

**DRAFT COPY**

**IRS:M-39/2001-2020**

**Hkkjr ljdkj**  
**GOVERNMENT OF INDIA**  
**jsy ea=ky;**  
**MINISTRY OF RAILWAYS**  
**( jsyos cksMZ ) (RAILWAY**  
**BOARD)**



**INDIAN RAILWAY STANDARD SPECIFICATION**  
**FOR**  
**CLASSIFICATION, TESTING AND ACCEPTANCE CRITERIA OF**  
**WIRE AND FLUX FOR SUBMERGED ARC WELDING OF**  
**STRUCTURAL STEEL FOR USE ON INDIAN RAILWAYS**

**~~Price: Rs. 2100/- only~~**

DRAFT

IRS:M-39--2020

## Indian Railway Standard Specification for classification, Testing and Acceptance Criteria of Wire and flux for Submerged Arc Welding of Structural Steel for use on Indian Railways

### O. FOREWORD

- 0.1 This specification is issued under the fixed Serial No. M.39, the final number indicates the year of original adoption as standard, or in the case of revision, the year of last revision.  
**ADOPTED 1968: REVISED 2020**
- 0.2 This specification is issued to facilitate assessment and procurement of wire and flux by Indian Railways for welding of structural steels in place of existing IRS **M: 39-68**.
- 0.3 In earlier IRS:M39, wire-flux combinations were taken into consideration. In this version, wire and flux have been delinked to the extent that approval and procurement of both can be done separately.
- 0.4 In earlier specification, the impact value of weld deposit of wire flux combinations was specified at  $27 \pm 2^{\circ}\text{C}$ . During this span of 32 years, Indian Railways has introduced many fast moving trains like Rajdhani and Shatabdi Express and expanded its network in colder regions. Occasionally cracks are being reported in the welded area. To combat this, minimum impact value requirement of the weldment has been specified at  $-20^{\circ}\text{C}$  in this specification.
- 0.5 In this specification, three more grades have been added for joining high tensile steels, steels to ASTM 516 Gr.70 and weather resistant steels to IRS M-41 & 42. All the grades have been made suitable for two run and multirun welding. Radiographic quality has been mandatory for all the grades.
- 0.6 In Table-1 of this specification reference has been made to MMAW electrodes of IRS M-28-2001 in Column 4. This has been provided for direct co-relation and interchangeability.
- 0.7 Packing conditions for both wire and flux have been incorporated in Clause 4.4 and 5.6. The same has been kept as requirement of acceptance also.
- 0.8 In framing this specification, guidance from the following specification has been taken:
- (i) IS: 3613-1993 (Acceptance tests for wire-flux

combinations for Submerged Arc Welding)

- (ii) IS: 7280-1997 (Bare wire electrodes for Submerged Arc Welding of Structural steels)
  - (iii) AWS-AA5.17-1977 (Bare Carbon steel electrodes and flux for Submerged Arc Welding).
  - (iv) AWS-A5.23-1990 (Low alloy steel electrodes and fluxes for Submerged Arc Welding)
- 0.9 Wherever a reference to any other standard appears in this specification, it shall be taken as a reference to the latest version of that standard.
- 0.10 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS: 2-1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off values shall be the same as that of the specified value in this standard.

### 1.0 Scope:

This standard lays down the classification, acceptance requirements and procedure for selection and testing of different grades of wire and flux manufactured indigenously for the use on Indian Railways.

### 2.0 Definition:

- 2.1 **Manufacturer** means the indigenous unit manufacturing the Submerged Arc Welding fluxes, wires or wire-flux combinations. A manufacturer must have complete infrastructure required for production along with quality control facilities. All the facilities must be located in single premises under its ownership dedicated for production of subject items.
- 2.2 **Sister Concern** means a separate production unit of the same concern or separate production unit under the same administrative control. Each such unit located in different premises will be treated as different firm.
- 2.3 **Approving authority** means Director General (M&C), R.D.S.O., Lucknow or his representative.

### 3. Classification:

- 3.1 The wire-flux combinations are classified into five classes i.e. I, II, III, IV & V depending upon the type of structural steel to be welded. The purpose for which each class of wire-flux combination is to be used is given in **Table.1**
- 3.2 The wire has been classified in five grades, namely **W-1** to **W-5**.
- 3.3 The flux has been classified in five grades, namely **F-1** to **F-5**.
- 3.4 When wire and flux combination of same grade i.e. W-1 & F-1 or W-5 & F-5 is used in combination, the weldment shall have the properties of the respective IRS class i.e. class-I or class V. Interchanging the grades of wire or flux is not permitted. However, a flux may be approved in more than one grade.

DRAFT

**TABLE-I**

**CLASSIFICATION OF DIFFERENT WIRE-FLUX COMBINATIONS  
AND THEIR PURPOSE OF USE**

Sr. No.	Class of wire & Flux Combination	Purpose of use	Equivalent Class of IRS:M-28 /2020	Grade of wire	Flux	
1	I	For two run and multirun submerged arc welding of steels to IS: 2062-91, IS:1875-91 Class I & IA and other equivalent steels. The weld shall be of radiographic quality.	A3	W-1	Agglomerated/ fused	F-1
2	II	For two run and multirun submerged arc welding of steels to IS: 8500-91 grade 440B and 490B, IS: 2002-91 grade I & II, IS:1875-91 class II & IIA or other equivalent steels. The weld shall be of radiographic quality .	B2	W-2	-do-	F-2
3	III	For two run and multirun submerged arc welding of steels to ASTM 516 Gr.70 or equivalent where low temperature (at -46°C) impact properties are required. The weld shall be of radiographic quality.	B3	W3	-do-	F-3
4	IV	For two run and multirun submerged arc welding of weather resistant steels to IRS: M41 and IRS: M42 with same steel and with other grades of steel with same or lower strength to IS: 20262-91, IS: 2002-91, IS: 1875-91 and IS: 8500-91. The weld shall be of radiographic quality.	C3	W-4	-do-	F-4
5	V	For two run and multirun submerged arc welding of steels to IS: 8500-91 grade 540B, 570B and 590B, IS: 2002-91 Grade-III, IS: 1875-91 class IIIA or other equivalent steels. The weld shall be of radiographic quality.	D	W-5	-do-	F-5

