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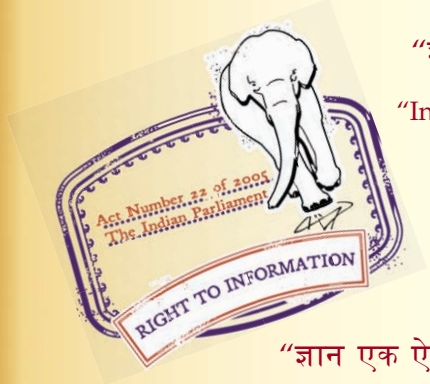

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Edition 3.2
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Indian Standard

SPECIFICATION FOR FILLER RODS FOR GAS WELDING

(Second Revision)

(Incorporating Amendment Nos. 1 & 2)

UDC 621.791.55.042

BUREAU OF INDIAN STANDARDS
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Indian Standard

SPECIFICATION FOR FILLER RODS FOR GAS WELDING

(Second Revision)

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Indian Standard
SPECIFICATION FOR FILLER RODS FOR GAS WELDING
(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 20 December 1972, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard, first published in 1958, was revised in 1967. In this second revision, the chemical compositions have been aligned with those specified in the following standards for filler rods and bare electrodes for inert gas arc welding:

IS : 5856-1970 Specification for corrosion and heat-resisting chromium-nickel steel solid welding rods and bare electrodes,

IS : 5857-1970 Specification for nickel and nickel alloy bare solid welding rods and electrodes,

IS : 5897-1970 Specification for aluminium and aluminium alloy welding rods and wires and magnesium alloy welding rods,

IS : 5898-1970 Specification for copper and copper alloy bare solid welding rods and electrodes,

IS : 6419-1971 Specification for welding rods and bare electrodes for gas shielded arc welding of structural steels, and

IS : 6560-1972 Specification for molybdenum and chromium-molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding.

0.2.1 The sizes of the rods have been based on ISO/R 546-1967 'Lengths and tolerances for drawn or extruded filler rods for welding supplied in straight lengths' issued by International Organization for Standardization.

0.3 Gas welding is used both for fabrication and repair purposes. The type of filler rods needed for a specific purpose depends on the parent metal to be welded, the strength required, etc. It is expected that this standard would form a useful guide in the manufacture and selection of filler rods. The use of filler rods is given in Appendix A for information.

0.4 This standard keeps in view the manufacturing and trade practices being followed in the country in this field. Assistance has also been derived from BS 1453 : 1972 Specification for filler materials for gas welding (metric units), issued by the British Standards Institution.

0.5 This edition 3.2 incorporates Amendment No. 1 (August 1977) and Amendment No. 2 (December 1980). Side bar indicates modification of the text as the result of incorporation of the amendments.

0.6 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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This specification covers requirements of ferrous and non-ferrous filler rods for gas welding, made of the following materials supplied in cut lengths:

a) Structural steels,

b) Austenitic stainless steels,

c) Cast irons (excluding spheroidal graphite and malleable iron castings),

d) Copper and copper alloys,

e) Nickel and nickel alloys,

f) Aluminium and aluminium alloys, and

g) Magnesium and magnesium alloys.

2. GENERAL REQUIREMENTS

2.1 For the purpose of this specification, the general requirements shall be as specified in IS : 1387-1967†.

3. DIMENSIONS AND TOLERANCES

3.1 The diameters of the filler rods shall be as given in Table 1.

3.1.1 The tolerance on the diameter of cast iron filler rods shall be ± 0.08 mm. For other gas welding filler rods the tolerance on diameter shall be as given in Table 1.

3.2 Length — Rods less than 2.5 mm diameter shall preferably be supplied in lengths of 500 or 1 000 mm. Rods 2.5 mm and larger in diameter shall preferably be supplied in lengths of 1000 mm. Rods may be supplied in other lengths by mutual agreement between the purchaser and the manufacturer.

3.2.1 Tolerance on each length of cast iron filler rods shall be $^{+6}_{-50}$ mm. For all other filler rods the tolerance on length shall be ± 5 mm.

