RDSO SPECN. NO. ELRS/SPEC/CB/0027-REV '0'

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION OF CARBON BRUSHES FOR TRACTION MOTORS OF ELECTRIC LOCOMOTIVES

SEPTEMBER, 2003

Issued by

Electrical Directorate

Research Designs & Standards Organisation

Manak Nagar, Lucknow-226011

SPECIFICATION OF CARBON BRUSHES FOR TRACTION MOTORS OF ELECTRIC LOCOMOTIVES

0.0 FOREWORD:

This specification is intended to serve as a guide to the manufacturers of Carbon Brushes for traction motors of Electric Locomotives. This specification should be read in conjunction with related drawings of products meant for use on various traction motors.

1.0 SCOPE :

This Specification covers manufacturing and testing of carbon brushes used on traction motors of Electric Locomotives.

It also covers properties and testing of various components used in manufacturing of carbon brushes, viz. Flexible shunts, tamping powder, insulated top, terminals etc.

1.1 The carbon brush block grades used in manufacturing of the brushes shall be as per approved list of grades issued by RDSO periodically.

2.0 REFERENCES:

2.1 STANDARDS :

(i)	IS:13466 - 1992	Brushes for Electrical Machines Specification
(ii)	IS:13584-1983	Brush Material for Electrical Machinery – Specification
(iii)	IS:13525-1992	Flexible Conductors for Carbon Brushes – Specification
(iv)	IS:9919-1999	Guide for selection and use of carbon brushes in Electrical Rotating Machines.
(v)	IS: 4848-1981	Determination of apparent density of free flowing powders for powder metallurgical purposes.
(vi)	IS:4840-1984	Method for determination of flow rate of metal powders for powder metallurgical purposes.
(vii)	RDSO/M&C/RP-130/84	Tentative Specification for rubber top of carbon brushes and rubber sleeve of pigtail of carbon brushes.
(viii)	IS: 10810 (Part-V)-1984	Methods of test for Cables – Conductor Resistance Test.
(ix)	BS:2848-1973	Specification for flexible insulating sleeving for Electrical purposes.

2.2 DRAWINGS:

S No	TM	Type of loco	Drawing No
1	TAO 659	WAM4, WAP1, WAG5, WCAM1,2	EL.3.BS.002 (Mod) Alt2
2	HS 1050/15250A	WAG7, WAP4, WAG5, WCAM3	EL.3.BS.013 (Mod) Alt 5
3	4939 AZ	WCG/2	El.3.BS.001
4	MB 3080 A	YAM1	EL.3.BS.011
5	HS15256/15556	WAG6B and WAG6C	Hitachi 10 S 807- 384
6	LJM 450-2	WAG6A	S.E.Rly. Drg. No. LOCO/4/H/BS/021

3.0 CARBON BLOCKS:

3.1 **Material :**

RDSO issues approved grade of carbon brushes for different Traction motors periodically. The manufacturer shall ensure that the carbon block grade used for manufacture of brushes is as per current list of approved grades of RDSO.

3.2 Carbon Brushes shall be cut as per recommended direction of cutting of carbon brush i.e., **grain axial** as stipulated in RDSO Drawing No SKEL-3602 **(Copy enclosed)**.

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4.0 COPPER FLEXIBLE SHUNTS:

4.1 Brush Flexible Shunts shall be provided as specified in the respective product drawing Except where otherwise specified in the product drawing, the flexible shunts shall conform to IS:13525-1992.

4.2 Brush flexible wire shall be made of Electrolytic Tough Pitch (ETP) grade of copper, as per IS 191 Alt.5. Wherever specified, suitable reinforcement with stainless steel wire as per IS 4454 (1975), Part 4, Grade 1 shall be made.

4.3 Flexible shunts shall be clean, compact, and reasonably uniform in size and shape.

4.4 The wire shall be bright and clean. It shall be free from blisters, slivers, scale, fins, spills, cracks and other defects etc.