#### **4.0 WIRE & WIRE SPOOL:**

- 4.1 **Quality of Wire** – The wire shall have a smooth finish and shall be free from surface imperfections, corrosion, grease, oxides or any other foreign material. It shall have a uniform copper coating, well bonded and smooth.
- 4.2 **Size of Wire**- Wire shall be manufactured in five different sizes, namely 2.5, 3.15, 4.0, 5.0 & 6.3 mm diameter. Approval will be considered only if the firm manufacturers at least 3.15, 4.0 or 5.0 mm diameter of wire and offer the same during inspection and sampling. The tolerance in diameter shall be  $\pm 0.05\%$ .
- 4.3 **Wire Spool** – The wire shall be supplied in spools closely wound in layers of continuous length made from single heat or lot and shall be free from kinks, burrs and sharp bends. The wire shall be free to unwind without restrictions. Open end of the wire shall be properly secured and identified. Total weight of the spool shall not exceed 25.0 kgs.
- 4.4 **Packing** – To guard against ingress of moisture and accidental damage during transportation and storage till its consumption, the packaging system shall be as follows:-
- 4.4.1 Wire shall be smoothly wound over a wooden, metallic or plastic spool.
- 4.4.2 The spool cover shall contain name of manufacturer, wire, dia., batch no., date of manufacture, expiry date, current condition & welding parameter, weight, IS code, IRS Grade, guidelines on safety during welding, storage & handling and other special recommendations, if any.
- 4.4.3 The spool shall be wrapped across the thickness of the spool along the periphery with a moisture proof polythene strip/gunny.
- 4.4.4 The spool shall be kept in plastic jacket, sealed and evacuated. Then it shall be kept in a cardboard box; be covered with polythene jacket and shrink sealed. The box shall have printed on it all the information given in **Cl.4.4.2**.
- 4.4.5 The details of packing may vary from one manufacturer to other, but in essence, it must have **3** moisture proof polythene layers or **2** moisture proof polythene layers with **1** layer of gunny along with cardboard box. At least one inner packing must be evacuated & shrink packed type.
- 4.5 **Requirement of acceptance for different grades of wire:**
- 4.5.1 **All the wires shall fulfill the condition as laid down in clause 4.1 to 4.4**

4.5.2 The acceptance criteria for each Grade of wire have been indicated in Table-2. The minimum value requirement of each criteria is either given in the table or reference to appropriate appendix and table has been made wherein the details have been given.

**TABLE-2**  
**ACCEPTANCE CRITERIA OF WIRE FOR**  
**SUBMERGED ARC WELDING**

Sr. No.	Gr.of Wire	Copper Content in Coating	Storage Stability Test	Chemical Composition	Cast & Helix
1.	W-1	0.2-04%	No appreciable corrosion	As per Table-3	As per Cl.4.5.6
2.	W-2	-do-	-do-	-do-	-do-
3	W-3	-do-	-do-	-do-	-do-
4	W-4	-do-	-do-	-do-	-do-
5	W5	-do-	-do-	-do-	-do-

4.5.3 **Copper Coating** : Details of testing of copper coating of the wire shall be as per Appendix 'A', the percentage of copper by weight should be between **0.2% to 0.4% in copper coating**.

4.5.4 **Storage Stability**: The test shall be carried out as per **Appendix "A"**. No appreciable corrosion shall be present on the surface of wire.

4.5.5 **Chemical Composition**: Chemical Composition of solid (base) wires shall be as per Table-3. The details of testing have been given in **Appendix "B"**.

4.5.6 **Cast and Helix**: The cast of helix of the wire in coil shall be such that the wire will run in an uninterrupted manner on automatic and semi-automatic equipment.



**TABLE-3**

Ref.Appendix ‘B’

**CHEMICAL COMPOSITION OF BARE WIRE**

IRS Class	Grade Of wire	Chemical composition %							
		C	Mn	Si	S	P	Mo	Ni	Cu
I	W-1	0.10	0.4-0.6	0.03	0.030	0.030	-	-	0.40
II	W-2	0.08-0.15	0.80-1.20	0.15-0.40	0.030	0.030	-	-	0.40
III	W-3	0.12	0.75-1.25	0.05-0.030	0.020	0.020	-	2.10-2.90	0.40
IV	W-4	0.07-0.17	1.20-1.70	0.20	0.030	0.025	0.45-0.65	-	0.40
V	W-5	0.10	0.30-0.55	0.10-0.20	0.035	0.030	-	-	0.40

**Note: Single values in the above table are max. value.**

**\*The Wt% of copper includes copper coating also.**

**5.0 FLUX:**

**5.1 Quality of Flux:** The flux shall be of agglomerated/fused type and be granular in nature. The consignment of flux shall be homogenous and free from any foreign matter. It shall be flow freely through the flux feeding system.

**5.2 Grain size:** Grain size distribution of flux shall be as follows:

- (a) Particles to remain within **10-30-44 BS** mesh  
Size equivalent to **1.7 mm, 500 micron and 350 micron** as per IS:460 Pt.I **90% min**
- (b) Particles above **5 BS** mesh equivalent to **3.5 mm** as per IS: 460 Pt.I **Nil**
- (c) Particles below **100 BS** mesh equivalent to **150 micron** as per IS: 460 Pt.I **2% max.**

**5.3 Basicity:**

**5.3.1** Basicity index of flux for all the grades shall be minimum **1.6**.

5.3.2 Basicity shall be determined by the formula given below:

$$\text{Basicity Index} = \frac{\text{CaO} + \text{CaF}_2 + \text{MgO} + \text{K}_2\text{O} + \text{Na}_2\text{O} + \text{Li}_2\text{O} + \frac{1}{2}(\text{FeO} + \text{MnO})}{\text{SiO}_2 + \frac{1}{2}(\text{Al}_2\text{O}_3 + \text{TiO}_2 + \text{ZrO}_2)}$$

The procedure for determination of Basicity is given in **Appendix “C”**

#### **5.4 Tap Density:**

Tap Density of flux shall be between **1.0 to 1.7** gm/c.c. The procedure for determination of Tap Density is given in **Appendix –“C”**

#### **5.5 Moisture Content:**

**5.5.1** The Moisture Content of flux when heated at 150°C for 2 hrs. will not exceed **0.3%**. The procedure for determination of Moisture Content shall be as given in **Appendix “C”**.