*Rules for rounding off numerical values (*revised*)

†General requirements for the supply of metallurgical materials (*first revision*)

4. CONDITION OF SUPPLY

4.1 Filler rods shall have a smooth finish and shall be free from surface imperfections, corrosion products, grease, excessive oxide or other foreign matter which would adversely affect the properties of the weld.

TABLE 1 DIAMETERS AND TOLERANCES OF FILLER RODS

(*Clause* 3.1)

DIAMETER mm	TOLERANCE mm
1.00, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00, 5.00, 6.30	± 0.05
8.0, 10.0, 12.5	+ 0.05 − 0.10

4.2 Unless otherwise specified, the structural steel filler rods shall be supplied with a protective copper coating. It shall be a uniform well bonded, smooth coating applied over a thoroughly cleaned surface. The copper content of the coated rod expressed as a percentage of the rod plus the coating shall not exceed 0.4 percent by weight. In the case of types S-FS 4 and S-FS 5 (*see* Table 2) the protective coating is not mandatory.

4.3 Aluminium, aluminium alloy and magnesium alloy filler rods shall be supplied in the as-manufactured (M) condition.

5. CHEMICAL COMPOSITION

5.1 The material shall have a chemical composition in accordance with the requirements specified in Tables 2 to 8 for the particular type ordered.

5.2 Method of Chemical Analysis

5.2.1 The low alloy steel and cast iron rods shall be analysed by the method specified in IS : 228-1959*.

5.2.2 The chemical analysis of austenitic stainless steel rods and magnesium and magnesium alloy rods shall be carried out in accordance with the method as agreed to between the purchaser and the manufacturer until an Indian Standard is prepared on the subject.

5.3 Aluminium and aluminium alloy rods shall be analysed as specified in IS : 504-1963†.

*Methods of chemical analysis of pig iron, cast iron and plain carbon and low-alloy steel (*revised*) (Since revised and split into various parts).

†Methods of chemical analysis of aluminium and its alloys (*revised*).

TABLE 2 CHEMICAL COMPOSITION OF FERRITIC STEEL FILLER RODS

(*Clauses* 4.2 *and* 5.1)

(All quantities expressed as percentages)

TYPE	CARBON		SILICON		MANGANESE		NICKEL		CHROMIUM		MOLYBDENUM		SULPHUR,	PHOSPHORUS,
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Max*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
S-FS1	—	0.10	—	—	—	0.60	—	0.25*	—	—	—	—	0.040	0.040
S-FS2	0.10	0.20	0.10	0.35	1.00	1.60	—	—	—	—	—	—	0.040	0.040
S-FS3	0.25	0.30	0 30	0 50	1.30	1.60	—	0.25*	—	0.25*	—	—	0.040	0.040
S-FS4	0.25	0.35	0.10	0 35	0.35	0.75	2.75	3.25	—	0.30*	—	—	0.040	0.040
S-FS5	0.35	0.45	0.40	0.70	0.90	1.10	—	—	0 90	1.20	—	—	0.035	0.035
S-FS6	—	0.15	0 25	0.30	0.60	1.50	—	0.20*	—	0.20*	0.45	0.65	0.040	0.040
S-FS7	0.08	0.15	0 10	0.35	0.80	1.10	—	—	—	—	—	—	0.040	0.040
S-FS8	—	0.12	0.20	0.90	0.40	1.60	—	—	1.10	1.50	0.45	0.65	0.030	0.030
S-FS9	—	0.12	0.20	0.90	0.40	1.60	—	—	2.00	2.70	0.90	1.10	0.030	0.030

*If present as a residual element.

