint between two members located at right angles to each other at the edge of components.

**(iv) Lap Joint**

A joint between two overlapping members.

**(v) Edge joint**

A joint between the edges of two or more parallel or nearly parallel members.



Application of Various Weld Joints

Almost all types of weld configuration are being used in IR for fabrication of components.

- Under frame - fillet, butt, corner
- Coach steel superstructure - butt, fillet, corner
- Wagon - fillet, butt, corner
- Steel bridges - fillet, butt, corner, lap

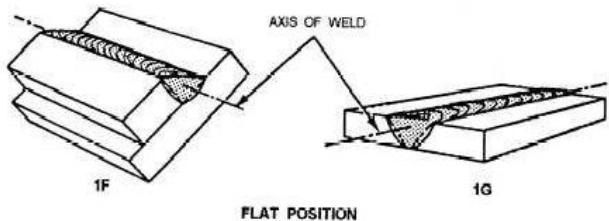
1.1.3 Welding Positions

The American Welding Society (AWS) has defined the four basic welding positions.

(i) Flat position

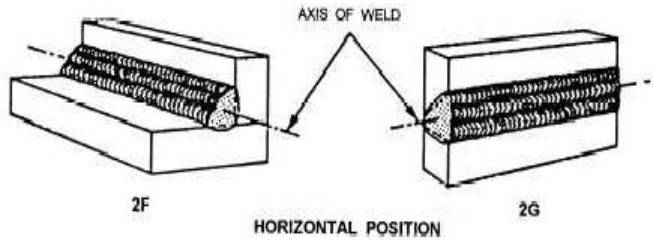
In a flat position, a weld is performed along largely a horizontal axis and from above the joint. It is the easiest type of weld to perform and to gain control over the weld pool and achieve the best weld quality.

However the same position is some time called down hand welding.



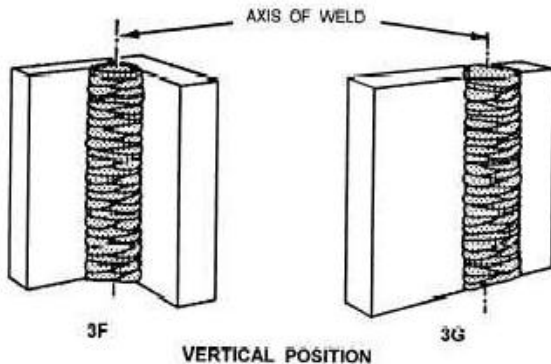
(ii) Horizontal Position

In the horizontal position, the weld axis is in the horizontal plane. Horizontal welding is often used for fillet or groove welds.



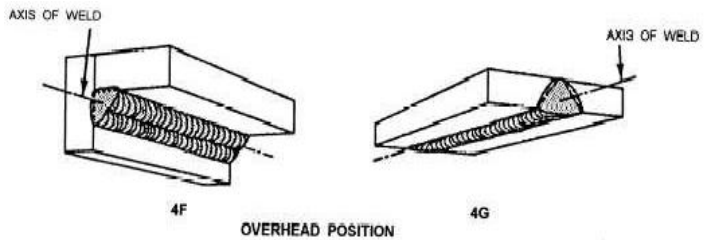
(iii) Vertical Position

With a vertical position, the weld axis is largely in a vertical or upright position. It is typically more complicated to perform than flat and horizontal. When welding is done on a vertical surface, the molten metal has a tendency to run downward and pile up.



(iv) Overhead Position

In this the most complicated of the four, the welding is performed from the underside of the joint. In this the metal deposited tends to drop or sag on the plate, causing the bead to have a high crown.



1.1.2 Other Factors

- Tensile strength of the required weld.
- Base metal composition.
- Electrode diameter
- The rate of deposit the weld metal.
- The type of current used.
- Penetration required.
- Metal thickness.
- The experience of the welder.
- The specifications and service Condition.

1.2 CLASSIFICATION OF ELECTRODES

Electrode: a coated metal wire having approximately the same composition as the base metal.

