सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION FOR METALLISED CARBON STRIPS SUITABLE FOR PANTOGRAPH WITH AUTO DROPPING DEVICE PROVISION FOR 25 KV A.C. ELECTRIC LOCOMOTIVES AND EMU / MEMU

Specification No: RDSO/2014/EL/SPEC/0114, Rev. '1'

Issue Date /Year XX.XX.2020

RESEARCH DESIGNS AND STANDARDS ORGANISATION
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Status of Revision

S.N.	Date of Revision	Page no.	Revision	Reasons for Revision
1.	-	All	0	First Issue
2.	xx.xx.2021	3, 4, 5, 6, 9, 10, 11-21, 25, 27 & 28	1	Specification revised to incorporate test procedure, acceptance criteria and parameters of metallised carbon strips

CONTENTS

0.0 FOREWORD:

This specification is intended to serve as a guide line to the manufacturers of Metallised Carbon Strip for Pantographs with auto dropping device provision being used on 25 kV, A.C., 50 Hz of A.C. Electric Locomotives and EMU/MEMU for the existing OHE as well as high rise OHE of dedicated freight corridor on IR. The specification covers the technical requirement of metallised carbon strips suitable for Pantograph with Auto Dropping Device (ADD) provision.

Auto Dropping Device (ADD) system for Pantograph shall lower the pantograph as per clause 4.9 of IEC-60494-1-2013 and also in case of too high wear of collector strips. The purpose of incorporation of auto dropping device system is to minimise the risk of consequential damages to OHE and pantographs in the event of pantograph entanglement with OHE. There is an air channel in the metallised carbon strip which is supplied with compressed air. If case of damage of metallised carbon strip during entanglement with OHE, compressed air vents out from metallised carbon strip which causes lowering of pantograph. In addition to the above, if the metallised carbon strips wears to a particular level below condemning limit, Auto Dropping Device shall lower the pantograph thus preventing any damage to the OHE.

1.0 SCOPE:

On Indian Railways, 25 KV AC electric locomotives / motor coaches of EMUs draw current from OHE through the Metallised carbon Strips fitted on pantographs of electric locomotives / EMUs /MEMUs to reduce the wear of contact wire thereby increasing its life.

This specification applies to Metallised carbon Strips for use on 25 kV, A.C., 50 Hz, electric locomotives and EMU/MEMU pantographs with Auto dropping device system for satisfactory

operation up to speeds of 250 Kmph under catenary heights varying from 4.54 meters to 7.57 meters from the rail level. This Specification covers manufacturing and testing of metallised carbon strips used on Pantograph with Auto Dropping Device provision in A.C. electric locomotives and EMU/MEMU.

The Metallised carbon Strips grades used for pantograph with ADD in manufacturing of the strips shall be as per approved list of grades issued by RDSO periodically.

This design of Metallised carbon strip for Pantograph shall be suitable for all class of Electric locomotives and AC EMU/MEMU.

2.0 REFERENCES:

STANDARDS:

(i) IS: 13466– 1992, Reaffirmed 2019
"Brushes for Electrical Machines"

(ii) IS: 13584-1993, Reaffirmed 2019
"Brush Material for Electrical Machinery."

(iii) Specification No: RDSO/2009/EL/SPEC/0097, Rev. '1' Technical Specification of metallised Carbon Strips Suitable for Pantograph without Auto Dropping Device of 25 kV A.C. Electric Locomotives and EMU/ MEMU

(iv) EN 50405 -2006 Current collector systems- Pantographs, testing methods for carbon contact strips

(v) IEC-62499: 2008 Railway applications – Current collection systems – Pantographs, testing methods for carbon contact strips

(vi) Latest version/revision of the standards and specifications etc shall be followed, unless specifically mentioned otherwise.

3.0 SUPPLIER'S RESPONSIBILITY

3.1 The Metallised carbon strip of pantographs offered shall be complete with all parts and accessories necessary for its efficient operation. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

3.2 Technical guidance and assistance for proper operation, investigation and generally all aspects of technical liaison that may be required during the service trial period as per extant ISO guideline shall also be organized by the Contractor.

3.3 Supplier shall engrave/emboss/pad printing identification marks indicating their monogram/brand names and the month and year of manufacture at a conspicuous place on all the components. Pad printing shall be applicable on metallised carbon strip portion for identification of condemning limit and grade.