TABLE 3 CHEMICAL COMPOSITION OF AUSTENITIC STAINLESS STEEL FILLER RODS

(*Clause* 5 1)

(All quantities expressed as percentages)

TYPE	CARBON		SILICON		MANGANESE		NICKEL		CHROMIUM		MOLYBDENUM		NIOBIUM*	SUL-PHUR, *Max*	PHOS-PHORUS, *Max*
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
S-B01	—	0 08	0 25	0 60	1 0	2 5	9 0	11 0	19 5	22 0	—	—	—	0 030	0 030
S-B01L	—	0 08	0 25	0 60	1 0	2 5	9 0	11 0	19 5	22 0	—	—	—	—	—
S B02MoL	—	0 03	0 25	0 60	1 0	2 5	11 0	14 0	18 0	20 0	2 0	3 0	—	0 030	0 030
S-Bo2MoNb	—	0 08	0 25	0 60	1 0	2 5	11 0	14 0	18 0	20 0	2 0	3 0	1 0 *Max* 8 × C to 1 0 *Max*	0 030	0 030
S-B03MoNb	—	0 08	0 25	0 60	1 0	2 5	13 0	15 0	18 5	20 5	3 0	4 0	10 × C to 1 0	0 030	0 030
S-B04	—	0 12	0 25	0 60	1 0	2 5	12 0	14 0	23 0	25 0	—	—	—	0 030	0 030
S-B04Nb	—	0 12	0 25	0 60	1 0	2 5	12 0	14 0	25 0	25 0	—	—	10 (C – 0 02) to 1 3 *Max*	0 030	0 030
S-B05	0 08	0 15	0 25	0 60	1 0	2 5	20 0	22 5	25 0	28 0	—	—	—	0 030	0 030
S-B05Nb	0 06	0 13	0 25	0 60	1 0	2 5	20 0	22 5	25 0	28 0	—	—	10 × C 1 3	0 030	0 030

*C under this column indicates the actual carbon content

NOTE — Single values shown are maximum percentages except otherwise stated

TABLE 4 CHEMICAL COMPOSITION OF CAST IRON FILLER RODS

(*Clause* 5.1)

(All quantities expressed as percentages)

TYPE	CARBON		SILICON		MANGANESE		NICKEL		SULPHUR, *Max*	PHOSPHORUS, *Max*
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
S-CI 1	3.0	3.6	2.8	3.5	0.5	1.0	-	-	0.15*	1.5
S-CI 2	3.0	3.6	2.0	2.5	0.5	1.0	—	—	0.15*	1.5
S-CI 3	3.0	3.5	2.0	2.5	0.5	1.0	1.25	1.75	1.10	0.50

*The sulphur content should be kept as low as possible.

5.3.1 Copper and copper alloy rods shall be analysed as specified in IS : 440-1964*.

5.4 The manufacturer shall carry out analysis from each cast of materials and when required by the purchaser, shall supply a certified cast analysis for each cast of metal.

5.4.1 If required by the purchaser, adequate quantity of rod or wire representing each cast shall be made available to perform a check analysis and ensure that the chemical composition conforms to the specified requirements.

6. METHOD OF SAMPLING

6.1 Sampling of Ferritic Steel and Austenitic Stainless Steel Filler Rods

6.1.1 The location and the method of sampling shall be as agreed to between the supplier and the purchaser.

6.1.2 The area to be sampled shall be from the combined transverse sections obtained by bundling the rods or wires after cutting into suitable lengths or by folding. The area shall be cleaned by grinding or pickling. The sample shall be collected by milling out the areas.

6.1.3 When heat treatment is required to reduce the hardness of the sample piece before machining, the annealing temperature and time shall be kept to a minimum and a suitable discard of the decarburized surface layer shall precede collection of the sample for analysis.

6.2 Sampling of filler rods not covered in **6.1** shall be done in accordance with IS : 1817-1961†.

*Methods of chemical analysis of copper (*revised*).