Electrodes are mainly classified into 5 main groups:

- 1) Mild steel - majority of welding
- 2) High carbon steel
- 3) Special alloy steel
- 4) Cast iron
- 5) Non ferrous - example Aluminum, Copper, & Brass

Standards are set by AWS (American Welding Society), ASTM (American Society for Testing Materials) & BIS (Bureau of Indian standards).

1.2.1 Mild steel electrodes

There are basically two kinds of mild steel electrodes:

- (i) Bare:

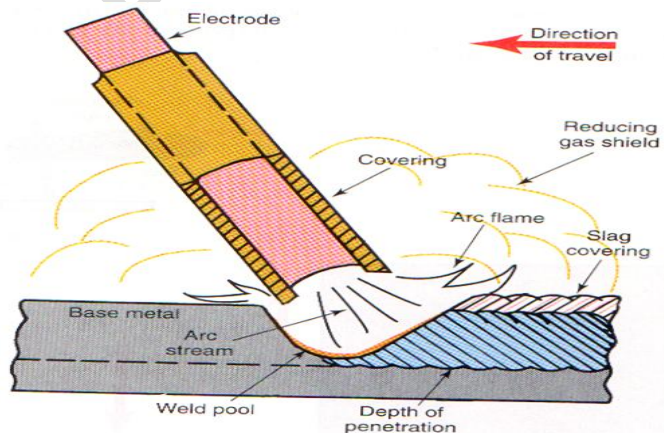
Bare electrodes are still covered with little covering, this limits their use in the welding field.

- (ii) Shielded (flux coated)

Shielded electrodes have a heavy coating on the outside of them (called flux).

Purpose of flux:

- ✓ It prevents corrosion from taking place.
- ✓ It acts as a cleaner and deoxidizes.
- ✓ It releases an inert gas to protect from oxygen, nitrogen, & hydrogen in the atmosphere. These elements will weaken the weld if they were to come in contact with the molten metal.
- ✓ It forms slag to protect the cooling metal & allows metal to cool at a slower rate protecting the metal properties.
- ✓ It provides easier starting arc, stabilizer, reduce splatter.
- ✓ It permits better penetration & X-ray quality.
- ✓ As the electrode burns the flux produces a gaseous shield around the weld. This prevents harmful contaminants from hurting the weld. The main 3 harmful elements present in the atmosphere
 - Hydrogen
 - Oxygen
 - Nitrogen



1.2.2 Welding Electrode Sizes

The electrode size refers to the diameter of its core wire. Each electrode has a certain current range. The welding current increases with the electrode size (diameter).

Electrode size	Electrode size
1.6mm	5.0mm
2.0mm	6.0mm
2.5mm	6.3mm
3.15mm	8.0mm
4.0mm	10.0mm

Standard length of electrodes

The electrodes are generally manufactured in the length of 250mm to 450mm.

1.2.3 Indian Railways Specifications

IRSM:28-2012

The Indian Railways has issued standard specification IRSM 28-2012 for manual metal arc welding electrodes and gas welding rods.

IRSM:46-2012

This specification has been framed for use of MIG (Metal Inert Gas) /MAG (Metal Active Gas) filler wire and classified into various classes as per the requirement of material to be welded.

IRSM:39-2001

This specification has been framed for use of SAW (Submerged Arc Welding) consumables and classified into various classes as per the requirement of material to be welded.

1.3 SUMMARY OF MMAW ELECTRODES

The summary of use of manual metal arc welding electrodes as per parent material and use as per **IRSM 28-2012** is given below:

Parent Material	Use	Class of electrode
Low tensile steel	Static	A1
-do-	Moderate Dynamic	A2
-do-	Highly Dynamic/ low temperature	A3, A4
Pipe welding	All application	A5
Medium Tensile steel	All standard application	B1, B2
-do-	Low temperature application below -20 ⁰ C	B3, B4
High Tensile steel	All application	C1, C2