5.0 SLEEVE OF FLEXIBLE SHUNT:

5.1 The sleeve for the flexible shunt of the carbon brushes, wherever specified, shall be made of single or double braid of glass coated with class H silicon varnish or elastomer by dipping process and shall also conform to BS 2848-1973, type 1/180 Ta in respect of material dimensions, tolerance, and various properties like Mechanical., Electrical & Chemical etc.

The dimensions and tolerance of sleeve shall be as per Table 3 of BS 2848-1973, which is reproduced below for ready reference :

Type of sleeving	Bore		Wall thickness		
	Nominal	Tolerance	Nominal	Minimum	Maximum
1/180 Ta	1 to 2.5 3 to 19.0	± 0.25 ± 0.5	-	-	0.75

5.2 'Class H' Silicon varnished glass sleeve shall be cut smoothly and put on the flexible shunts of carbon brushes up to the required length as per specified drawing.

6.0 TERMINALS:

6.1 Terminals shall be made of electrolytic grade copper. The type and size of the terminals shall be as per product drawing.

6.2 The joints between terminals and flexible shunt of carbon brushes shall be crimped and soldered, unless specified otherwise in the product drawing.:

7.0 TAMPING POWDER:

7.1 The tamping powder grade used by the manufacturer shall be compatible to the carbon block grade. Tamping powder for use in manufacture of particular grade of carbon brush shall, therefore, be procured only from approved sources of that grade of carbon block. The manufacturer shall maintain and furnish documentary evidence of procurement and testing of each batch of tamping powder from the approved source of carbon block

8.0 INSULATED TOP:

8.1 Carbon brushes shall be provided with insulated top wherever specified in the product drawing. Dimension & tolerances of the insulated top shall be as per specified product.

8.2 The insulating material of the insulated top shall be suitable grade of silicon rubber compound and conform to the requirements of RDSO Specification No RDSO/ M&C/ RP-130/84 **(copy enclosed)**.

8.3 A suitable hard top made of hard material bonded with the silicon rubber insulation shall be provided wherever specified in the product drawing. The hard top should not break, crack and the bonding between the hard top and insulating rubber should not fail due to the mechanical forces encountered in service.

8.4 Insulated top shall be properly fixed on carbon brush top surface by good quality of adhesive. The adhesive used shall not adversely affect the properties of rubber or carbon. The joint formed shall not be removable with normal effort.

9.0 INSPECTION AND TESTS ON CARBON BRUSHES:

9.1 The tests to be carried out on finished carbon brushes at the manufacturers' works are classified as follows:

(a) Type tests: To be carried out on prototype samples of carbon brushes of the given design.

(b) Routine tests : To be carried out by the manufacturer on each lot. The manufacturer shall maintain record of test results to be produced as and when required by the authorized inspecting agency.

(c) Acceptance tests: To be carried out by the manufacturer at the time of acceptance of supplies. The sampling procedure and criteria for acceptance shall be as per Annexure C of IS 13466-1992.

In addition to above, the purchaser shall have right to carry out stage inspection also at firm's premises particularly with reference to manufacturing process, quality control and compliance with various clauses of the specification.

9.2 The following Table gives the details of tests to be carried out on finished carbon brushes:

S.N.	Tests	Governing Specification	Acceptance Limits	Type Test	Routine Test	Acceptance tests
1	Workmanship	Cl. 16.4 of IS 13466-1992	No abnormality	√	√	√
2	Dimensional Checks	Product Drawing	Product drawing	√	√	√
3	Millivolt drop Test	Cl. 16.6 of IS 13466-1992	20 mV (max.)	√	√	√
4	Pull out Strength Test	Cl. 16.7 of IS 13466-1992	Clause 9.3	√		√
5	Endurance Test	Annexure-I	Annexure-I	√		
6	Test for effect of temperature	Clause 9.4	Clause 9.4	√		√

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9.3 **Pull Out Strength Test:**

Pull Out Strength Test shall be carried out on finished samples in accordance with IS 13466 – 1992. The acceptable values of Pull Out Strength shall, however, be as follows:

Type of Traction motor	Nominal Sectional area (mm^2)	Minimum Pull Out Strength (kgf)
TAO 659	2.920	30
HS 1050/15250 A	4.578	40
4939 AZ	3.270	30
MB 3080 A	4.171	40
HS 15256/15556	4.031	40
LJM 450-2	2.597	30

9.4 **Test for effect of Temperature:**

Two samples out of every lot of finished carbon brushes shall be taken and hardness of insulating rubber measured. The samples shall then be put inside oven at 180^0 C for 2 hours. The hardness of insulating rubber shall not vary by more than ±5% from the value measured before putting the samples in oven. The insulated top joint shall not be removable with normal effort.