†Methods of sampling non-ferrous metals for chemical analysis

TABLE 5 CHEMICAL COMPOSITION OF COPPER AND COPPER ALLOY FILLER RODS

(*Clause* 5.1)

(All quantities expressed as percentages)

TYPE	COPPER	ZINC	LEAD	ALUMINIUM	IRON	NICKEL	MANGANESE	SILICON	TIN	ARSENIC	ANTIMONY	BISMUTH	PHOSPHORUS	TELLURIUM	TOTAL IMPURITIES (EXCL. SILVER NICKEL, ARSENIC, PHOSPHORUS)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
S-C1	99.85* (*Min*)	—	0.010	—	0.030	0.10	—	—	0.01	0.05	0.005	0.003	0.015-0.08	0.01†	0.060
S-C2	94.0	1.5	0.02	0.01	0.5	—	1.5	2.8-4.0	1.5	—	—	—	—	—	0.50
S-C3	93.5	—	0.02	0.01	—	—	—	—	4.0 6.0	—	—	—	0.10-0.35	—	0.50
S-C4	Remainder	0.02	0 02	9.0-11.0	1.5	—	—	1.10	—	—	—	—	—	—	0.50
S-C5	Remainder	0.02	0.02	11.0-12.0	3.0-4.25	—	—	0 10	—	—	—	—	—	—	0.50
S-C6	57.0-63.0	Remainder	0.03	0.03	—	—	—	0.2-0.5	0.5	—	—	—	—	—	—
S-C7	59.0-61.0	Remainder	0.03	0.03	0.15	—	—	—	0.10	0.05	0.05	0.05	—	—	—
S-C8	57.0-63.0	Remainder	0.03	0.03	0.1-0.5	—	0.05-0.25	0.15-0.3	0.5	—	—	—	—	—	—
S-C9	45.0-53.0	Remainder	0.03	0.03	0.5	8.0-11.0	0.5	0 15-0 5	0.5	--	—	—	—	—	—
S-C1041	0-45.0	Remainder	0.03	0.03	0.3	14.0-16.0	0.2	0.2-0.5	1.0	—	—	—	—	—	—

*Also includes silver 0.5 percent, *Min* and 1.2 percent, *Max*.

†Selenium plus tellurium 0.020 percent, *Max*.

NOTE — Single values shown are maximum percentages except otherwise stated

TABLE 6 CHEMICAL COMPOSITION OF ALUMINIUM AND ALUMINIUM ALLOY FILLER RODS

(*Clause* 5.1)

[Extract from IS : 739-1966 Specification for wrought aluminium and aluminium alloys, wire (for general engineering purposes) (revised)]

(All quantities expressed as percentages)

IS Designation	Aluminium	Copper	Silicon	Iron	Manganese	Zinc	Magnesium	Chromium	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
S-G1	99.99	—	—	—	—	—	—	—	Cu + Si + Fe = 0.01 *Max*
S-G1A	Remainder	0.02	0.15	0.15	0.03	0.06	—	—	Cu + Si + Fe + Mn + Zn = 0.20 *Max*
S-G1B	Remainder	0.05	0.30	0 40	0.05	0.10	—	—	Cu + Si + Fe + Mn + Zn = 0.50 *Max*
S-NG21	Remainder	0.10	4.5 to 6.0	0.60	0.50	—	—	—	The supplier shall undertake that the material does not contain the following impurities in excess of the amounts stated:
S-NG2	Remainder	0.10	10 0 to 13.0	0.60	0.50	—	—	—	
									Percent
									Magnesium 0.25
									Nickel 0.20
									Zinc 0.20
									Tin 0.05
									Lead 0.05
S-NG3	Remainder	0.1	0.6	0.7	1.0 to 1.5	—	—	—	The supplier shall undertake that the material does not contain zinc in excess of 0 2 percent.
S-NG5	Remainder	0.10	0.6	0.7	0.6	—	2.8 to 4.0	0.25	
S-NG6	Remainder	0.10	0 6	0.7	0.4	—	4.5 to 5.5	0.25	

TABLE 7 CHEMICAL COMPOSITION OF MAGNESIUM ALLOY FILLER RODS

(*Clause* 5.1)

(All quantities expressed as percentages)

