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METRIC UNITS

SPECIFICATION FOR

MATERIALS FOR RESISTANCE WELDING ELECTRODES AND ANCILLARY EQUIPMENT

BRITISH STANDARDS INSTITUTION

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MATERIALS FOR RESISTANCE WELDING ELECTRODES AND ANCILLARY EQUIPMENT

BS 4577 : 1970

BRITISH STANDARDS INSTITUTION
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THIS BRITISH STANDARD, having been approved by the Non-ferrous Metals Industry Standards Committee, was published under the authority of the Executive Board on 20 March, 1970.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, price £1. The BS Yearbook may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 18. Methods for tensile testing of metals.
BS 240. Method for Brinell hardness test.
BS 427. Method for Vickers hardness test.
BS 891. Method for Rockwell hardness test.
BS 1420. Glossary of terms applicable to wrought products in copper, zinc and their alloys.
BS 3239. Determination of resistivity of metallic electrical conductor materials.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following BSI references relate to the work on this standard:
Committee reference NFE/29 Draft for comment 67/24342

CONTENTS

APPENDICES

TABLES

CO-OPERATING ORGANIZATIONS

The Non-ferrous Metals Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Aluminium Federation
Association of Bronze and Brass Founders
Association of Consulting Engineers
Board of Trade
British Bronze and Brass Ingot Manufacturers' Association
*British Electrical and Allied Manufacturers' Association
British Lead Manufacturers' Association
British Non-ferrous Metals Federation
British Non-ferrous Metals Federation High Conductivity Copper Group
*British Non-ferrous Metals Research Association
*Copper Development Association
Crown Agents for Oversea Governments and Administrations
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Institute of Metals
Institution of Mechanical Engineers (Automobile Division)
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Institution of Production Engineers
Institution of Structural Engineers
Lead Development Association
Light Metal Founders' Association
London Metal Exchange
Magnesium Industry Council
Ministry of Defence, Army Department
Ministry of Defence, Navy Department
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*Society of Motor Manufacturers and Traders Ltd.
Tin Research Institute
Zinc Development Association
*Individual manufacturers

The scientific and industrial organizations marked with an asterisk in the above list, together with the following were directly represented on the committee entrusted with the preparation of this British Standard:

Welding Institute

BRITISH STANDARD SPECIFICATION FOR

MATERIALS FOR RESISTANCE WELDING ELECTRODES AND ANCILLARY EQUIPMENT

FOREWORD

This British Standard, authorized by the Non-Ferrous Metals Industry Standards Committee, specifies the requirements for materials for resistance welding equipment.

SPECIFICATION

1. SCOPE

1.1 SCOPE

This British Standard specifies requirements for wrought, sintered and cast metal products associated with resistance welding electrodes and ancillary equipment, i.e. materials for equipment which can generally be considered as consumable and which are used for carrying current and transmitting force to the work.

2. GENERAL REQUIREMENTS

2.1 GENERAL

The materials shall comply with the general requirements set out in the following clauses and the specific requirements in 3 or 4, as appropriate.

2.2 DEFINITIONS

For the purposes of this British Standard, the following definitions apply:

(1) *Rod.** A round, square or polygonal solid product usually supplied in straight lengths.

(2) *Bar.** Rod of rectangular cross section over 10·0 mm thick and up to and including 300 mm wide.

(3) *Rolled flat product.** Flat material brought to final thickness by rolling. It may be supplied in straight lengths or coiled. The edges may be unsheared or finished by shearing, slitting, sawing, machining, or rolling.

(4) *Drawn flat product.** Flat material with square or rounded corners or edges obtained by drawing through a die with or without subsequent rolling. It may be supplied in straight lengths, or coiled.

* Extracted from BS 1420, ' Glossary of terms applicable to wrought products in copper, zinc and their alloys '.

(5) *Section.** A solid product with cross section other than round, hexagonal, square or rectangular, such as angle or channel supplied in straight lengths.

(6) *Forging.** A shape produced by hammering or pressing, usually when hot, between open or closed dies.

(7) *Sintered product.* A material manufactured by one of the established methods of powder metallurgy.

2.3 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser shall state on his enquiry and order the following information:

(1) Material specification in 3 or 4 with which the material shall comply.

(2) The condition of the material, i.e. drawn, rolled, forged, cast or sintered.

(3) Whether a certificate of compliance is required.

(4) Whether the material is to be inspected and tested in the presence of the purchaser or his representative.