3.4 Supplier is advised to familiarize themselves with pantographs and roof equipments layout on the existing locomotives.

3.5 Once a prototype is approved, no Supplier shall change his source of supply or sub-Supplier for purchased components and sub-assemblies without RDSO approval.

4.0 INFRINGEMENT TO PATENT

Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of Metallised Carbon Strips and any other factor which may cause such dispute. The responsibility to settle any issue lies with the Supplier.

5.0 TERMINOLOGY:

Terms/abbreviations used frequently in the document are explained below:

IR	Indian Railways
RDSO	Research Designs & Standards Organisation.
CLW	Chittaranjan Locomotive Works
Tenderer	Firm/companies participating in the tender.
Supplier	The person, firm or company on whom the order for supply of the work has been placed
Sub Supplier	Any person, firm or company from whom the Supplier may obtain any materials or fittings to be used for the Pantograph.
Inspecting Officer	Nominated person to inspect the Metallised carbon strips.
OEM	Original Equipment Manufacturer
BG	Broad Gauge 1676 mm used in IR
IS	Indian Standard
IRS	Indian Railways Standard
IEC	International Electro technical Commission
ISO	International Standards Organization
OHE	Overhead Equipment
AC	Alternating Current
EMU / MEMU	Electrical Multiple Unit / Mainline Electrical Multiple Unit
ADD	Auto Dropping Device

6.0 CLIMATIC, ENVIRONMENTAL AND OPERATING CONDITIONS:

Atmospheric temperature	Under Sun: 75°C max. In shade: 55°C max. Minimum temperature: -10°C (also snow fall in certain areas during winter season)
Humidity	100% saturation during rainy season.
Altitude	1776Mts. above mean sea level.
Rain fall	Very heavy in certain areas.
No. of Rainy days per annum	May be as high as 120 days.
No. of thunderstorms days/ year.	May be as high as 85 days
Coastal area	Metallised carbon Strips shall be designed to work in coastal areas in humid and salt laden atmosphere with maximum pH value of 8.5, sulphate of 7 mg per liter, max. Concentration of chlorine 6 mg per liter and maximum conductivity of 130 µSiemens/Cm, wind pressure reaching 150 kg/cm^2.

7.0 SCOPE OF SUPPLY:

The deliverables include complete Metallised carbon Strips suitable for pantographs with Auto Dropping Device provision along with all its components including the hardware & air tube-

(i) Operating and maintenance manual containing essential technical information like composition of material, hardware details, details of ADD operation and tightening torque etc. shall be supplied. The manual shall be in A4 size sheet printed on one side in suitable folder in English. Drawings/sketches shall be in A4 /A3 size sheets only. The

Supplier shall list out the special tools, if any which shall be required for installation and maintenance of the Metallised Carbon Strips.

(ii) Acceptance Tests reports of Metallised Carbon strips

8.0 PROPERTIES

The properties of Metallised carbon strips are as under:-

Parameters	Unit	Requirements
Hardness	BHN 5/100 Or HRB 5/100	95±10% Or 105±10%
Bulk density	gm/cm^3	Min. 2.0
Copper content	by weight	15% to 33%
* %age of other metal	by weight	Max. : 10%
Transverse Strength (Bending strength)	M N / m^2	Min. : 75
Compressive Strength	M N / m^2	Min. 250
Resistivity	μΩ– m	Max. : 11.0

Note:*Lead being a hazardous material shall be avoided. If considered absolutely necessary, its percentage to be kept minimum.

9.0 DRAWING & OHE PARAMETERS:

A) DRAWINGS:

RDSO's Drg. NO. SKEL-4994 Alt. '0' indicates the constructional and fitment features in brief of metallised carbon strips for pantograph with ADD and is enclosed as **Annexure II**. Unspecified Tolerance shall be as per EN 22768.

B) Physical Design of Metallised Carbon strip:

The length of the strip shall be approximately 1030±2 mm having a flat zone of 800 +0/-20 mm in the middle and both the ends should be tapered for the pantograph with ADD. This Metallised Carbon Strip shall be of single piece design only.

C) The condemning limit mark line shall be Painted/ pad printed as indicated in the Drawing no. SKEL 4994 (Alt. '0') for Metallised carbon strip with ADD.

D) The impact force required for Auto Dropping Device shall be tested in accordance with EN-50405.