TYPE	MAGNESIUM	ZINC, *Max*	MANGANESE		ALUMINIUM		COPPER, *Max*	SILICON, *Max*	IRON, *Max*	NICKEL, *Max*	CALCIUM *Max*	REMARKS
			Min	*Max*	*Min*	*Max*						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
S-Mg 1	Remainder	1.0	0.15	0.4	9.0	10 5	0 15	0.30	0 03	0.01	—	Cu + Si + Fe + Ni = 0.40 *Max*
S-Mg 2	Remainder	1.5	0 15	0.40	5.5	8.5	0 05	0.05	0.03	0.005	—	—
S-Mg 3	Remainder	0.6-1.4	0.15	0.7	2.5	3.5	0.05	0.30	0.005	0 005	0.3	—
S-Mg 4	Remainder	0.03	1.0	2.0	—	0 08	0.02	0.05	0.03	0.005	0 02	—

TABLE 8 CHEMICAL COMPOSITION OF NICKEL AND NICKEL ALLOY FILLER RODS

(*Clause* 5.1)

(All quantities expressed as percentages)

TYPE	NICKEL AND COBALT	IRON, *Max*	TITANIUM, *Max*	CHROMIUM	MANGANESE, *Max*	CARBON, *Max*	SILICON, *Max*	COPPER, *Max*	SULPHUR, *Max*	OTHER ELEMENTS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
S-Ni 1	97.00 (Min)*	0.40	0.40	—	0.35	0 15	1.00	0.25	0.01	0.50
S-Ni 2	63.00-70.00	2.50	—	—	2.00	0.30	0.50	Remainder	0.02	0.50
S-Ni 3	Remainder*	0.50	—	18.0-20.0	1.20	0.25	0.50	0.20	—	—

*Cobalt, if present, shall not exceed 1.00 percent.

7. TESTS

7.1 Where required, the inter-crystalline corrosion (embrittlement) test as given under **7.2** shall be conducted in the case of austenitic stainless steel filler rods.

7.2 A test piece cut from a rod or wire from each cast shall be tested in accordance with the method given in Appendix B. On completion of the test, the test piece shall show no signs of cracking.

7.3 Retests — Should any one of the test pieces first selected fail to pass the test specified under **7.2**, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both of these additional samples pass the test, the material represented by the test samples shall be deemed to comply with the requirements of the test. Should a test piece from either of these additional samples fail, the material represented by the test samples shall be liable for rejection.

8. PACKING

8.1 Filler rods shall be suitably packed to guard against damage, contamination or deterioration during storage, transit and inspection.

9. MARKING

9.1 Each package of filler rods shall be clearly marked with the following information:

a) Type,

c) Name of manufacturer,

c) Trade designation of rods,

d) Size, and

e) Cast number/batch number.

9.1.1 The package may also be marked with the ISI Certification Mark.

NOTE The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

APPENDIX A

(*Clause* 0.3)

GUIDE FOR SELECTION AND USE OF GAS WELDING RODS

A-1. FERRITIC STEEL FILLER RODS

Type S-FS 1	This is a general purpose low-carbon mild steel rod meant for application where a minimum butt-weld strength of 340 N/mm^2 (35.0 kgf/mm^2) is required.
Type S-FS 2	This is a mild steel rod intended for application in which minimum butt-weld tensile strength of 430 N/mm^2 (44.0 kgf/mm^2) is required. It is not intended for general welding purpose.
Type S-FS 3	This is a medium tensile steel rod intended for application when a minimum butt-weld tensile strength of 490 N/mm^2 (50 kgf/mm^2) is required.
Type S-FS 4	This rod containing 3 percent nickel is intended for use in repair and reconditioning of parts which have to be subsequently hardened and tempered.
Type S-FS 5	This type of rod is applicable for welding steels of similar classification.
Type S-FS 6	This type of rod is intended for use in the welding of alloy steels of the 0.5 percent molybdenum type with or without chromium.
Type S-FS 7 Type S-FS 8 Type S-FS 9	These types of rods are applicable for welding steels of similar classification.