(5) In the case of castings, whether radiological examination is required.

(6) Any special dimensional tolerances.

2.4 MATERIAL AVAILABILITY

Materials are available as shown in Tables 1 and 2.

2.5 FREEDOM FROM DEFECTS

2.5.1 Rod, bar, rolled or drawn flat product, section, forging. The material shall be clean, smooth, sound and free from harmful defects.

2.5.2 Casting. The casting shall be clean and free from harmful defects. Castings shall not be repaired unless permission in writing has been obtained previously from the purchaser or his representative.

2.5.3 Sintered products. The metallic sintered products, as delivered to the purchaser, shall be free from harmful defects.

2.5.4 General. All materials shall meet any dimensional requirements specified by the purchaser and agreed with the supplier.

2.6 DEFECTS REVEALED AFTER DELIVERY

In the event of any material proving defective during subsequent manufacturing operations, such materials shall be deemed not to comply with the requirements of this British Standard, notwithstanding any previous certificate of satisfactory testing, provided the materials have not been improperly treated after delivery.

* Extracted from BS 1420 ' Glossary of terms applicable to wrought products in copper, zinc and their alloys '.

2.7 SELECTION OF TEST SAMPLES

When mechanical and electrical tests are specifically called for by the purchaser, the selection of test samples and the number of tests to be made shall be agreed between the purchaser and the supplier.

2.8 MECHANICAL TESTS

2.8.1 Tensile tests. Tensile tests shall be made in accordance with BS 18* where appropriate, and the results shall be in accordance with the requirements specified in 3.

2.8.2 Hardness tests—cast and wrought material. Hardness tests shall be made in accordance with BS 427† where appropriate. Other methods of hardness testing, e.g. BS 240‡ and BS 891§, may be used where agreed between the purchaser and the manufacturer.

2.8.3 Hardness tests—sintered materials. It is difficult to obtain an accurate impression without careful preparation on sintered materials where the constituents are of widely different hardness values when using Vickers or Brinell tests, and Rockwell tests are preferred for those materials.

2.9 ELECTRICAL TESTS

The electrical tests and hence the conductivity shall be determined in accordance with BS 3239|| and the results shall be in accordance with the requirements specified in 3 and 4. Other methods of determining the electrical conductivity, e.g. comparator methods using eddy currents, shall be agreed between the purchaser and the supplier.

2.10 RETESTS

Should any of the test pieces first selected by the purchaser or his representative fail to pass any of the prescribed tests, two further samples from the same batch shall be selected for testing, one of which shall be from the same piece of material from which the original sample was taken, unless that piece of material has been withdrawn by the supplier.

Should the test piece from both these additional samples pass, the batch represented by the test sample shall be deemed to comply with this standard. Should the test piece from either of these additional samples fail, the batch represented by the test samples shall be deemed not to comply with this standard.

* BS 18, ' Methods for tensile testing of metals '.
† BS 427, ' Method for Vickers hardness test '.
‡ BS 240, ' Method for Brinell hardness test '.
§ BS 891, ' Method for Rockwell hardness test '.
|| BS 3239, ' Determination of resistivity of metallic electrical conductor materials '.

2.11 CERTIFICATE OF COMPLIANCE

The supplier shall, if required, certify that the material complies with the requirements of this standard. When the purchaser desires to receive a certificate, this shall be stated in the enquiry and order.

2.12 INSPECTION

The purchaser shall notify the supplier when placing the order if it is his intention to inspect the material at the supplier's works. The supplier shall afford the purchaser all reasonable facilities to satisfy himself that the material is in accordance with the standard. For this purpose, the purchaser or his representative may, by prior arrangement, attend to inspect the material to select and identify the test samples for testing and to witness the tests being made.

2.13 MARKING

The manufacturer shall mark the product with the number of this British Standard, the group, type and number of the alloy or material (as shown in 3.1.2 and 4.1.2), together with his identification mark.

Any special method of marking shall be agreed between the purchaser and the manufacturer.

3. SPECIFIC REQUIREMENTS FOR GROUP 'A'—COPPER ALLOYS

3.1 INTRODUCTION

3.1.1 This section states requirements for 4 types of material, namely:

Type 1. Non-heat-treatable alloys of high conductivity and medium strength, the wrought forms of which are given the quoted strengths by cold working during manufacture.

Type 2. Alloys which are stronger than Type 1 and have developed their mechanical properties by heat treatment during manufacture.