Parent Material	Use	Class of electrode
Corten to IRS M-41 & IRS M-42	All application	D
Low & medium tensile steel	Low heat input welding	E1 & E2
Cast irons	For reclamation & repair	F & G
Ferrous components	Hard facing of ferrous components	H series
Non ferrous metal & alloys (Cu & Al)	All application	K & L
Stainless Steels of various grades	All application	M series
All ferrous & non ferrous metal & alloys	For cutting & gouging	N1, N2 & N3

1.4 CLASSIFICATION OF WELDING ELECTRODES (As per IRSM 28-2012)

The electrodes have been classified into 34 different classes i.e. A1, A2, A3, A4,A5, B1, B2, B3, B4, C1, C2, D, E1, E2, F, G, H3, H3A, H3B, H3C, H4A, H4B, K, L, M1, M2, M3, M4, M5, M6,M7, N1, N2 & N3.

The purpose for which each class of electrode is to be used, together with the IS/AWS code and type of coating, is given here under:

Sr.No. 1

IRS Class	: A-1
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	ER 4112 (Medium coated)
Purpose/ Use:	
	Fabrication of component meant for static application made of steels to IS: 2062-11, Gr E250 Quality A, IS: 1875-04 Class 1 & 1A or equivalent. Suitable for joining steel sheets to IS:513-98, IS: 1079-94 & Gr. Fe 330 to IS:5986-02 or equivalent and for repair welding of cast steels to IS: 1030-98 Gr.-200-400W. This electrode can also be used for welding where strength requirement is not specified.
Expert Notes:	
	Not fit for dynamic applications.
	Dry the electrode at 100-120 degree C for 1 hrs. before use.
	Recommended current AC/DC

Sr.No. 2

IRS Class:	A-2
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	ER 4211X (Medium coated)
Purpose/ Use:	
	Fabrication of component meant for semi-dynamic application such as bridges etc., made of steel to IS: 2062-11 Gr. E250 Quality BR&B0, IS: 1875-04 Class I & IA or similar. The weld deposit shall be of radiographic quality.
Expert Notes:	
	Fit only for moderate dynamic application.
	Recommended current AC/DC
	Dry the electrode at 100-120 degree C for 1 hrs. before use.

Sr.No. 3

IRS Class:	A-3
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	EB 5326H2X (Heavy coated)
Purpose / Use:	
	Fabrication of component meant for highly dynamic application made of steels to IS: 2062-11 Gr.E 250 quality C or for other applications where low temperature impact property is required. The weld deposit shall be of radiographic quality.
Expert Notes:	
	Fit for highly dynamic application.

Sr.No. 4

IRS Class:	A-4
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	EB 5326H2JX (Heavy coated)
Purpose / Use:	
	Fabrication of component meant for highly dynamic application made of steels to IS: 2062-11 Gr. E 250 quality C or for other applications where low temperature impact property is required. The weld deposit shall be of radiographic quality with high deposition efficiency .
Expert Notes:	
	Fit for highly dynamic application.
	Electrode should be preferably used in down hand position for high deposition efficiency.

Sr.No. 5

IRS Class:	A-5
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	EC 4316X (Medium coated)
Purpose / Use:	
	For pipe welding or other applications where high penetration of arc is needed.
Expert Notes:	
	It is of radiographic quality.
	Recommended current AC/ DC+

Sr.No. 6

IRS Class:	B-1
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	EB5426H3X (Heavy coated)
Purpose / Use:	
	Fabrication of component made of steels to IS: 2062-11 Gr.E300 & E350 all quality, IS:2002-01 Gr.1&2, IS: 1875-04 Class 2, 2A and 3 or similar. Also suitable for repair welding of cast steels to IS: 1030-98 Gr.230-450W. Also for joining of stainless steels type 3 Cr12, IRS M-44 or its equivalent with mild steel/ low alloyed steel/ Corten steel. The weld deposit shall be radiographic quality.
Expert Notes:	