A-2. AUSTENITIC STAINLESS STEEL FILLER RODS

Type S-BO 1	Filler rods of this type are most often used to weld base metal of similar composition.
Type S-BO 1 L	The composition of this filler metal is identical to Type S-BO 1 except for the carbon content. By specifying low carbon in this filler rod it is possible to obtain stability

from intergranular corrosion due to carbon precipitate without the use of stabilizers, such as columbium or titanium. These low carbon alloys, however, are not as strong at elevated temperatures as the columbium stabilized alloys.

Type S-BO 2 — Filler rods of this type are more successful in applications involving special alloys for high surface temperatures. The presence of molybdenum provides increased creep resistance at elevated temperatures.

Type S-BO 2 L — The composition and use of this filler rod is identical to S-BO 2 except for the carbon content. By specifying low carbon in this type it is possible to obtain stability from intergranular corrosion due to carbide precipitates without the use of stabilizers, such as columbium and titanium. The alloy is, however, not as strong at elevated temperatures as the columbium stabilized alloy.

Type S-BO 2 Nb — The composition of this filler rod is identical to S-BO 2 except for the addition of columbium. Columbium provides stabilization against another granular corrosion due to carbide precipitation. These filler metals are used primarily for welding base metals of similar composition.

Type S-BO 3 Mo — The alloy content of this type is somewhat higher than the type S-BO 2, particularly in molybdenum. It is normally used for welding alloy sectional composition. Its use is usually limited to severe corrosion applications involving sulphuric and sulphurous acids and their salts.

Type S-BO 4 — The filler rod is commonly used for welding similar alloys in wrought or cast forms. Occasionally it is used to weld 18-8 base metals when severe corrosion conditions exist which require higher alloy content weld metal. It is also used in welding dissimilar metals, such as joining 18-8 to mild steel, welding the

clad side of 18-8 quality steels and for applying sheet linings of 12 percent chromium steels to mild steel shells.

Type S-BO 5 — Filler rods of this type are most often used to weld base metals of similar compositions.

Type S-BO 5 Nb — Addition of columbium provides stabilization against inter-granular corrosion due to carbide precipitation. These filler rods are used primarily for welding base metals of similar composition.

A-3. CAST IRON FILLER RODS

Type S-CI 1 — This type of filler rod containing high silicon content is intended for use in the welding of cast iron where an easily machinable deposit is required.

Type S-CI 2 — These rods are intended for welding cast iron where a harder deposit than that obtained from Type S-CI 1 is required, such as in the building up of valve seats and similar parts.

Type S-CI 3 — These filler rods contain 1.25 to 1.75 percent nickel and are intended for use in the welding of nickel cast iron and other alloy cast irons where greater strength and wire resistance are required.

A-4. COPPER AND COPPER ALLOY FILLER RODS

Type S-C 1 — These rods are used in the welding of copper.

Type S-C 2 — These rods containing approximately 3 percent silicon are used for welding of copper, copper silicon and copper zinc base metals between themselves and also to steel. A slightly oxidizing flame will give better results.

Type S-C 3 — The filler metals contain about 5 percent tin with up to 0.30 percent phosphorus added as a deoxidizer. The tin increases the wear resistance of the weld metal and also broadens the temperature range between liquidus and solidus points, thereby slowing

up solidification of the weld metal. This slower solidification increases the tendency to hot shortness. To minimize this effect the weld pool should be kept small and welding time as short as possible. The filler rods are used to weld copper and copper tin base metals.

Type S-C 4 — The deposits from these aluminium bronze welding rods are characterized by their relatively high mechanical properties tensile strength, yield strength and hardness. The filler material is used for joining aluminium bronze of similar composition, high strength copper zinc alloys, silicon bronze, semi-copper nickel alloys, ferrous metals, dissimilar metals and to provide bearing, wear and corrosion resisting surfaces.

Type S-C 5 — These filler rods are intended for use in the bronze welding (brass welding) of copper and mild steel and for the fusion welding of materials of the same or closely similar composition.

Type S-C 6 — These rods contain 0.5 percent tin which improves the strength and corrosion resistance. The rods are primarily used in bronze welding steel, cast iron, and malleable iron. They are also used in gas welding of brass, and bronze welding of copper, bronze and nickel alloys.