Type 3. Heat-treated alloys which have superior mechanical properties to Type 2 but a lower electrical conductivity than either Type 1 or 2.

Type 4. Alloys having certain specialized properties which may, in some cases, obtain their properties either by cold working or heat treatment. Alloys of this type are not necessarily interchangeable with each other.

NOTE. All of the above materials will lose their properties if heated above the indicated softening temperature, but the heat-treatable alloys may, under certain conditions, recover some of their mechanical properties by further heat treatment.

3.1.2 Examples of coding. (See Table 1.) Cadmium copper shall be coded as BS 4577—A 1/3. Beryllium copper shall be coded as BS 4577—A 4/2.

3.1.3 Recommended applications of the materials are included in Appendix A.

3.2 GENERAL

The material shall comply with the general requirements of Section 2 and the specific requirements set out below.

3.3 NOMINAL COMPOSITION

The nominal composition is shown in Table 1, to designate the type and number of the material.

3.4 ELECTRICAL CONDUCTIVITY

The electrical conductivity determined in accordance with the requirements of 2.9 shall comply with the requirements shown in Table 1.

3.5 MECHANICAL TESTS

The test samples selected and tested in accordance with the requirements of 2.7 and 2.8 shall comply with the requirements of Table 1.

4. SPECIFIC REQUIREMENTS FOR GROUP 'B'—SINTERED MATERIALS

4.1 INTRODUCTION

4.1.1 This section states requirements for 5 types of material based upon the constituents used:

Type 11. A sintered product of copper and tungsten.
Type 12. A sintered product of copper and tungsten carbide.
Type 13. A sintered and worked product of molybdenum.
Type 14. A sintered and worked product of tungsten.
Type 15. A sintered product of silver and tungsten.

4.1.2 Examples of codes. (See Table 2.) Molybdenum shall be coded as BS 4577—B13. Silver tungsten shall be coded as BS 4577—B15.

4.1.3 Recommended applications of the materials are included in Appendix A.

4.2 GENERAL

The material shall comply with the general requirements of Section 2 and the specific requirements set out below.

4.3 NOMINAL COMPOSITION

The nominal composition is shown in Table 2 to designate the type and number of the material.

4.4 ELECTRICAL CONDUCTIVITY

The electrical conductivity determined in accordance with the requirements of 2.9 shall comply with the requirements shown in Table 2.

4.5 MECHANICAL TESTS

The test samples selected and tested in accordance with the requirements of 2.7 and 2.8 shall comply with the requirements of Table 2.

TABLE 1. GROUP 'A'—

Material			Alloy	Nominal composition*	Softening temperature† min.
Group	Type	Number		%	°C
A	1	1	High Conductivity Copper	99·93 Cu	150
		2	Tellurium Copper	1 Te/0·1 Ni/Cu	350
		3	Cadmium Copper	1 Cd/Cu	250
	2	1	Chromium Copper	1 Cr/Cu	500
		2	Chromium Zirconium Copper	1 Cr/0·1 Zr/Cu	525
	3	1	Cobalt Beryllium Copper	2·5 Co/0·4 Be/Cu	500
		2	Nickel Silicon Copper	2·5 Ni/0·5 Si/Cu	500
	4	1	Nickel Phosphorus Copper	1 Ni/0·2 P/Cu	475
		2	Beryllium Copper	2 Be/Cu	300
		3	Silver Copper	6 Ag/Cu	375
		4	Aluminium Bronze	10Al/5 Fe/5 Ni/Cu	650

* The nominal composition is given for information only and the material should be manufactured to the properties shown in the table.

† These temperatures are for information only and are based on the lowest temperature that, if maintained for 2 hours, will give a reduction in hardness of 20 % of the difference between the hardest as received condition and the softest possible condition of that material.