**5.6 Packaging:** To guard against ingress of moisture and accidental damage during transportation and storage till its consumption, the packaging shall be as follows:

**5.6.1** Flux shall be packed in plastic container, with replaceable lid which when placed tightly shall prevent any ingress of moisture.

**5.6.2** Net weight of the flux shall be max. 50 kg. The container shall contain the brand name, name of manufacturer, batch No., date of manufacture, current condition & welding parameter, grain size distribution, weight, IS Code, IRS Grade, guidelines on safety during welding, storage & handling and other special recommendations, if any. A tag containing all the information as above shall also be kept inside the container.

**5.6.3** Alternatively, flux shall be packed in a polythene inner bag sealed and kept it inside the polythene lined paper bag or polythene lined plastic bag. After filling the flux, these bags shall be sealed so that flux is protected through two polythene coverings. The thickness & strength of inner polythene & outer polythene lined bag shall be adequate resistance against transportation damage. The net weight of flux in this type of packaging shall be kept as 20±1 or 25±1. The outer bag shall contain the information as given in clause 5.6.2 for plastic container

#### **5.7 Requirement of acceptance for different grades of fluxes:**

**5.7.1** All the flux shall fulfill the conditions as laid down in clause **5.1 to 5.6**.

**5.7.2** The flux when used in conjunction with the wire of corresponding IRS grade/grades as recommended by the manufacturer shall produce satisfactory

crack free weld deposit meeting the acceptance criteria of that particular class of wire flux combination (weldment). When welded with normal parameter, slag shall be self-peeling or easily detachable by light tapping. The weld bead shall be sound and free from porosities and any other welding defect. Bead shape shall be flat to convex and blend evenly with the parent metal.

5.7.3 The acceptance criteria for each class of wire-flux combination (weldment) have been indicated in **Table.4**. The minimum value requirement of each criteria is either given in the table or reference to appropriate appendix and table has been made wherein details have been given.

**TABLE-4**  
**ACCEPTANCE CRITERIA OF WIRE-FLUX COMBINATION**  
**FOR SUBMERGED ARC WELDING**

S. No.	IRS Class of wire-flux combination	Corresponding Grade of wire Flux	Multirun All Weld		Two Run Weld		Chemical composition	Corrosion Resistance
			Mechanical	Radio Graphy/Ultrasonic	Mechanical	Radio Graphy/Ultrasonic		
1.	I	W-1,F-1	Tab-5	IW Blue/RDSO Procedure No.MC-4	Tab-6	IW Blue/RDSO Procedure No.MC-4	-	-
2.	II	W-2,F-2	-do-	-do-	-do-	-do-	-do-	-
3	III	W-3,F-3	-do-	-do-	-do-	-do-	Tab-7	-
4	IV	W-4,F-4	-do-	-do-	-do-	-do-	Tab-7	-
5	V	W-5,F-	-do-	-do-	-do-	-do-	Tab-7	Cl.F-4 of APP-F

5.7.3.1 **Mechanical properties of Multirun All Weld:** Method of preparation of Multirun All Weld assembly and test pieces for mechanical testing shall be as given in **Appendix “D”**.

5.7.3.2 **Mechanical properties of Two Run Weld:** Method of preparation of Two Run Weld assembly and test pieces for mechanical testing shall be as given in **Appendix “E”**.

Minimum acceptance values of different mechanical properties shall be as given in **Table-6.**

5.7.3.3 **Non Destructive Testing:** Both Multirun All Weld and Two Run Weld assembly shall be subjected to radiographic/ultrasonic examination. Minimum acceptance criteria shall be as per **IIW Blue Standard** for radiographic examination or as per **RDSO Procedure No.MC-4** for ultrasonic testing of plates.

5.7.3.4 **Chemical composition:** Method of preparation of pad weld and testing shall be as given in Appendix "B"  
The acceptable range of each element shall be as given in Table-7

5.7.3.5 **Corrosion Resistance:** Method of preparation of corrosion test assembly and testing shall be as per **Appendix "F"**.  
There shall not be any significant difference in the appearance of the parent plate, heat affected zone and weld zone with respect to corrosion.

**TABLE-5**

**Ref: Appendix 'D'**

**MECHANICAL PROPERTIES OF MULTIRUN ALL WELD**

IRS Class	UTS (N/mm <sup>2</sup> )	YS (N/mm <sup>2</sup> )	% Elongation on 5 x d G.L.	% Reduction in Area	Impact (Joules)
I	410	330	26	50	27 at -20°C
II	490	360	24	45	30 at -20°C
III	540	390	24	45	25 at -46°C
IV	590	450	20	40	25 at -20°C
V	490	350	22	40	50 at -20°C

**TABLE-6**

**Ref: Appendix 'E'**

**MECHANICAL PROPERTIES OF TWO RUN WELD**

IRS Class	Transverse tensile strength (N/mm <sup>2</sup> )	Bend Test at 90° bend both with face up & root up using 3T mandrel	Impact value (Jules)
I	410	Satisfactory without any crack	27 at -20°C
II	490	-do-	30 at -20°C
II	540	-do-	25 at -20°C
II	590	-do-	25 at -20°C
II	490	-do-	50 at -20°C

**TABLE-7**

**Ref: Appendix 'B'**

**CHEMICAL COMPOSITION OF WELDMENT**

S. No.	Class	Chemical composition %								
		C	Mn	Si	S	P	Mo	Ni	Cu	Cr
1	I	-	-	-	-	-	-	-	-	-
2	II	-	-	-	-	-	-	-	-	-
3	III	0.12	0.60	0.80	0.30	0.30	-	2.0-2.90	0.40	
4	IV	0.15	0.60	0.80	0.40	0.40	0.40-0.65	-	0.40	
5	V	0.10	0.25-0.90	0.28-0.90	0.045	0.045	-	0.28-0.75	0.25-0.75	0.35-1.20

**Note: 1) Single values in the above table are max. values.**

**2) Wt% of Cr + Wt% of Mn shall not exceed 2% for Sl.No.5**

**6.0 It shall be the responsibility of the flux manufacturer to submit free of cost one spool of wire of 3.15 mm dia. of corresponding grade for which approval is sought. However, RDSO reserves the right to test the flux against any approved brand of wire in the corresponding grade to arrive at a conclusion about the suitability of the flux against that particular grade of wire.**

**7.0 Retest:** Where any test specimen fails to satisfy the requirement of a particular test, twice the no. of test specimens for that test shall be prepared using filler wire and/or flux from the same batch wherever possible and subjected to the test in which failure occurred. The filler wire or the flux shall not be accepted as having passed that test unless all the test results on the additional specimens are satisfactory.