E) OHE PRAMETERS:

Technical details existing & Dedicated Freight Corridor OHE of Indian Railway is enclosed as **Annexure IA & Annexure IB.**

10.0 INSPECTION AND TESTS

The tests to be carried out on finished Metallised Carbon Strips at the manufacturers' works are classified as Type, Routine & Acceptance. After completion of successful prototype test the metallised carbon strips with ADD system shall be subjected to extended field trial for quantity and period as per extant ISO guideline. The performance report format is included in Annexure II. Prototype approval will be provided after such successful field trial. Tests shall be conducted as per table given below:

The following Table gives the details of tests to be carried out on finished Metallised Carbon Strips:

S. NO.	PARAMETER	TYPE	ROUTINE	ACCEPTANCE	TEST METHOD
1.	Hardness	✓	✓	✓	BHN(5/100) or Rockwell B 5/100
2.	Bulk Density	✓	-	-	As per IS: 13584 Clause 6.2
3.	Copper Content	✓	√	-	Chemical Analysis
4.	Percentage of Other Metal	✓	√	-	Chemical Analysis
5.	Transverse Strength (Bending Strength)	✓	-	-	As per IS: 13584 Clause 9
6.	Resistivity	✓	-	-	As per IS: 13584 Clause 8
7.	Dimension Check	✓	√	√	As per SKEL Drg. No. 4994 (Alt. 0) with ADD

10.1 Hardness Test shall be carried out as per Clause 7 of IS-13584: 1993 Reaffirmed 2019 or subsequent Clause of latest revision.

General
There are two methods in general use for determining the hardness of carbon materials, namely:
a) Rebound method (7.2 of IS-13584),
b) Indentation method (7.3 of IS-13584).
Test shall be carried out by using one of the above methods and detailed procedure shall be mentioned in the report.

10.2 Bulk Density The bulk density shall be determined as per Clause 6.2.2 Measurements-and-weight method of IS-13584: 1993 Reaffirmed 2019 or subsequent Clause of latest revision and detailed procedure shall be mentioned in the report.

10.3 Chemical composition of Metallised Carbon Strips: shall be determined by Chemical Analysis from approved labs or in-house facility available with firm.

10.4 Transverse Strength (Bending Strength): Test shall be carried out as per clause 9 of IS-13584: 1993 Reaffirmed 2019 or subsequent Clause of latest revision by using test specimens of 10 mmx 10 mm x 64 mm and detailed procedure shall be mentioned in the report.

10.5 Resistivity test shall be carried out as per Clause 8 RESISTIVITY of IS-13584: 1993 Reaffirmed 2019 or subsequent Clause of latest revision.

8.1 General
There are several different methods in general use for determining the resistivity of brush materials.
The methods used most frequently for production quality control are as follows:
a) Voltmeter-ammeter method (8.2 of IS-13584),
b) Kelvin bridge method (8.3 of IS-13584).
Test shall be carried out by one of the above methods and detailed procedure shall be mentioned in the report.

10.6 In addition to the above tests the following test must also be carried out.

List of tests as per IEC-62499:

IEC-62499 Clauses	Test Description	Routine test	Type test
5.2.1	Test for the temperature characteristic of the carbon contact strip under rated current loading	-	✓
5.2.2	Test for deflection and extension of the carbon contact strip under extremes of temperature	-	✓
5.2.3	Test for flexural characteristic of the carbon contact strip	-	✓
5.2.4	Test of shear strength of the carbon contact strip X	-	✓
5.2.5.2.1	Sealing integrity	✓	✓
5.2.5.2.2	Temperature test	-	✓
5.2.5.2.3	Flow continuity	✓	✓
5.2.5.2.4	Impact function of the autodrop detection sensor	-	✓
5.2.6	Test of mechanical fatigue resistance of the carbon contact strip	-	✓
5.2.7	Test of the electrical resistance of the carbon contact strip	✓	✓

10.6.1 5.2.1 Tests for the temperature characteristic of the carbon contact strip under rated current loading