10.0 TESTS ON RAW MATERIALS/ BOUGHT OUT ITEMS

10.1 The manufacturers shall maintain Quality Assurance plan of all raw materials/bought out items used in the manufacture of carbon brushes to ensure the quality and compliance to prescribed standards.

10.2 The tests to be carried out on raw materials/bought out items are classified as follows :

(a) Type tests: To be carried out on prototype samples of raw materials/bought out items.

(b) Acceptance tests: To be carried out on each batch of supply. The manufacturer shall maintain record of test results to be produced as and when required by the authorized inspecting agency.

10.3 The following Table gives details of tests to be carried out on raw materials/ bought out items :

10.3.1 **On Copper wire**

S.N.	Tests	Governing Specification	Type Test	Acceptance Test
i.	Dimensional Checks (No. of Strands, Dia. Of wire Formation, Overall dia.)	Product Drawing	√	√
ii.	Annealing Test (Before stranding)	IS:10810 (Part1)-1984.	√	√
iii.	Electric Resistance Test	IS:10810 (Part5)-1984.	√	√
iv.	Measurement of Conductivity at 20 ^{0}C	Clause 6.3.6 of IS 13525-1992	√	√
v.	Chemical Composition for ETP Copper	IS:191 (Part5)-1980	√	
vi.	Measurement of weight	Clause 6.3.5 of IS 13525 - 1992	√	√
vii	Visual test	Clause 5.4 and 6.3.1 of IS 13525 - 1992	√	√

10.3.2 **On Flexible shunt**

S.N.	Tests	Governing Specification	Type Test	Acceptance Test
i.	Construction	Product Drawing.	√	√
ii.	Measurement of Diameter	Clause 6.4.3 of IS 13525 - 92	√	√
iii.	Electrical resistance test	Clause 6.4.4 of IS 13525 -92	√	√
iv.	Measurement of Weight	Clause 6.4.5 of IS 13525 - 92	√	√
v.	Visual test	Clause 6.4.1 of IS 13525 - 92		√

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10.3.3 **On Rubber Top**

S.N.	Tests	Governing Specification	Acceptance Limits	Type Test	Acceptance Test
i.	Hardness (Shore `A")	RDSO/M&C/ RP-130/84	70±5	√	√
ii.	Tensile Strength (Kg./Sq.cm)	-do-	50 (min)	√	
iii.	Elongation at Break %	-do-	125 (min)	√	
iv.	Compression set (%) with 25% compression at 175°C+2°C for 24 +0/-2hrs.	-do-	25 (max)	√	
v.	**Accelerated Ageing Test** Hardness (Shore A) **max.** Tensile strength Elongation at Break	-do-	 +7/-0 ±25% ±30%	√	

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11. MARKING:

11.1 The following particulars shall be legibly and indelibly engraved/ pad printed on each carbon brushes on two wider faces above the condemning mark :

a) Grade of carbon brush.
b) Identification of source of manufacturer, and
c) Batch number, month and year of manufacture.

11.2 The condemning mark line shall be indelibly pad printed on two wider faces of the brush. Alternatively, 2 condemning dots may be engraved on both wider faces. The condemning line shall not be engraved on the brushes.

12. PACKING:

Carbon brushes shall be suitably packed so as to avoid any damage during transit.

Annexure-1

Endurance Test on Carbon Brush as per RDSO Specification No. EL/2.2.70 dated 27.9.1982

1. **Quantities to be tested :**

This test shall be conducted on quantities equal to 0.5% of the total quantities of every type of brush supplied during every half year period. For quantities supplied during the half period say April to Sept. the test shall be completed in the following quarter (Oct-Dec). Similarly on quantities supplied during half-year period Oct.-March, this test shall be completed in the following quarter (April-June). In any event, irrespective of the quantities supplied at least one test (on fifteen brushes) shall be conducted every half yearly on every type of brush supplied during previous half year.