COPPER ALLOYS

Electrical conductivity I.A.C.S.§ min.	Material availability	Tensile strength min.	Elongation on $5{\cdot}65\sqrt{S_0}$ min.	Hardness HV min.
%		hbar‡	%	
98	Drawn >25 mm	25	25	85
98	Drawn < 25 mm	28	20	90
98	Forged	17	20	50
85	Cast	15	25	40
85	Drawn >25 mm	25	14	90
85	Drawn <25 mm	30	14	95
85	Forged	25	14	90
80	Drawn >25 mm	30	14	90
80	Drawn <25 mm	30	14	95
80	Forged	30	14	90
78	Drawn >25 mm	37	15	120
78	Drawn <25 mm	41	15	140
78	Forged	36	17	115
75	Cast	28	14	110
75	Drawn >25 mm	37	15	120
75	Drawn <25 mm	41	15	140
75	Forged	36	17	115
45	Drawn >25 mm	62	9	180
45	Drawn <25 mm	62	9	180
45	Forged	62	9	180
40	Cast	54	5	180
38	Drawn >25 mm	65	14	200
38	Drawn <25 mm	65	14	200
38	Forged	59	13	168
35	Cast	43	7	158
50	Drawn >25 mm	39	20	130
50	Drawn <25 mm	41	18	140
50	Forged	38	18	130
50	Cast	26	18	110
23	Drawn >25 mm	105	2	350
23	Drawn <25 mm	105	2	350
23	Forged	105	2	350
23	Cast	92	1	350
80	Drawn >25 mm	49	9	150
80	Drawn <25 mm	49	9	150
80	Forged	42	5	125
10	Rolled	70	13	190
10	Forged	70	13	190
8	Cast	64	13	168

‡ For conversion to tonf/in² and kgf/mm², see Appendix B: 1 hbar = 10MN/m² = 10N/mm².
§ I.A.C.S. International annealed copper standard. Copper which has a resistivity at 20°C of 1/58 = 0·017 241 microhmmetre is said to have a conductivity of 100% I.A.C.S.

TABLE 2. GROUP 'B'—SINTERED MATERIALS

Material		Alloy	Nominal composition*	Softening temperature†	Electrical conductivity I.A.C.S. min.	Material availability	Tensile strength min.	Elongation on $5{\cdot}65\sqrt{S_0}$ min.	Hardness§ min.
Group	Type		%	°C	%		hbar‡	%	
B	11	Copper Tungsten	75W/Cu	1000	30	Sintered	65	0	97HRB
	12	Copper Tungsten Carbide	30 Cu/WC	1000	20	Sintered	59	0	30HRC
	13	Molybdenum	99·5 Mo	1000	30	Sintered and Worked	35	0	85HRB
	14	Tungsten	99·5 W	1000	30	Sintered and Worked	54	0	42HRC
	15	Silver Tungsten	35 Ag/65 W	900	50	Sintered	57	0	81HRB

* The nominal composition is given for information only and the material should be manufactured to the properties shown in the table.
† These temperatures are for information only and are based on the lowest softening temperature, which in the case of Types 11, 12 and 15 materials, is defined as the lowest temperature that will melt part of the constituents used and thus allow disintegration of the product.
‡ For conversion to tonf/in² and kgf/mm², see Appendix B: 1 hbar = 10 MN/m² = 10 N/mm².
§ For approximate comparison of hardness scales, see Appendix C.

NOTE. Materials in Group B should be used as a tip or an insert and silver brazed to a suitable backing plate.

APPENDIX A

RECOMMENDED APPLICATIONS

Material			Recommended applications
Group	Type	Number	
A	1	1	Unstressed current-carrying parts. Electrodes for spot and seam welding aluminium.
		2	Electrodes for spot and seam welding aluminium.
		3	Electrodes for spot and seam welding aluminium and coated steel. Flash or butt welding dies or inserts for welding mild steel. Electrodes for high frequency resistance welding of non-ferrous metals.
	2	1	Electrodes for spot and seam welding mild steel. Electrode holders and shafts for seam welding electrode wheels. Flash or butt welding dies or inserts for welding mild and carbon steels, stainless steels and heat resisting alloys. Backing for sintered electrode material.
		2	Electrodes for spot and seam welding mild steel and coated steel. Seam welding electrode wheels for welding mild steel where cooling is poor. Flash or butt welding dies or inserts for welding mild steel, stainless steels and heat resisting alloys.
	3	1 & 2	Projection welding electrodes. Electrodes for spot and seam welding stainless and heat resisting alloys. Electrode holders and shafts for seam welding electrode wheels. Flash or butt welding dies or inserts for welding mild and carbon steels, stainless steels and heat resisting alloys and non-ferrous metals. Backing for sintered electrode material.