**8.0 Storage:** The spools of wire/container of flux shall be stored in some dry area to minimize ingress of moisture. The roof, floor and walls shall be made of damp proof concrete/brick. The storeroom shall not be used as storage place for grease, oil or other chemicals, which may affect the performance of wire or flux adversely. Preferably a separate room shall be allotted. The storing system shall be **First In First Out (FIFO)** to prevent undue storage.

## 9.0 **Shelf Life:**

- a) **Wire:** The shelf life of wire shall be minimum **9 months** from the date of receipt in Stores or **12 months** from the date of manufacture, whichever is more.
- b) **Flux:** the shelf life of flux shall be minimum **12 months** from the date of receipt in Stores or **18 months** from the date of manufacture, whichever is more.

## 10.0 **Approval of wire and flux:**

- 10.1 Research Design & Standard Organization, Manak Nagar, Lucknow has been entrusted with the job of assessment and approval of different brands of wire and flux for Sub-merged Arc Welding manufactured indigenously. The approval list shall be published once in a year, namely 1st July, wherein the brands of wire and flux found suitable under this specification will be listed. This approval list will be valid for three years. The procedure of approval has been detailed in **Appendix G**. **Appendix-H** describes sampling plan for wire and flux.
- 10.2 The firm desirous of getting its product approved may apply to the Director General(M&C), R.D.S.O., Lucknow-226 011 to that effect. On receipt of such application, the firm will be asked to deposit a sum as applicable from time to time in the form of Demand Draft payable to the **Executive Director (Finance), R.D.S.O., Lucknow** and forward the same to the **Director General(M&C), Manak Nagar, Lucknow-226 011**.
- 10.3 On receipt of such payment, the firm will be sent a copy of the specification along with Proforma of application Questionnaire Form and Schedule of Testing Charges.
- 10.4 Further processing will be done in line with the procedure of approval as given in **Appendix-G**.
- 10.5 A brand once assessed and found suitable will be included in the ensuring approval list and will remain valid for next three years after which the product has to be re-assessed for inclusion in the approval list.
- 10.6 General conditions, procedure for approval and other relevant information shall be as per **Appendix-G**.

**LIST OF APPENDICES**

1.	Appendix 'A'	Procedure for determination of Copper Content in coating of wires and Storage Stability test.
2.	Appendix 'B'	Procedure for determination of Chemical Composition of wire and wire & flux combination.
3.	Appendix 'C'	Procedure for determination of Basicity Index, Tap Density, Moisture Content and Grain Size Distribution of flux.
4.	Appendix 'D'	Procedure for preparation of Multirun All Weld assembly and test pieces.
5.	Appendix 'E'	Procedure for preparation of Two Run Weld assembly and test pieces.
6.	Appendix 'F'	Procedure for preparation of Corrosion Resistance Test assembly and testing.
7.	Appendix 'G'	General conditions, procedure for approval and other relevant information.
8.	Appendix 'H'	Sampling plan for wire and flux.

**APPENDIX 'A'**

**PROCEDURE FOR DETERMINATION OF COPPER  
CONTENT IN COATING OF WIRES AND  
STORATE STABILITY TEST**

**A-1 Copper Content in Coating:**

A-1.1 About 50 cms of wire of 3.15 mm dia. Shall be taken form coil and weighed on chemical balance ( $W_1$  gms).

A-1.2 After weighing, the wire shall be kept in 25% ammonia solution for about 10-12 hrs. Reaction may be accelerated and completed within 1 hour by addition of 1-3 cc of Hydrogen Peroxide.

A-1.3 After all the copper is dissolved, the wire shall be removed from ammonia solution, washed with distilled water and alcohol, dried and weighed ( $W_2$  gms.).

A-1.4 Difference in weight of wire (Cl.A-1 and A-1.3) shall be calculated.

A-1.5 The percentage of copper by weight =  $\frac{(W_1 - W_2)}{W_1} \times 100$

A-1.6 The percentage of copper by weight in copper coating shall be within 0.2-0.4%.

**A-2 Accelerated Storage Stability Test:**

A-2.1 A coil of wire shall be kept in a humidity chamber at 95%-100% RH at 48°C temperature for 24 hours.

A-2.2 After removal of coil from humidity chamber the wire shall be free from any rust or peeling off of copper coating from the surface.



## APPENDIX 'B'

### PROCEDURE FOR DETERMINATION OF CHEMICAL COMPSOITION OF WIRE AND WIRE-FLUX COMBINATION

#### **B-1 Solid (bare) wire:**

- B-1-1 Sample for analysis shall be taken from 3.15 mm dia. Wire.
- B-1.2 Chemical analysis of solid wire shall be conducted after removing the copper coating by emery paper.
- B-1.3 Clean wire shall be forged into flat condition and small chips cut out so that weighing and dissolve become easy.
- B-1.4 The wet analysis for different elements shall be carried out in accordance with IS: 228. The composition of the wire shall conform to the values given in **Table-3**.

#### **B-2 Wire-flux combination:**

- B-2.1 About 15 mm thick weld metal shall be deposited on mild steel plate conforming to IS: 2002-91 or IS: 2062-91 or its equivalent in flat position using 3.15 mm/4.0 mm wire to prepare a pad.
- B-2.2 Sufficient sample shall be taken from that weld metal by an appropriate means (by drilling or shaping). Metal for the analysis purpose shall not be taken closer than 5 mm from the base metal. No oil or other lubricant shall be used while removing the samples.
- B-2.3 The wet analysis for different elements shall be carried out in accordance with IS: 228.
- B-2.4 Spectrometric analysis may also be carried out on solid and smooth surface of the pad on at least 3 spots. The average of 3 readings shall be taken as the value for a particular element.
- B-2.5 In case of any controversy in the spectrometric analysis, wet analysis shall be considered as reference method.
- B-2.6 The chemical composition of wire-flux combination i.e. all weld metal shall conform to the range of values for respective IRS class given in **Table-7**

**APPENDIX 'C'**

**PROCEDURE FOR DETERMINATION OF BASICITY INDEX, TAP DENSITY, MOISTURE CONTENT AND GRAIN SIZE DISTRIBUTION OF FLUX**

**C-1 Basicity Index:**

C-1.1 Flux is to be dried in a drying oven at around 150°C for 1 hour.