2. **Details of Endurance Test :**

i) Select 15 carbon brushes at random from the lots offered.

ii) From the 15 selected brushes, subject 5 brushes to initial millivolt drop test followed by pigtail pull out strength. Average values of mV drop and pigtail pull out strength shall be used for evaluating performance of remaining 10 brushes subjected to endurance.

iii) Subject the balance 10 carbon brushes to mV drop test. 100 heating and cooling cycles. The heating/cooling cycle shall consist of passing 1.7 time the normal machine current per flexible for 2 minutes followed by 4 minutes cooling under natural environment. A small hole will be drilled near pigtail into the brush, to determine the temperature rise during this test.

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iv) During the test, record following for each above 10 brushes :-

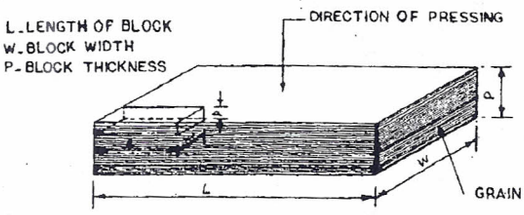
a) Millivolt drop at each pigtail.
b) Pull out strength of each pigtail.

3. **Criteria of Acceptance :**

i) The millivolt drop of the each brush, subjected to endurance test, shall not exceed five times the average millivolt drop as observed in Test (2-ii).

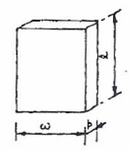
ii) The average value of pull out strength of the 10 brushes, after the test, shall not be less than 70% of the average value of five brushes subjected to Test (2-ii).

4. The results of each test shall be conveyed to RDSO in addition to being shown to inspecting officials.



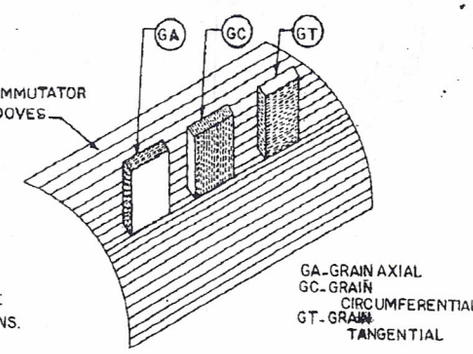
ELECTROGRAPHITIC CARBON BLOCK AND NOMENCLATURE FOR VARIOUS DIMENSIONS.

FIG. NO. 1



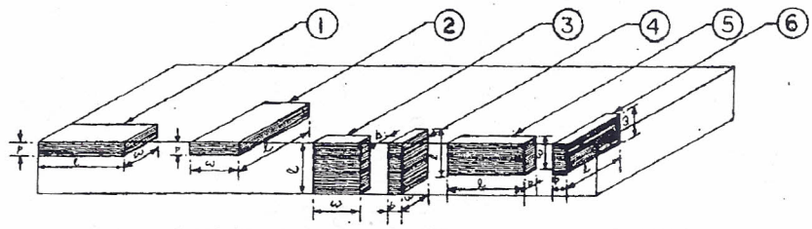
CARBON BRUSH-NOMENCLATURE FOR VARIOUS BRUSH DIMENSIONS.

FIG. NO. 2



TYPE OF BRUSHES WHICH CAN BE OBTAINED FROM BLOCK BY ADOPTING VARIOUS COMBINATIONS OF DIRECTION OF CUTTING.