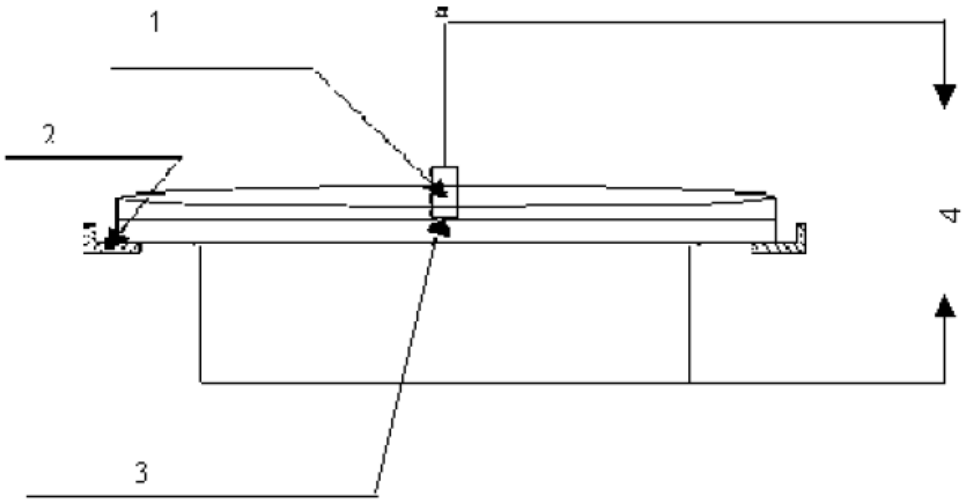
5.2.1.1 General

The test aims to determine the temperature characteristic to stability of the carbon contact strip at the maximum designed current loading.

5.2.1.2 Test method

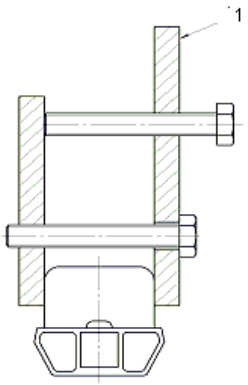
The carbon contact strip shall be fixed at one end and freely supported at the other end (see Figure 1).

The current supply connection shall be made by clamping suitable interfaces to the vertical faces of the carbon, but not in contact with the carrier material (see Figure 2). The current take off shall be made at the normal design interface(s).



Key
1 parallel clamp (steel)
2 carbon contact strip fixed end
3 temperature sensor 2 mm above carbon carrier interface
4 power supply

Figure 1 – Arrangement of test device for testing temperature characteristic



Key
1 current supply connection (steel, copper)

Figure 2 – Example of current supply connection

The temperature shall be monitored adjacent to the current supply connection at a point 2 mm above the carbon / carrier interface. The maximum rated current loading shall be applied to the carbon contact strip until the monitored temperature remains constant and then for a further 30 minutes. The temperature shall be continuously recorded during the test as a temperature – time characteristic.

***Test acceptance criteria*:** The carbon contact strip shall remain fit for purpose. The contact strip shall remain in accordance with drawing at room temperature.

10.6.2 5.2.2 Test for deflection and extension of the carbon contact strip under extremes of temperature

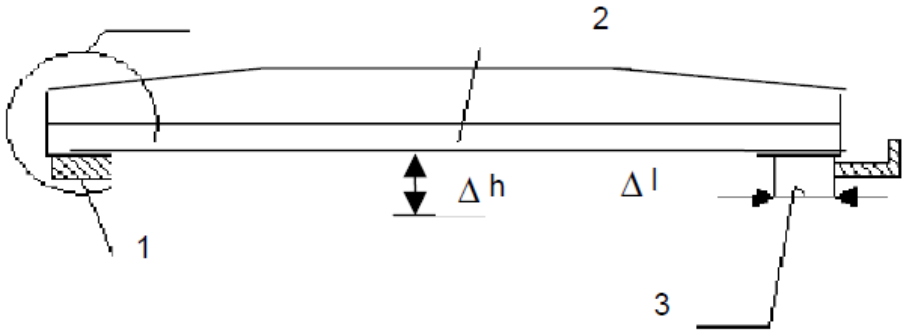
5.2.2.1 General

The test aims to determine the vertical displacement and change in length of the carbon contact strip under extremes of temperature.

5.2.2.2 Test method

5.2.2.2.1 High temperature test

This test may be carried out concurrently with the test described in 5.2.1. Under the steady state heated conditions of 5.2.1.2, the change of length of the carrier (Δl) and vertical displacement of the strip (Δh) from the room temperature condition shall be recorded (see Figure 3).