C-1.2 Measured amount of flux shall be taken to analyse for determination of CaO, CaF<sub>2</sub>, MgO, K<sub>2</sub>O, Na<sub>2</sub>O, Li<sub>2</sub>O, MnO, FeO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub> and ZrO<sub>2</sub>.

C-1.3 Basicity of flux shall be determined as per the formula given below:

$$\text{Basicity Index} = \frac{\text{CaO} + \text{CaF}_2 + \text{MgO} + \text{K}_2\text{O} + \text{Na}_2\text{O} + \text{Li}_2\text{O} + \frac{1}{2}(\text{FeO} + \text{MnO})}{\text{SiO}_2 + \frac{1}{2}(\text{Al}_2\text{O}_3 + \text{TiO}_2 + \text{ZrO}_2)}$$

C-1.4 The minimum acceptable value of basicity Index shall be 1.6.

**C-2 Tap Density:**

C-2.1 Flux is to be dried in drying oven at around 150°C for 1 hour.

C-2.2 An empty 100 c.c. Graduated cylinder is to be carefully weighed (W<sub>1</sub> gms).

C-2.3 About 50 gms of dried flux is to be taken in the cylinder and weighed (W<sub>2</sub> gms).

C-2.4 The cylinder is to be kept on a vibratory platform or tapped lightly till the level of the flux in the cylinder reaches a constant.

C 2.5 The volume of the flux is to be recorded (V c.c.).

C 2.6 The density of flux shall be determined as per the formula given below-

$$\text{Tap Density} = \frac{W_2 - W_1}{V} \text{ gms/c.c}$$

C-2.7 The value of Tap density shall be between **1.0 – 1.7 gms/c.c.**

C-3 **Moisture Content:**

C-3.1 Some quantities of flux say 50 gms. is to be taken in a previously dried glass dish and carefully weighed ( $W_1$  gms).

C-3.2 The dish is to be placed in a drying oven at 150°C for 2 hours.

C-3.3 The dish is to weighed.

C-3.4 Clause 3.2 and 3.3 is to be repeated till weight becomes constant ( $W_2$  gms.).

C-3.5 Moisture content of the flux shall be determined as per the formula given below –

$$\text{Moisture content} = \frac{W_1 - W_2}{W_1} \times 100\%$$

C-3.6 The moisture content of flux shall be maximum **0.3%**.

C-4 **Grain size distribution:**

C-4.1 A sieve set is to be prepared consisting of BS: 5, 10, 30, 44 and 100 mesh or corresponding IS sieve No. along with base pan.

C-4.2 Flux is to be dried in drying oven at around 150°C for 1 hour.

C-4.3 100 gms of dried flux is to be kept at the top most pan and lid placed. The whole sieve set is to be put on a sieve shaker and shaken for 5 minutes.

C-4.4 The lid shall be opened after 2 minutes and contents of each sieve and bottom pan shall be weighed separately and reported.

C-4.5 If the sum total of all the weights becomes less than 99.5 gms., the results are to be discarded and repeat experiment shall be carried out.

C-4.6 The acceptance criteria shall be as per clause 5.2.

**APPENDIX 'D'**

**PROCEDURE FOR PREPARATION OF MULTIRUN  
ALL WELD ASSEMBLY AND TEST PIECES**

D-1 **Preparation of all weld test assembly:**

D-1.1 **Material**

D-1.1.1. Parent Plates and Backing Strips: The parent plates used for preparing test assembly and backing strip shall conform to IS: 2002, or any other equivalent specification.

D-1.1.2. Wire: The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4

D-1.1.3. Flux: The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.

D-1.2 **Dimensions:** The dimension of plates and backing strips shall be as given below.

(a) **Parent Plate**

Length	-	600 mm ± 10 mm
Breadth	-	150 mm ± 10 mm
Thickness	-	20 mm ± 2 mm
Edge Angle	-	10° ± 1°

(b) **Backing Strip:**

Length	-	700 mm ± 10 mm
Breadth	-	40 mm - 50 mm
Thickness	-	10-12 mm

D-1.3        **Pre-setting and Welding:**

- D-1.3.1        The back strip shall be tacked with parent plates at root gap of about  $24 \pm 1$  mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.
- D-1.3.2        Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.
- D-1.3.3        Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.
- D-1.3.4        The gap shall then be filled up by using 3.15 mm, 4.0 mm or 5.0 mm diameter of wire in combination with flux in flat position.
- D-1.3.5        Each run shall be properly de-slugged before putting another run on or adjacent to previous run.
- D-1.3.6        The temperature of weld assembly shall be kept between **110°C-180°C**. For this, inter pass time gap, if necessary shall be maintained.

D-2            **Preparation of test pieces:**

D-2.1        **Radiographic/Ultrasonic Examination:**

- D-2.1.1        About 20 mm from both sides of the assembly shall be cut and discarded.
- D-2.1.2        After removal of back strip, assembly shall be subjected to Radiographic/Ultrasonic examination.
- D-2.1.3        The assembly shall meet the criteria as given in **Clause 5.7.3.3**.
- D-2.1.4        After satisfactory completion of radiographic/Ultrasonic tests, the assembly shall be used for making tensile and impact test pieces.

D-2.2        **All Weld Tensile Test:**

- D-2.2.1.        Two tensile test pieces shall be made from weld metal consuming a length of about 300 mm.
- D-2.2.2.        The dimension of test piece shall be as per IS: 3613.

- D-2.2.3 The test piece shall be tested as per IS: 1608.
- D-2.2.4 The value of both test results shall meet the minimum requirement of offered class as given in **Table-5**.
- D-2.3 **Charpy Impact Test :**
- D-2.3.1 Six test pieces shall be made from the remaining plate.
- D-2.3.2 The dimension of test pieces shall be as per IS: 3613.
- D-2.3.3 From these test pieces, 5 nos. shall be tested as per IS: 1757 at required temperature as indicated in **Table-5** against different classes of wire-flux combinations.
- D-2.3.4 From these five test results, the highest and lowest results shall be discarded. The average of remaining three shall be taken as average impact value.
- D-2.3.5 One test piece shall be kept as spare, which shall be tested in case one more test results is to be discarded because of testing fault.
- D-2.3.6 The individual value of the three tests shall not fall below 20% of the minimum average value given in **Table-5** for respective class. The average value shall meet the minim requirement of offered class as given in **Table-5**

**APPENDIX 'E'**

**PROCEDURE FOR PREPARATION OF TWO RUN WELD ASSEMBLY AND TEST PIECES**

**E-1 Preparation of two run weld assembly:**

**E-1.1 Material**

E-1.1.1 Parent Plate: The parent plates used for preparing test assembly shall conform to IS: 2002, IS: 2062 or any other equivalent specification

E-1.1.2 Wire: The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4.