Type S-C 7 — These rods are used to weld base metal of similar composition.

Type S-C 8 — These manganese bronze (high tensile brass) rods are intended for use in the bronze welding of copper, cast iron, and malleable iron and for fusion welding of materials of same or closely similar composition.

Type S-C 9 — These medium nickel bronze (medium tensile nickel brass) rods are intended for use in the bronze welding of mild steel, cast iron or malleable iron.

Type S-C10 — These high nickel bronze (high tensile nickel brass) rods are intended for use in the bronze welding (brass welding), of cast iron or malleable iron.

A-5. ALUMINIUM AND ALUMINIUM ALLOY FILLER RODS

Type S-G 1	These rods are intended for use in the welding of aluminium Grade I in places where corrosion resistance or other special properties of the joint are required.
Type S-G 1A	These rods are used for welding of aluminium Grade IA in places where corrosion resistance is of the utmost importance. It is recommended that rods of purity equal to or higher than the parent metals should be used.
Type S-G 1B	These rods are used for welding of aluminium Grade IB in places where corrosion resistance is of the utmost importance. It is recommended that rods of purity equal to or higher than the parent metals should be used.
Type S-NG 21	The rods containing 5 percent silicon are intended for use in the welding of aluminium casting alloys except those containing magnesium or zinc as the main addition. They may also be used to weld wrought aluminium magnesium-silicon alloys.
Type S-NG 2	These filler rods containing 10 percent silicon are intended for the welding of aluminium casting alloys except those containing magnesium or zinc as the main addition. They may also be used to weld wrought aluminium-magnesium silicon alloys.
Type S-NG 3	These rods are intended to weld aluminium alloys of similar composition.
Type S-NG 5	These rods are intended to weld aluminium alloys of similar composition (*see* Appendix C).
Type S-NG 6	These rods are used to weld aluminium alloys of similar composition and wrought alloys of lower magnesium content (*see* Appendix C).

A-6. MAGNESIUM ALLOY FILLER RODS

S-MG 1 S-MG 2 S-MG 3 S-MG 4	These filler rods are used to weld magnesium alloys of similar composition.

A-7. NICKEL AND NICKEL ALLOY FILLER RODS

S-NI 1 S-NI 2 S-NI 3	These filler rods are used for welding nickel alloys of similar composition.

APPENDIX B

(Clause 7.2)

INTER-CRYSTALLINE CORROSION (EMBRITTLEMENT) TEST

B-1. The test piece shall be heated at 650°C for 30 minutes and cooled in air. It shall then be immersed for 72 hours in a boiling solution prepared as follows:

Dissolve 111 g of copper sulphate ($CuSO_4 \cdot 5H_2O$) in 98 g of concentrated sulphuric acid, made up to 1 litre with distilled water.

B-2. Precautions shall be taken during boiling to prevent concentration due to evaporation.

B-3. The test piece shall then withstand bending, without cracking, when bent through 90° over a radius equal to four times the diameter of the test piece.

APPENDIX C

(Clause A-5)

WELDING OF ALUMINIUM-MAGNESIUM ALLOYS AND ALUMINIUM-MAGNESIUM SILICON

C-1. Aluminium alloy N4 has approximately 2.5 percent magnesium which renders the weld liable to crack under restraint. Although it is possible to make good welds in this material using N4 filler rod, it is a common practice to use a higher magnesium content alloy, such as N5 or N6. In addition to being used with parent metal N6, the NG6 filler rods and wires (5 percent magnesium) are commonly used for welding N4, N5 and N8 alloys, since joint strength is improved because of the increased magnesium content in the weld metal. It is also often convenient to use only one filler rod material for a range of parent metal.

C-2. The composition of wrought aluminium-magnesium-silicon alloys are such that when welded under restraint, cracking may occur when no filler or parent metal is used. When welding material of the aluminium-magnesium-silicon type, the NG2, NG21 or NG6 filler rods may be used, as these materials lessen the risk of cracking in the weld bead.

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