Key
1 carbon contact strip fixed
2 vertical displacement
3 change of length

Figure 3 – High temperature test

5.2.2.2.2 Low temperature test

The contact strip shall be cooled by a suitable method until the temperature of the strip is -40 °C. The contraction and vertical displacement from the room temperature condition shall be recorded.

***Test acceptance criteria*:** The carbon contact strip shall remain fit for purpose. The contact strip shall remain in accordance with drawing at room temperature.

10.6.3 5.2.3 Test for flexural characteristic of the carbon contact strip

5.2.3.1 General

The test aims to determine the flexural characteristic of the carbon contact strip at room temperature.

5.2.3.2 Test method

The flexural characteristic is determined by three point bending of the complete contact strip when supported at each end of the strip along the longitudinal centre line of the contact strip and loaded vertically at the centre. The force shall be gradually applied until permanent deformation is recorded on a force-deflection chart. The effective stiffness shall be determined from the results of the test and the applied force at which permanent deformation is recorded.

10.6.4 5.2.4 Test for shear strength of the contact strip

5.2.4.1 General

Definition of shear strength: T**s** = ***F*s** / **A** (*N*/mm2)

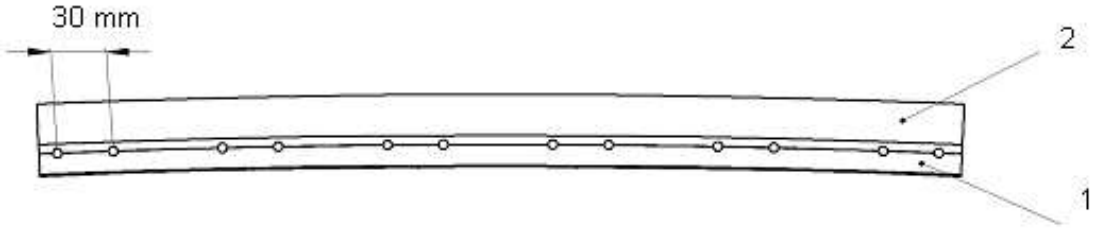
This test shall demonstrate that the adhesion between carbon and supporting structure meets the minimum shear strength criteria at room temperature, at specified temperatures (criteria specified by the manufacturer) and thermal fatigue. The shear strength at

failure of the specimen at room temperature shall exceed a minimum acceptable value or result in failure of the parent carbon material alone.

5.2.4.2 Test method

5.2.4.2.1 Test at room temperature

Samples of the contact strip material shall be prepared in accordance with Figure 4:

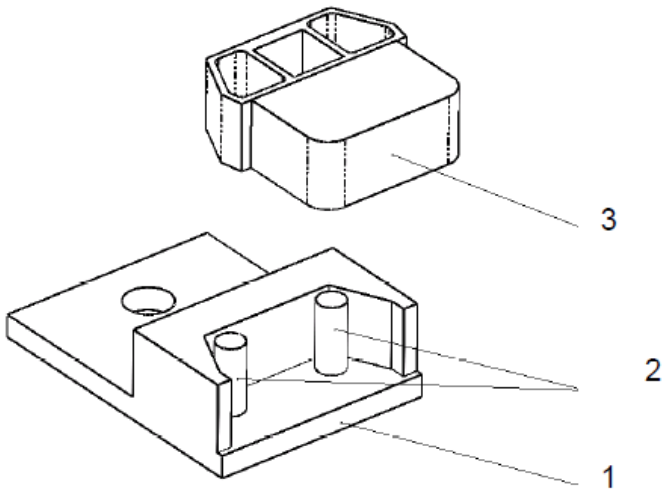


Key
1 carrier
2 carbon

Figure 4 – Preparation of samples

A minimum of 3 samples shall be prepared from a production contact strip and shall include each end of the contact strip and the centre. Each sample shall be prepared to a preferable length of 30 mm. Each sample shall be installed in a suitable fixture (see Figure 5) in order that the applied shear force *F***s** is guided directly into the interface defined as area of adhesion A between carrier and carbon (see Figure 6).The force of failure of the sample shall be recorded. The shear strength shall be determined by calculation of Ts.