Sr.No. 7

IRS Class: B-2
IS/ AWS Spec. : IS: 814-04
IS/ AWS Code : EB5426H3JX (heavy coated)
Purpose / Use:
<p>Fabrication of component made of steels to IS: 2062-11 Gr.E300 & E350 all quality, IS: 2002-01 Gr.1&2, IS: 1875-04 Class 2, 2A and 3 or similar.</p> <p>Also suitable for repair welding of cast steels to IS: 1030-98 Gr.230-450W.</p> <p>Also for joining of stainless steels type 3 Cr12, IRS M-44 or its equivalent with mild steel/ low alloyed steel/ Corten steel.</p> <p>The weld deposit shall be radiographic quality with high deposition efficiency.</p>
Expert Notes:
Basic coated low hydrogen iron powder type electrode.
Recommended current AC/ DC+
Dry electrode at 200-250 degree C for 1 hr. before use.
Keep the arc as short as possible.
Electrode should be preferably used in down hand position for high deposition efficiency.

Sr.No. 8

IRS Class:	B-3
IS/ AWS Spec. :	IS: 1395-03
IS/ AWS Code :	E55BC126 (heavy coated)
Purpose / Use:	
Fabrication of components made of steel to ASTM 516 GR. 70 or equivalent where low temperature (at-46 ⁰ C) impact properties are required. The weld deposit shall be of radiographic quality.	
Expert notes :	

Sr.No. 9

IRS Class:	B-4
IS/ AWS Spec. :	IS: 1395-03
IS/ AWS Code :	E55BC126J (heavy coated)
Purpose / Use:	
Fabrication of components made of steel to ASTM 516 GR. 70 or equivalent where low temperature (at-46 ⁰ C) impact properties are required. The weld deposit shall be of radiographic quality with high deposition efficiency .	
Expert Notes:	
Electrode should be preferably used in down hand position for high deposition efficiency.	

Sr.No. 10

IRS Class: C-1
IS/ AWS Spec. : IS: 1395-03
IS/ AWS Code : E63BD126 (heavy coated)
Purpose / Use:
Fabrication of components made of steel to IS: 2062-11 Gr.E410, 450, IS: 2002-01 GR.3, IS: 1875-04 class 3A or similar. The weld deposit shall be of radiographic quality.
Expert Notes:
For high quality mild steel component welding.

Sr.No. 11

IRS Class: C-2
IS/ AWS Spec. : IS: 1395-03
IS/ AWS Code : E63BD126J (heavy coated)
Purpose / Use:
Fabrication of components made of steel to IS: 2062-11 Gr.E410, 450, IS: 2002-01 GR.3, IS: 1875-04 class 3A or similar. The weld deposit shall be of radiographic quality with high deposition efficiency.
Expert Notes:
Electrode should be preferably used in down hand position for high deposition efficiency.

Sr.No. 12

IRS Class: D
IS/ AWS Spec. : AWS A5.5
IS/ AWS Code : E8018W2 (heavy coated)
Purpose / Use:
For joining weathering steels conforming to IRS M-41 or M-42 with same steel or steels to IS: 2062-11, IS: 2002-01, IS: 1875-92 as mentioned above. This can also be used for combination joint of IRS M-44 & IRS M-41 and IRS M-41 & M-42. The weld deposit shall be of radiographic quality.
Expert Notes:
It is suitable for corten steel.
It is suitable for ICF/RCF coach body and LHB bogie fabrication.
recommended current condition AC minimum 70 V OCV/ DC+
Dry electrodes in oven at 200-300 degree C for 2-3 hrs. before use.

Sr.No. 13

IRS Class:	E-1
IS/ AWS Spec. :	IS: 814-04
IS/ AWS Code :	ER4211X (medium coated)
Purpose / Use:	For fabrication & repairing of Buckles, Gear cases, Protector Tubes, Door Patches, Side Panels, End Wall Patches etc. of rolling stock & locomotives . The electrodes shall be low heat input type with 350 mm length.
Expert Notes:	Care to be taken while using this electrode with AC or Dc machine, AC OCV less than 70 V to improve toughness and ductility.