E-1.1.3 Flux: The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.

E-1.2 Dimensions: the dimensions and edge preparation of the plates shall be as given below:

Length	-	600 mm ± 10 mm
Breadth	-	150 mm ± 10 mm
Thickness	-	20 ± 2 mm
Edge Preparation	-	As per IS: 3613

**E-1.3 Presetting & Welding:**

E-1.3.1 The plates shall be tack welded at the ends keeping a gap of about 1 mm-2mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.

E-1.3.2 Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.

E-1.3.3 Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.

E-1.3.4 One welding run each shall be given from both the sides of the plates.

- E-1.3.5 The temperature of weld assembly shall be kept between 110°C-180°C. For this, inter pass time gap, if necessary shall be maintained.
- E-2 Preparation of test pieces:
  - E-2.1 Preparation of test pieces:
    - E-2.1.1 About 20 mm from both sides of the assembly shall be cut and discarded.
    - E-2.1.2 The assembly shall be subjected to Radiographic/Ultrasonic examination, the assembly shall be used for making test pieces.
    - E-2.1.3 The assembly shall meet the criteria as given in Clauses 5.7.3.3.
    - E-2.1.4 After satisfactory completion of Radiography/Ultrasonic examination, the assembly shall be used for making test pieces.
  - E-2.2 Transverse Tensile Test:
    - E-2.2.1 Two test pieces shall be made as shown in fig.1.
    - E-2.2.2 The test pieces shall be tested as per IS:1608.
    - E-2.2.3 The value of both test results shall meet the minimum requirement of offered class as given in Table-6.
  - E-2.3 Bend Test
    - E-2.3.1 Bend Test pieces shall be made as shown in fig.1.
    - E-2.3.2 The test pieces shall be tested as per IS: 1599. One piece shall be tested keeping one face in tension and other piece with opposite face in tension.
    - E-2.3.3 No crack shall appear on the tension face. However, minor cracks at the end may be ignored.
  - E-2.4 Charpy Impact Test:
    - E-2.4.1 Six test pieces shall be made as shown in fig.1.
    - E-2.4.2 The test pieces shall be tested as per IS: 17757.
    - E-2.4.3 From these test pieces, 5 nos. shall be tested as per IS: 1757 at temperature as indicated in Table-6 against different classes of wire-flux combinations



- E-2.4.4 From these five results, the highest and lowest results shall be discarded. The average of remaining three shall be taken as average impact value.
- E-2.4.5 One test piece shall be kept as spare, which shall be tested in case one more test result is to be discarded because of testing fault.
- E-2.4.6 The individual value of all three tests shall not fall below 20% of the minimum average value given in Table-6 for respective class. The average value shall meet the minim requirement of offered class as given in Table-6.

50 mm discarded minimum			
		30 mm Bend piece	
		30 mm Bend piece	
20 mm discard			
25 mm	25 mm	Transverse Tensile Piece	
25 mm	25 mm	Transverse Tensile Piece	
20mm discard			
		10 mm	Impact
		10 mm	
		10 mm	
		10 mm	
		10 mm	
		10 mm	
50mm discard minimum			

Fig.1 – Preparation of different test pieces from Two Run Weld Assembly.

**APPENDIX 'F'**

**PROCEDURE FOR PREPARATION OF CORROSION  
RESISTANCE TEST ASSEMBLY AND TESTING**

- F-1 Preparation of Corrosion Resistance Test Assembly:
- F-1.1 Material:
- F-1.1.1 Parent Plate: The parent plates shall conform to Indian Railways Standard Specifications IRS: M-41, IRS: M-42 or their equivalent.
- F-1.1.2 Backing Strip: The backing strip shall conform to IS: 2002, IS: 2062, IS: 2062, IRS: M-41, IRS: M-42 or their equivalent.
- F-1.1.3 Wire: The wire of 3.15 mm or 4.0 mm or 5.0 mm diameter shall be used. The grade of wire shall correspond to grade of flux as explained in Clause 3.4.
- F-1.1.4 Flux: The material to be tested. The flux must be preheated for specified time and temperature as recommended by the manufacturer.
- F-1.2 Dimension: The dimensions of plates and backing strips shall be as given bellow:
- (a) Parent Plate:
- |            |   |              |
|------------|---|--------------|
| Length     | - | 300mm ± 10mm |
| Breadth    | - | 150mm ± 10mm |
| Thickness  | - | 10mm ± 2mm   |
| Edge Angle | - | 10 ± 1       |
- (b) Backing Strip:
- |           |   |              |
|-----------|---|--------------|
| Length    | - | 400mm ± 10mm |
| Breadth   | - | 50mm ± 10mm  |
| Thickness | - | 10 ± 2mm     |
- F-1.3 Pre-setting and Welding:

- F-1.3.1 The back strip shall be tacked with parent plates at root gap of about  $24 \pm 1$  mm. The faces to be welded shall be free from dust, dirt, grease, oil or any other foreign material.
- F-1.3.2 Wire shall be fitted on the stand of the machine and flux shall be kept in well-connected flux hopper.
- F-1.3.3 Welding parameters like current, voltage, travel speed etc. shall be adjusted suitably as recommended by manufacturer.
- F-1.3.4 The gap shall then be filled up by using 3.15 mm or 4.0 mm or 5.0 mm diameter of wire in combination with flux in flat position.
- F-1.3.5 Each run shall be properly de-slagged before putting another run on or adjacent to previous run.
- F-1.3.6 The temperature of weld assembly shall be kept between  $110^{\circ}\text{C}$ - $180^{\circ}\text{C}$ . For this, inter pass time gap, if necessary, shall be maintained.
- F-1.3.7 Two such test assemblies shall be prepared as shown in fig.2.