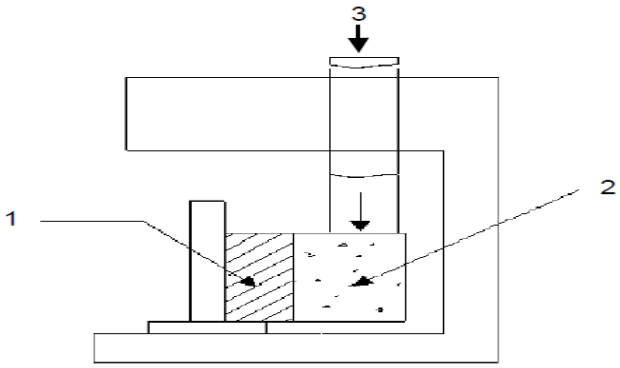
***Test acceptance criterion*:** The minimum calculated shear strength shall be 5 N/mm².



Key
1 sledge

2 metal pins
3 test specimen

Figure 5 – Example of suitable fixture for testing shear strength of carbon contact strip



Key
1 carrier
2 carbon
3 force

Figure 6 – Example of testing configuration of shear strength test

5.2.4.2.2 Test at specified temperature

Test specimens shall be prepared in accordance with 5.2.4.2.1. Specimens shall be cooled / heated to - 40 °C, 100 °C, 200 °C, 250 °C and the steady state temperature recorded in test 5.2.1 where this is greater than 250 °C. The temperature shall be measured at the retention interface of the carbon and supporting structure. It shall be verified that the temperature of the monitoring point is representative of temperature at the interface and maintained during the test. The force of failure of each sample shall be recorded. The characteristics of Ts with temperature shall be provided.

5.2.4.2.3 Thermal fatigue test

The contact strip used in 5.2.1 shall be thermally cycled from room temperature to the maximum temperature achieved in 5.2.1.2 for 100 cycles. The electrical resistance shall be measured before and after the test (see 5.2.7). The shear strength of the contact strip shall be measured at the conclusion of the test by taking samples from the heated region.

***Test acceptance criteria*:** It shall be demonstrated that the electrical resistance and method of attachment of carbon to the carrier have not deteriorated during the test.

10.6.5 5.2.5 Test of autodrop detection sensor integral with contact strips

5.2.5.1 General

The following tests shall demonstrate the sealing integrity of the contact strips, the flow continuity of the detection sensor and the operation of the detection sensor.
NOTE The tests are applicable only to contact strips that are equipped with a channel at the base of the carbon as a sensing device.

5.2.5.2 Test method

5.2.5.2.1 Sealing integrity

The carbon contact strip autodrop detection sensor shall be inflated for a minimum of 10 seconds at maximum operating pressure of the automatic dropping device (ADD). The maximum operating pressure shall be specified by the manufacturer and be agreed by the customer; a pressure of 10 bar is suggested.

The air leakage rate shall be measured and demonstrated at room temperature. Maximum operating pressure shall be applied to the contact strip and the leakage rate shall be measured using a flow meter.

Alternative methods of measurement are acceptable where it can be demonstrated that they equate to the above leakage rate at maximum operating pressure.

***Test acceptance criterion*:** The leakage rate shall not exceed 0.1l/min.

5.2.5.2.2 Temperature test

The carbon contact strip, tested under 5.2.2, where fitted with an autodrop detection sensor, shall be inflated during the test described in 5.2.2 to the maximum operating pressure of the automatic dropping device as specified by the manufacturer and be agreed by the customer (a pressure of 10 bar is suggested) and the sealing integrity during this test shall be continuously monitored.

***Test acceptance criterion*:** The leakage rate shall not exceed 0.1l/min.

5.2.5.2.3 Flow continuity

A flow meter shall be connected between the air supply and the contact strip. The supply shall be inflated to a minimum operating pressure of the autodrop system as specified by the manufacturer and be agreed by the customer (a pressure of 5 bar is suggested) and the blanking plug sealing the autodrop sensing system shall be removed.

***Test acceptance criterion*:** The flow rate shall be recorded and shall exceed the minimum ADD requirement.

5.2.5.2.4 Impact function of the autodrop detection sensor

5.2.5.2.4.1 General

The test shall demonstrate the operation of the autodrop detection sensor by impacting the contact strip and causing a severe failure of the carbon material.