Sr.No. 14

IRS Class:	E-2
IS/ AWS Spec. :	IS: 1395-03
IS/ AWS Code :	E55BG1Ni26 (heavy coated)
Purpose / Use:	For repair welding of bogies, both cast & fabricated . The electrodes shall be low heat input type with 350 mm length.
Expert Notes:	Care to be taken while using this electrode with AC or Dc machine, AC OCV less than 70 V to improve toughness and ductility.

Sr.No. 15

IRS Class:	F
IS/ AWS Spec. :	IS: 5511-03
IS/ AWS Code :	EFe B26 (medium coated)
Purpose / Use:	
	For reclamation of cast iron with non-machinable deposit.
Expert Notes:	
	Post welding treatment with slow cooling rate to avoid crack in component.
	Cast iron are liable to crack during welding, to avoid cracks, hard welds and Heat Affected Zone (HAZ), preheating is necessary 400 to 600 degree C, followed by slow cooling.

Sr.No. 16

IRS Class:	G
IS/ AWS Spec. :	IS: 5511-03
IS/ AWS Code :	ENiFeG16 (Medium coated)
Purpose / Use:	
	For welding of cast iron with machinable deposit (Ni-Fe type core wire).
	Also suitable for joining of cast iron to other ferrous & non-ferrous materials.
Expert Notes:	
	Post welding treatment with slow cooling rate to avoid crack in component.

Sr.No. 17

IRS Class:	H3
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
For resurfacing of fabricated medium-Mn steel or cast Mn. Steel crossings to withstand traffic density of 15 GMT minimum.	
Expert Notes:	
Care to be taken while welding to avoid crack in component.	

Sr.No. 18

IRS Class:	H3A
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
For resurfacing of fabricated medium-Mn steel or cast Mn. Steel crossings to withstand traffic density of 25GMT minimum.	
Expert Notes:	
Care to be taken while welding to avoid crack in component.	

Sr.No. 19

IRS Class:	H3B
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
	For resurfacing of fabricated medium-Mn steel or cast Mn. Steel crossings to withstand traffic density of 35 GMT minimum.
Expert Notes:	
	Care to be taken while welding to avoid crack in component.

Sr.No. 20

IRS Class:	H3C
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Use:	
	For resurfacing of fabricated medium-Mn steel or cast Mn. Steel crossings to withstand traffic density of 50 GMT minimum.
Expert Notes:	
	Care to be taken while welding to avoid crack in component.

Sr.No. 21

IRS Class:	H4A
IS/ AWS Spec. :	IS: 7303-03
IS/ AWS Code :	EFe-IC314 (heavy coated)
Purpose / Use:	
	For non-machinable hard facing of ferrous items with hardness range of 55-62 Rc.
Expert Notes :	
	Preheating of the up to specified temperature.
	After welding post heat treatment is necessary to remove residual stresses developed during welding.
	To avoid cracks during and after welding, controlled cooling is required to be maintained particularly in martensitic steel.

Sr.No. 22

IRS Class:	H4B
IS/ AWS Spec. :	IS: 7303-03
IS/ AWS Code :	EFe-B314 (heavy coated)
Purpose / Use:	
	For machinable hard facing of ferrous items with hardness range of 30-40 HRc like reclamation of equalizing beam etc.
Expert Notes:	
	Preheating of the up to specified temperature.
	After welding post heat treatment is necessary to remove residual stresses developed during welding.
	To avoid cracks during and after welding, controlled cooling is required to be maintained particularly in martensitic steel.

Sr.No. 23

IRS Class:	K
IS/ AWS Spec. :	IS:8666-03
IS/ AWS Code :	ECuSn-A (medium coated)
Purpose / Use:	
For welding of copper, bronze and other copper alloys including gun-metal.	
Expert Notes:	
Used in traction motor repair work of locomotives.	
As the thermal conductivity of copper is high, preheating is necessary and any non conductive material such as asbestos sheet etc. may be used for heat conservation.	
Tacking should not be used.	