**F-2 Preparation of Test Pieces:**

- F-2.1 After removing the back plate a square panel of 100mm x 100mm x 10mm shall be removed from center as shown in fig.3.
- F-2.2 A test panel of 100mm x 100 mm x 6mm shall be prepared as shown in fig.4 by shaping.
- F-2.3 The whole test panel shall be thoroughly polished.
- F-2.4 Two such panels shall be prepared from two test assemblies.
- F-2.5 One blank panel of same dimensions shall be prepared using same material of parent plates.

**F-3 Testing:**

Two test panels with weld bead at middle along with one blank panel shall be subjected to corrosion test at a temperature of  $42^{\circ}\text{C}$ -  $48^{\circ}\text{C}$  with humidity between 95%-100% as per Clause 18.0 of IS: 101. Condition of the weld and parent metal surfaces shall be examined after a period of seven day exposure as follows.

1st 24 hours	-	The weld assembly shall be Exposed as indicated in Cl.F-3.
--------------	---	--

- 2<sup>nd</sup> 24 hours - Air-dried at ambient temperature.
- 3<sup>rd</sup> to 7<sup>th</sup> day - The weld assembly shall be exposed as above.

F-4

**Acceptance Criteria:**

There shall not be any significant difference in the appearance of the parent plate, heat affected zone and weld zone with respect to corrosion.

DRAFT

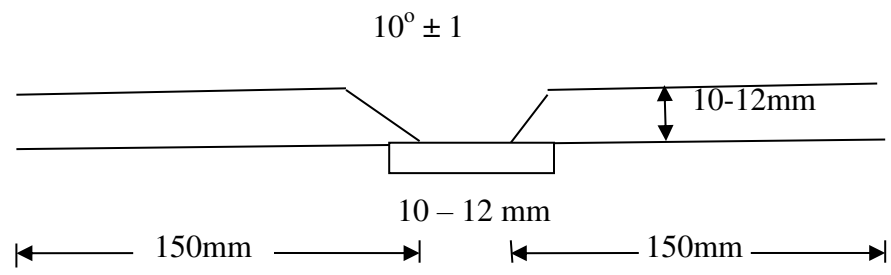


Fig.2 - Presenting of Plates & back strip before welding.

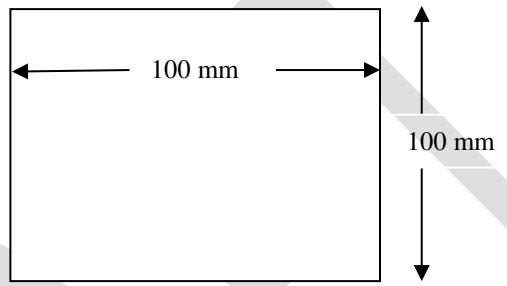


Fig.3 - Middle part of the assembly for making the test panel.

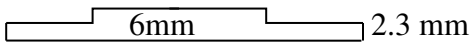
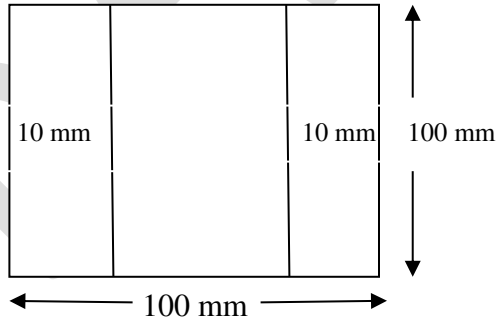


Fig.4- Plan & Elevation of the test panel.

## APPENDIX "G"

### GENERAL CONDITIONS, PROCEDURE FOR APPROVAL AND OTHER RELEVANT INFORMATION

- G-1 All the firms seeking RDSO approval must have ISO-9001/9002 certification for their product.
- G-2 All correspondence must be addressed to **Executive Director (M&C), RDSO/Lucknow-226 011.**
- G-3 All the payments must be made in the form of Demand Draft drawn in favour of "Executive Director (Finance), R.D.S.O., Lucknow" and forwarded to the address given in clause G-2. Payment in any other form shall not be accepted.
- G-4 In the application form, where space provided against any item is not adequate and where separate documents are to be attached as annexure, the same shall be allotted a number and the number shall be referred against the relevant item in the main body of the application form.
- G-5 The information given in reply to queries and various items of application form shall be clear, precise and to the point.
- G-6 All the items given on the application form shall be filled and no item shall be left blank or incomplete.
- G-7 The original application form shall be duly filled up and submitted to Executive Director(M&C), RDSO, Lucknow along with covering letter and list of annexure. The duly filled questionnaire form (one for each brand) shall also be submitted along with technical literature and latest test report with batch no. and date.
- G-8 On receipt, the application form shall be subjected to technical scrutiny. If on the basis of the information furnished in the application form, the infrastructure at the firm's Works are prima facie considered to be sufficient/satisfactory, the firm will be advised to deposit requisite inspection charges. Otherwise, the deficiencies observed will be conveyed to the firm for rectification.
- G-9 It is required to pay two days' inspection charges for initial approval and one day's charge for periodic inspection and sampling up to six brands of wire and flux.
- G-10 On receipt of inspection charges, RDSO official will visit the firm premises to inspect the infrastructure and facilities to assess technical capability of the firm for manufacturing such brands of wire/flux as

offered. The date of inspection will be conveyed to the firm well in advance.

G-11 During the visit, the inspecting official shall have access to all the department of manufacturer's Works, which concern the production, testing and quality assurance of the brands for which approval is sought. The manufacturer shall offer to inspecting official all the reasonable facilities to undertake assessment.

**G-12 Sampling:**

G-12.1 For initial approval:

G-12.1.1 During inspection if infrastructure/facilities are found sufficient /satisfactory, RDSO officer shall select samples of the offered brands as per sampling plan as given in Appendix 'H' for testing at RDSO. He shall satisfy himself that the packaging of the brands are being made as per clause 4.4 for wire and 5.6 for flux of the specification. Half of the quality sampled shall be treated as counter sample, which are to be preserved by the firm in safe custody till the approval is granted or otherwise. If approval is granted, these counter samples are to be preserved till the shelf life of the product is over. Other half shall be the sample for testing.,

G-12.1.2 An inspection report shall be submitted to competent authority for approval. If approved, estimate of testing charges shall be sent to the firm by post.