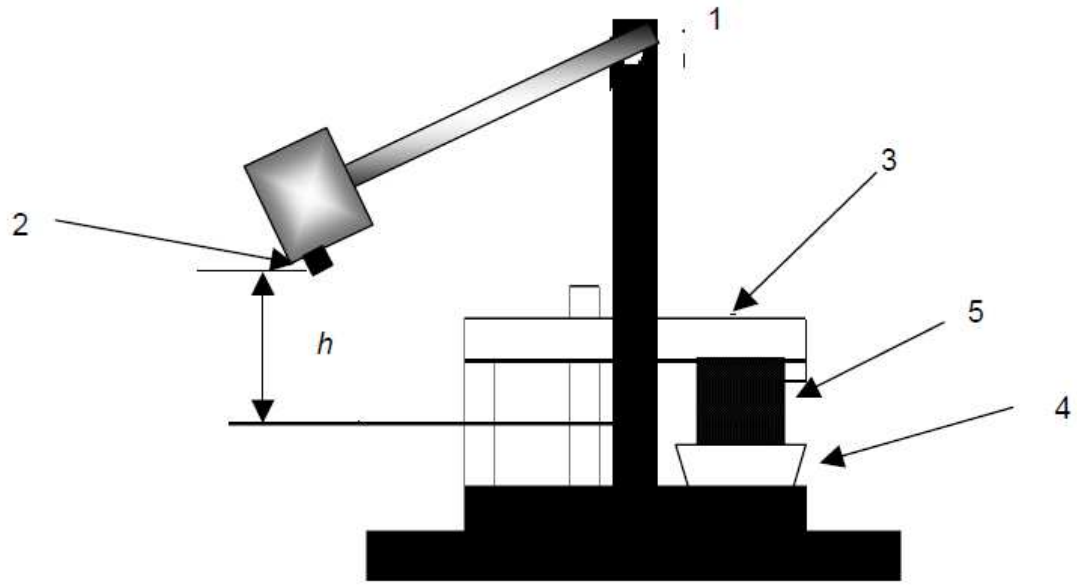
5.2.5.2.4.2 Test method

The carbon contact strip shall be supported at the interface between the pantograph and carbon carrier at a height to allow the striking point of the pin to be in line with the maximum wear line of the collector at mid span of the collector strip (example Figure 7). An air supply and monitoring equipment shall be connected and the system shall be inflated to the minimum operating pressure (Figure 8). The mass shall be retracted to a height *h* to provide sufficient energy to cause a successful operation of the autodrop detection sensor with one strike, or to an energy level as defined in the customer specification. In addition also a linear impact method producing the equivalent energy level defined by the customer is permissible.

The energy shall be derived from the following formula:

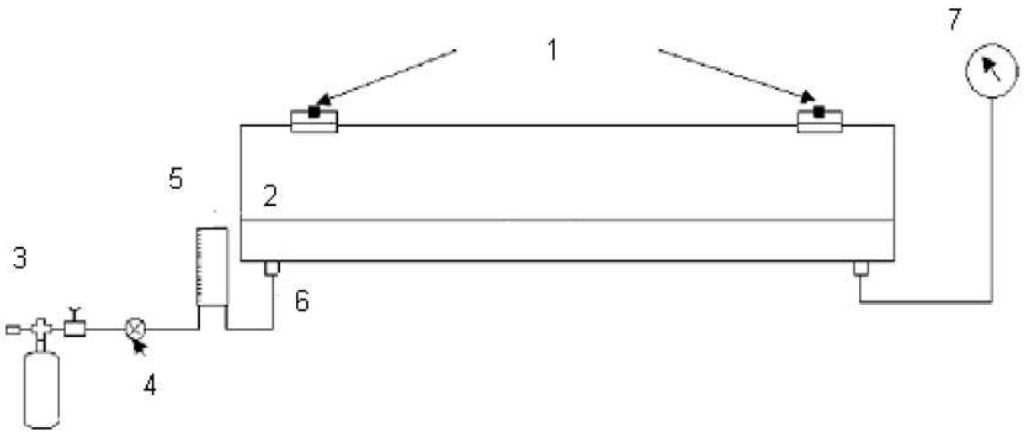
Energy (Joules) = Mass m (kg) × gravity g × height h (m)

Test acceptance criteria: Successful autodrop operation shall be demonstrated and the energy level recorded.



Key
1 typical length of pendulum 1 m
2 typical striking pin contact diameter 13 mm
3 clamp
4 carrier
5 carbon

Figure 7 – Typical impact test device



Key
1 clamps at normal working position
2 carbon
3 air supply
4 on/off valve
5 flow meter
6 pneumatic tube with appropriate length & size
7 pressure gauge

Figure 8 – Air supply and monitoring equipment

10.6.6 5.2.6 Test of mechanical fatigue resistance of the carbon contact strip

5.2.6.1 General

This test shall demonstrate that the structural integrity of the assembly will not deteriorate in service.