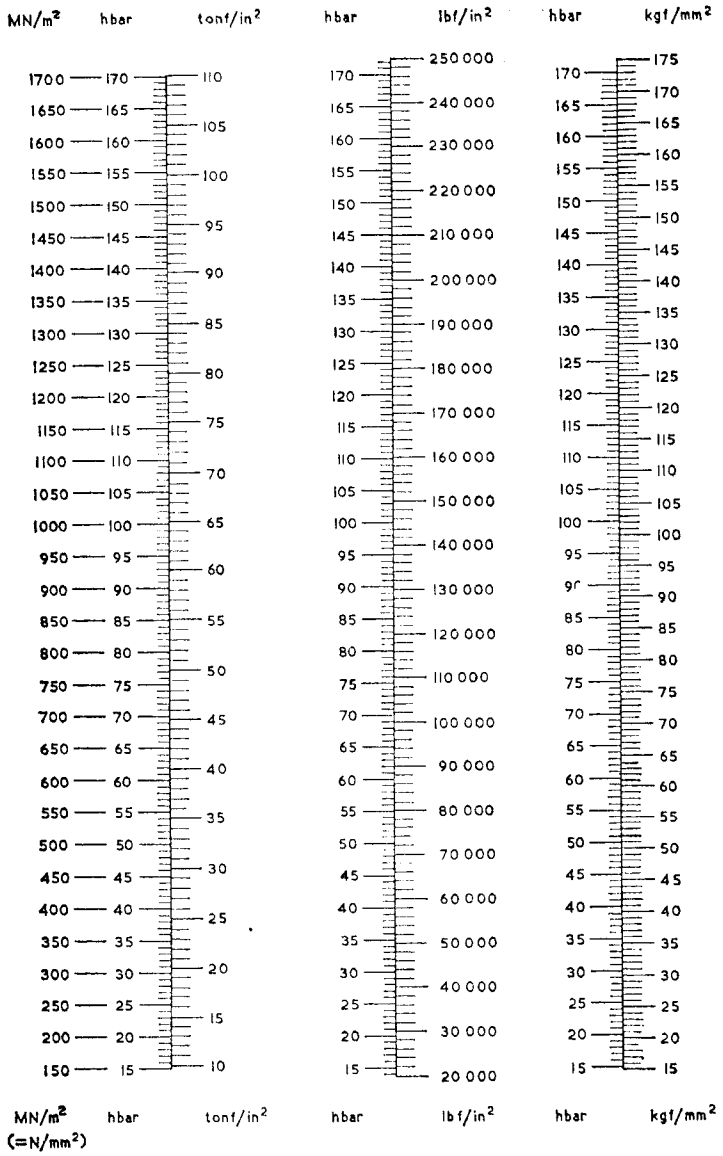
APPENDIX A *(cont.)*

RECOMMENDED APPLICATIONS *(cont.)*

Material			Recommended applications
Group	Type	Number	
A	4	1	Electrode holders. Flash or butt welding dies or inserts for welding mild steel.
		2	Long dies for flash welding. Electrode holders and shafts for seam welding electrode wheels.
		3	Seam welding electrode wheels for welding mild steel where cooling is poor.
		4	Electrode holders and shafts for seam welding electrode wheels.
B	11	—	Inserts for projection welding. Inserts for hot riveting or hot upsetting. Inserts for flash or butt welding dies for welding mild and carbon steel and non-ferrous metals.
	12	—	Inserts for hot riveting or hot upsetting.
	13	—	Inserts for spot welding high conductivity materials. Inserts for resistance brazing.
	14	—	Inserts for spot welding high conductivity materials. Inserts for resistance brazing. Inserts or electrodes for hot staking.
	15	—	Inserts for high frequency resistance welding of steel.

APPENDIX B

STRESS UNIT CONVERSIONS



CONVERSION FACTORS

1 hbar = 100 bar = 10 MN/m² = 10 N/mm² = 0·64749 tonf/in² = 1450·38 lbf/in² = 1·01972 kgf/mm²
1 Joule (J) = 0·73756 ft lbf = 0·10197 kgfm
For more detailed conversions see B.S.350 'Conversion factors and tables'

APPENDIX C

APPROXIMATE COMPARISON OF HARDNESS SCALES

Rockwell	Brinell	Vickers
97HRB	215HB	220HV
30HRC	295HB	300HV
85HRB	—	—
42HRC	395HB	420HV
81HRB	—	—

The above approximate comparisons have been extracted from BS 860 ' Table of approximate comparisons of hardness scales', and are given solely as an indication of the order of the relationship between the three systems of hardness readings and should not be used for the conversion of hardness values given on one scale to those of another scale.

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