Sr.No. 24

IRS Class:	L
IS/ AWS Spec. :	AWS A5.3
IS/ AWS Code :	AL-43 (Medium coated)
Purpose / Use:	
For welding of aluminium and aluminium alloys.	
Expert Notes:	
AC welding machine is preferred for clean welding.	
As the thermal conductivity of aluminium is high, preheating is necessary.	
Cleanliness is essential at the fusion phases. (grease, moisture shall be removed.	

Sr.No. 25

IRS Class:	M1
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E19.9R26 (Heavy coated)
Purpose / Use:	
	For fabrication of stainless steels type 18% Cr 8% Ni type or its equivalent.
Expert Notes:	
	For welding of Austenitic stainless steel to same steel. (SS inlay and SS trough floor of coaches).

Sr.No. 26

IRS Class:	M2
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E19.9LR26 (Heavy coated)
Purpose / Use:	
	For fabrication of stainless steels type 3Cr12, IRS M-44 or its equivalent. Also suitable for fabrication of 18% Cr 8% Ni stainless steels with low carbon.
Expert Notes:	
	For welding of ferritic stainless steel to same steel. (for wagon body and LHB coach body)

Sr.No. 27

IRS Class:	M3
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E19.12.2R26 (Heavy coated)
Purpose / Use:	
	For fabrication of stainless steels type 316 or its equivalent.
Expert Notes:	
	Welding electrode for bio toilet tank of coaches.

Sr.No. 28

IRS Class:	M4
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E23.12LR26 (heavy coated)
Purpose / Use:	
	For fabrication of ferritic stainless steels type 3Cr12, IRS M-44 or its equivalent. Also suitable for joining dissimilar stainless steels as mentioned in M1, M2 and M3 or their equivalent. This is also suitable for joining M1, M2 and M3 type of stainless steels as mentioned above or their equivalent with mild steel or low alloyed steel. This can also be used for welding of heat resisting stainless steels 22% Cr 12% Ni type or its equivalent.
Expert Notes:	
	Most useful electrode for stainless steel welding in coaches and wagons in of M1, M2, & M3

Sr.No. 29

IRS Class:	M5
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E18.8MnR26 (Heavy coated)
Purpose / Use:	
	For joining of manganese steel liners and other austenitic manganese steel components with steel casting to IS: 1030-98 Gr.230-450W/280-520W or to IS: 2062-11
Expert Notes:	
	For side frame and body frame liners of wagon bogies.

Sr.No. 30

IRS Class:	M6
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E25.20R26 (heavy coated)
Purpose / Use:	
	For repair welding of cracked gas inlet casting of diesel locomotives . These can also be used for other repair welding of stainless steels castings having higher percentage of carbon and for welding of high heat resisting stainless steels 25% Cr 20% Ni type or its equivalent.
Expert Notes:	
	Very high chromium contents electrode requires special care during welding.

Sr.No. 31

IRS Class:	M7
IS/ AWS Spec. :	IS: 5206-03
IS/ AWS Code :	E29.9R26 (Heavy coated)
Purpose / Use:	
	For joining of cast ferrous alloy of similar composition, dissimilar metals such as carbon steels to stainless steels & welding of steels of unknown composition.
Expert Notes:	
	For welding of stainless steel components of unknown composition.

Sr.No. 32

IRS Class:	N-1
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
	For cutting mild steels, low alloy steels, stainless steels, austenitic manganese steels, cast iron, cast steel & non-ferrous alloys such as nickel alloys, Al, Cu, bronzes etc.
Expert Notes:	

Sr.No. 33

IRS Class:	N-2
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
	For gouging & piercing of steels and non-ferrous alloy as described in class N-1.
Expert Notes:	

Sr.No. 34

IRS Code :	N-3
IS/ AWS Spec. :	--
IS/ AWS Code :	--
Purpose / Use:	
	For gouging of mild steels, low alloy steels, stainless steels, austenitic manganese steels and cast iron & cast steel. The electrode shall be of copper coated graphitic type.
Expert Notes:	

Low Heat Input Type:

An electrode shall be called “Low Heat Input Type” provided it runs with max.70V OCV at the current ranges mentioned below:

Electrode Diameter	Current Range (Amps)
2.5 mm X 350mm	60-90
3.15mm X 350mm	90-120
4.00mm X 350mm	120-150
5.00mm X 350mm	150-200

Current range of N series of electrodes shall be as given below:

Dia. of electrode In mm	Current range in Amp. AC (OCV 50)/ DC(-)	
	N1	N2 &N3
2.5	130 – 180	150 - 200
3.15	150 – 230	200 - 250
4.0	200 – 300	250 - 350
5.0	250 – 350	350 - 400

All stainless steel electrodes must have stainless steel core wire.

Coating factors:

For medium – 1.36 to 1.50 and for heavy-1.51 to 2.20

1.5 GAS WELDING RODS

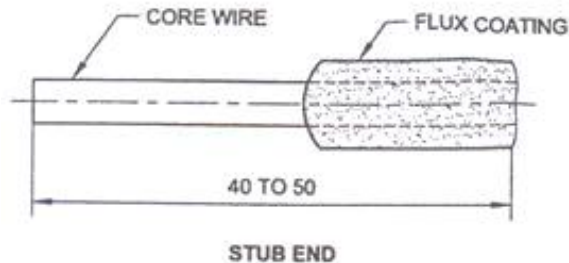
The gas welding rods have been classified into 4 different classes i.e. Class I to Class IV. The purpose for which each class of the gas welding rod is to be used together with corresponding IS specification is given in table below:

IRS Class	Purpose/ Use	Equivalent type in IS:1278-03
Class I	General purpose low carbon mild steel rods meant for application where a minimum butt-weld strength of 35.0 kg/sqmm is required.	S-FS1
Class II	Mild steel rod intended for application in which minimum butt weld tensile strength 44 kgf/mm ² is required. It is not intended for general welding purpose.	S-FS2
Class III	Medium tensile steel rod intended for application where a minimum butt weld tensile strength of 50.0 kgf/mm ² is required.	S-FS3
Class IV	Silicon-Bronze (Brass) rods intended for Bronze welding (Brass welding) of copper & mild steel and fusion welding of materials of same or closely similar composition.	S-C6

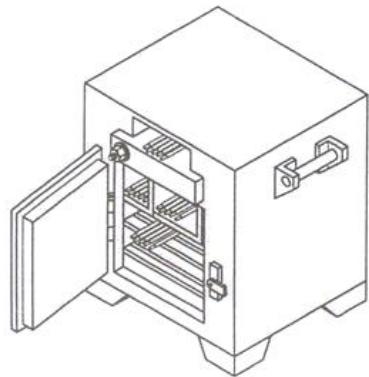
1.6 USAGE AND STORAGE OF ELECTRODES

1.6.1 Usage and Storage of Electrodes

- Electrodes are costly, therefore, use and consume every bit of them.
- Do not discard STUB ENDS more than 40-50 mm length.
- Electrode coating can pick up moisture if exposed to atmosphere.



- Store and keep the electrodes (air tight) in a dry place.
- Heat the moisture affected/ prone electrodes in an electrode drying oven at 110-150°C for one hour before using.



ELECTRODE DRYING OVAN

Remember a Moisture Affected Electrode:

- has rusty stub end
- has white powder appearance in coating
- produces porous weld.

1.6.2 Storage of Electrodes:

The efficiency of an electrode is affected if the covering becomes damp.

- Keep electrodes in unopened packets in a dry store.
- Place packages on a duckboard or pallet, not directly on the floor.
- Store so that air can circulate around and through the stack.
- Do not allow packages to be in contact with walls or other wet surfaces.
- The temperature of the store should be about 5°C higher than the outside shade temperature to prevent condensation of moisture.
- Free air circulation in the store is as important as heating. Avoid wide fluctuations in the store temperature.
- Where electrodes cannot be stored in ideal conditions place a moisture absorbent material (e.g. silica gel) inside each storage container.

1.6.3 Drying Electrodes: Water in electrode covering is a potential source of hydrogen in the deposited metal and thus may cause.