G-12.2 For periodic approval:

The inspection and sampling procedure will be same as above except that a joint report shall be drawn duly signed by both the inspecting official and representative of the firm. To save time, estimate of testing charges shall be handed over on the spot after satisfactory inspection and sampling. The joining inspection report shall be submitted to competent authority for ratification and the competent authority shall reserve the right to withdraw further proceeding if joint inspection and sampling is found satisfactory after due scrutiny.

G-13 For the purpose of sampling, the firm must submit minimum nos. of spools of 3.15 mm, 4 mm and/or 5 mm dia. of wire and/or minimum quantity of flux as mentioned in sampling plan at Appendix 'H'. failing which sampling of the brand shall not be carried out. Part sampling of any brand is not allowed.

G-14. Based on the estimate, the firm shall send the testing charges in the form of Demand Draft along with the selected samples to Welding Section of M&C Directorate, RDSO within 15 days from the date of inspection. Samples without testing charges shall not be accepted.

- G-15 In case testing charges are sent in part, testing shall be undertaken of those brands only for which testing charges have been received. The sampling of those brands for which testing charges have not been received will be treated null and void. Fresh inspection and sampling shall be carried out if the firm desires to get approval for those brands.
- G-16 After receipt of the samples along with testing charges, the brands offered will be tested as per the Specification.
- G-17 If the test results re found satisfactory, the firm as well as the brands offered will get approval. The name of such brands and manufacturer will appear against the respective IRS class in the ensuing approval list. Approval certificate to this effect will be issued to the firm.
- G-18 In case any of the brands offered fails to conform to this specification, the same shall be communicated to the firm with detailed test results. If none of the brands meets the specification, the firm shall not get approval.
- G-19 Testing equipment, namely UTM and Impact Testing Machine must be calibrated once in a year.
- G-20 During inspection, photocopies of the following documents must be submitted by the firm:
- (i) Telephone Bill/any other document for ownership of the factory.
  - (ii) Calibration certificate of UTM, Impact Testing Machine not more than one year old.
  - (iii) Latest Income Tax Clearance Certificate.
  - (iv) Valid ISO accreditation certificate.
- G-21 The firm shall maintain the following registers and records that shall be offered to inspecting official for scrutiny during inspection.
- (a) Attendance Register - Indicating that Production In charge and Quality Control In charge having requisite qualification are in regular pay roll.
  - (b) Inspection/Quality Control Register - Indicating that the Inspection and Quality Control of raw material and finished goods are being done regularly as per approved QAP.
  - (c) Rejection Register - Indicating that the substandard raw material and finished goods are effectively filtered out.



- (d) Customer Complain Register - Indicating the means and measures adopted to handle customer complaint.
- G-22 The assessment report will be issued by RDSO on 1st July every year. This report with approved list will be valid for the period of three years from the due date of issue of the report. After expiry of the validity period, the brands have to be re-assessed for further approval.
- G-23 Procedure of re-approval will start at least one year before the expiry of the validity. RDSO will normally send the call letter for submitting application for processing. If, however the same is not received by the firm, the firm has to send filled Questionnaire Form, Batch Test Certificate and Technical Leaflet along with inspection charges late3st by 31<sup>st</sup> August without waiting for call letter.
- G-24 If, at any point of time, it so happens that none of the brands of wire or flux manufactured by the firm has valid approval, then the approval of the firm shall automatically stand null and void. In such cases, the firm desirous of getting approval for its product has to apply as a new firm and go through the process of initiation approval. However, if the firm applies for re-approval within such time that its products if approved can be enlisted in the approval report whose due date of publication is within one year from the expiry of the last validity, the firm's application may be considered by approving authority depending on the merit of the case.
- G-25 The firm shall not shift the place of manufacture without due verification and approval of RDSO, which will make the firm liable for delisting.
- G-26 The firm shall not change the chemistry of wire and flux, grain size distribution, basicity, current condition and other welding parameters without approval of RDSO, which will make the brand liable for delisting.
- G-27. All the new firms/new products of an approved firm will be given approval in Part-II. The products approved in Part-II will be eligible for developmental/trial/educational/part orders. The product will be eligible for up gradation to part-I i.e. regular approval only after specified period of time and successful supply of specified quantity of material to Railways/Pus. Extant DOP of M & C Directorate will be followed for upgrading/downgrading/delisting of firms.
- G-28 RDSO may pick up samples for quality audit from any Zonal Railway Workshops or Production Units randomly to assess the quality of supply. If the quality of supply is not found conforming to the specification, the firm will be advised to attend joint inspection. If the complain is established during joint inspection it will be treated as a customer complain and appropriate action will be taken against the firm as per

extant DOP of M&C Directorate. Established complains received directly from the customer will also be taken into account for the purpose of taking action against the erring firm.

G-29

The firm shall have a minimum turnover, the value of which may vary from time to time. The firm has to submit documentary evidence in support of its statement of annual turnover.

DRAFT

**APPENDIX 'H'**

**SAMPLING PLAN FOR WIRE AND FLUX**

The basic purpose of sampling is to obtain real representative quantity of a particular welding consumable out of the entire bulk stock of the manufacturer. During inspection for periodic and initial assessment statistical methods as indicated in IS: 4905 will be resorted to. A few salient features of sampling are given below:

1. No. of samples to be drawn will be decided as per testing requirement.
2. The manufacturer has to submit a minimum lot size 'N' as indicated against each consumables so that representative sample can be drawn.
3. All the individual spools of the lot size 'N' must be of same batch.
4. Sampling of flux shall be done by coning & quartering process.
5. During sampling, double the quantity required in each size will be drawn and sealed. Half of the quantity sampled shall be treated as counter sample, which are to be preserved by the firm in safe custody till the approval is granted or otherwise. In case of any discrepancy while t4sting, reference may be drawn from the counter samples to finalize the issue. If approval is granted, these counter samples are to be preserved till the shelf life of the product is over. Other half shall be sent to RDSO for testing.

The minimum lot size requirement is given below:-

Type of Consumable	No. of Samples To be drawn	Minimum lot size to be offered
A) Wire (Size 3.15, 4.0 And/or 5.0mm)	2 spools of each size	15 spools of each size
B) Flux		
1) 25 Kg Container	4 Container	25 Container
2) 50 Kg Container	2 Containers	15 Container