FIG. NO. 3



TYPE OF BRUSHES OBTAINED WHEN CUT FROM BLOCK AS PER TABLE 4

(FIG. NO. 4)

TABLE 4-POSSIBLE CUTTING SEQUENCES FROM BLOCKS FOR BRUSH FABRICATION

CARBON BRUSH NO. REF FIG. 4	DIM. OF BRUSH CUT ALONG 'L'	DIM. OF BRUSH CUT ALONG 'W'	DIM. OF BRUSH CUT ALONG 'P'	TYPE OF BRUSH OBTAINED
1	ℓ	ω	p	GRAIN AXIAL (GA)
2	ω	L	p	
3	ω	p	ℓ	GRAIN TANGENTIAL (GT)
4	p	ω	L	
5	ℓ	p	ω	GRAIN CIRCUMFERENTIAL (GC)
6	p	L	ω	

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Dt.	5.2.83
D	
T	
C	

REF:	SCALE: NTS	APPROVED: Sd KEWAL KUMAR DS 9-3-83 (FOR DG)

CUTTING OF CARBON BRUSH FROM BLOCK

R.D.S.O. ELEC. DTE.	SKEL-3602

MCS-1606, Ed.1

RDSO/M&C/RP-130/84

TENTATIVE SPECIFICATION FOR RUBBER TOP OF CARBON BRUSH AND RUBBER SLEEVE OF PIGTAIL OF CARBON BRUSH

1. SCOPE

1.1 This specification covers the material requirements, methods of sampling and test for moulded rubber top of carbon brush and rubber sleeve of pigtail of carbon brush used at ~~temperature~~ **temperature 0-200°C continuous and intermittent upto 250°C.**

2. REQUIREMENTS

2.1 Material - The rubber used for the manufacture of seals shall be suitable grade of silicone rubbers compounded so as to conform to the requirements specified in clause 2.4.

2.2 The surface of rubber top of carbon brush and rubber sleeve of pigtail of carbon brush shall be smooth, free from air bubbles and other moulding defects.

2.3 Dimensions and tolerances - The dimensions and tolerances of the rubber top and carbon brush and rubber sleeve of pigtail of carbon brush shall be in accordance with the relevant drawings.

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2.4 Tests

Note: All test procedure shall be as per IS:3400. The tests shall be carried out from the finished products wherever practicable or from prepared test slabs of approximately same degree of vulcanisation and using the same compound.

2.4.1 Physical properties - The rubber compound used for the manufacture shall conform to the following requirements:

a)	Hardness (Shore 'A')	70 ± 5
b)	Tensile strength(kg/cm^2) min.	50
c)	Elongation at break (%) min.	125
d)	Compression set(%) with 25% compression at 175°+ 2°C for 24 + 0 − 2 hours, max.	25

2.4.2 Accelerated ageing test - After ageing at 225 ± 3°C for a period of 72 hours in an air oven, the hardness, tensile strength and elongation at break shall not vary from the values obtained before ageing more than the following:

a)	Hardness (Shore 'A')	+ 7
b)	Tensile strength ± 25%	- 0
c)	Elongation at break	± 30%

....2/-

3. SAMPLING AND CRITERIA FOR CONFORMITY

3.1 A minimum of six test samples or 0.5% of the lot offered for inspection, shall be drawn for the tests indicated in clause 2.4. Should any of the test samples fail to meet the requirements, an additional two sets of samples from the same lot shall be drawn for retesting. Should any of the retest samples fail to meet the requirements, the entire lot shall be rejected.

3.2 In the event of rejection of the entire lot after the retest of samples, the entire lot offered for inspection shall be made unusable in the presence of the Inspecting Officer/Purchaser.

4. STORAGE

4.1 Rubber tops and sleeves shall be stored in a cool, dry place in their original packings.

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सत्यमेव जयते

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No. EL/2.2.70 25.08.2005

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Chittaranjan Locomotive Works, Chittaranjan 713 331.

Amendment No. 1

Sub: Specification No. ELRS/SPEC/CB/0027 (Rev. '0') for Traction Motor Carbon Brushes of Electric Locomotives.

The following correction may be done in the subject specification issued in September 2003.

S.No.	Page No./ Clause No.	TM	Drawing No.	
			Existing	Correct to Read as
1	2 / 2.2	TAO-659	EL3.BS.002 (MOD) ALT.2	EL.BS.002 (MOD.) ALT.2

25/8/2005

Encl: As above.

(M K Singhal)
for Director General (Elec)