- Porosity in the weld
- Cracking in the weld

Indications of electrodes affected by moisture are:

- White layer on covering
- Swelling of covering during welding
- Dis-integration of covering during welding
- Excessive spatter
- Excessive rusting of the core wire.

Electrode affected by moisture may be dried before use by putting them in a controlled drying oven for approximately one hour at a temperature around 110-150°C. This should not be done without reference to the conditions laid down by the manufacturer. It is important that hydrogen controlled electrodes are stored in dry, heated conditions at all times.

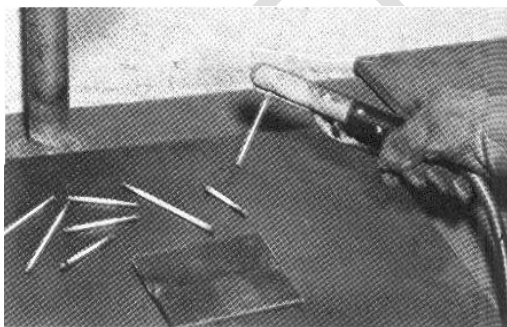


Electrode
Drying
Oven

For further details, refer the manufacturer's instructions and follow them.

REMEMBER

1. Never use a rod with a diameter larger than the thickness of the base metal.
2. Electrode size means the size of the wire, not overall size of the rod.
3. Electrodes are very expensive so use them upto 1½” to 2” in length. (do not burn them into the stinger handle).



4. Date of packing and expiry of electrodes shall be checked before use.
5. Fumes and gases are generated while the electrode burns, these are injurious to health, proper protection shall be taken.
6. Clean the weld area thoroughly, and shall be free from any surface contamination.

IS SPECIFICATIONS

1. **IS:814** –
Covered electrodes for MMAW of carbon and carbon Manganese steel.
2. **IS:1395** –
Low & Medium alloy steel covered electrodes for MMAW.
3. **IS:8666** –
Cu & Cu alloy covered electrodes for MMAW.
4. **IS:5206** –
Covered electrodes for MMAW of stainless steel & other similar alloy steel.
5. **IS:5511**-
Covered electrodes for MMAW of cast iron.
6. **IS:7303**-
Covered electrodes for surfacing of metal by MMAW.
7. **IS:1278** –
Filler rod for gas welding.
8. **IS:6419**-
Welding rods & bare electrodes for gas shielded arc welding.

REFERENCES

1. Indian Railways standard specification for classification, testing, and acceptance criteria of manual metal arc welding electrodes and gas welding rods. IRS M: 28-2012.
2. Handbook prepared by CAMTECH, "Handbook on Welding techniques".
3. Literature collected from field units and downloaded from internet on the subject matter.
4. Suggestions/ Comments received during seminar held on 19.04.2017 on the subject at CAMTECH, Gwalior.
5. Expert comments received from RRWI/CRWS/BPL and M& C directorate RDSO, Lucknow.

OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

CAMTECH is continuing its efforts in the documentation and up-gradation of information on maintenance practices of electrical assets. Over the years a large number of publications on electrical assets have been prepared in the form of handbooks, pockets books, pamphlets & video films etc. These publications have been uploaded on the internet as well as rail net.

For downloading these publications please do following:

1. On internet visit : www.rdsso.indianrailways.gov.in

Go to Directorates → CAMTECH → Publications for download → Electrical Engineering

2. On Railnet visit RDSO website at 10.100.2.19

Go to Directorates → CAMTECH → Publications for download → Electrical Engineering

For any further information regarding publications please contact:

Director (Elect.) – 0751- 2470740 (O) BSNL, 9752447030 (CUG)

SSE/Electrical - 9755549297 (CUG)

E-mail at direlcamtech@gmail.com

Fax to 0751- 2470841

Write at : Director (Electrical)

Indian Railways

Centre for Advanced Maintenance technology,

In front of Hotel Adityaz,

Airport Road, Maharajpur,

Gwalior, Pin code – 474 005