5.2.6.2 Test method

The carbon contact strip shall be supported at the interface between the pantograph and the carbon carrier. A sinusoidal varying load including a random frequency sweep shall be applied vertically downward on the carbon at the midpoint or the maximum distance from the mechanical support of the contact strip. The carbon contact strip shall be subjected to 1.2 x10^6 cycles at a minimum frequency of 0.5 Hz, with a vertically applied load equivalent to twice the static contact force applied by the pantograph to a single contact strip. The maximum load generated shall be greater than 150 N and the vertical displacement shall be at least 4 mm. A minimum of 10 million cycles shall be completed and shall include random frequency sweep.

***Test acceptance criterion*:** No structural deterioration of the contact strip shall be observed.

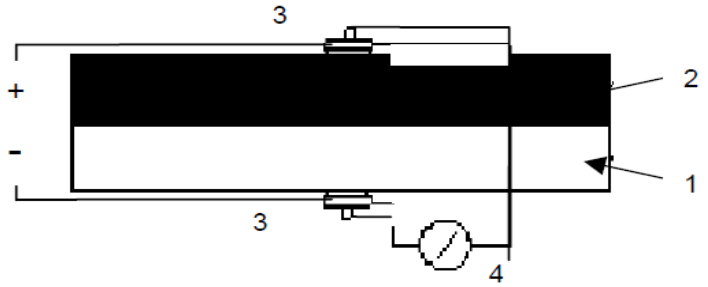
10.6.7 5.2.7 Test of the electrical resistance of the contact strip

5.2.7.1 General

This test shall demonstrate the electrical conductivity (or resistance) from the carbon surface to the supporting structure and can be used to demonstrate consistent manufacture.

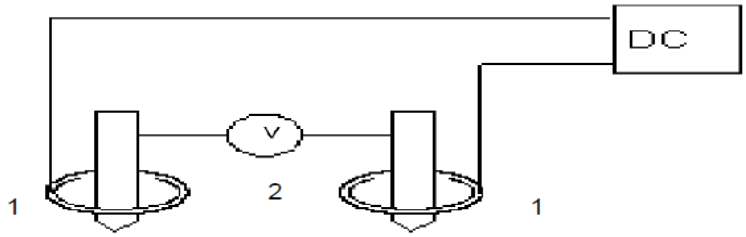
5.2.7.2 Test method

The resistance shall be measured by using a tool which incorporates contact points for the transmission of current and monitoring of voltage drop (see Figure 9). The tool shall be applied with repeatable force to test locations at a maximum distance of 10 cm along the length of the contact strip.
At each application a constant DC current of minimum 1 A shall be applied and the mV-drop at the location of current application shall be recorded (see Figure 10).
***Test acceptance criterion*:** Resistances shall be within the manufacturer's declared resistance limits for the carbon contact strip.



Key
1 carrier
2 carbon
3 contact points for the transmission of current
4 mV meter

Figure 9 – Test of electrical transfer resistance from the carbon contact surface to the supporting structure



Key
1 contact points for the transmission of current
2 mV meter

Figure 10 – Connection scheme for test of electrical resistance

10.7 TYPE TESTS

To be carried out on prototype samples of carbon strips of the given design. Complete type tests shall be organised and conducted by the manufacturer in presence of the authorised representative of RDSO. The test results of any grades once approved by RDSO shall be valid for a period of Five years. Supplier shall submit internal test report alongwith following details prior to offering the metallised carbon strip for type testing:

(i) The Bill of material indicating drawing no, material, sub Supplier etc.

(ii) Complete technical details of air tubes insert inside the current collector metalised carbon strip.

(iii) If TOT with the firm outside India is involved, then the supply experience of collaborator shall be furnished.

10.8 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.

10.9 ACCEPTANCE TEST

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. Acceptance test shall be conducted on 0.5% subject to a minimum of 2 samples (drawn at random) against each order. Routine test results of the lot will also be submitted by manufacturer.

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.

10.10 TESTS ON RAW MATERIALS/ BOUGHT OUT ITEMS

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

(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.

11.0 MARKING:

Condemning limit and grade shall be pad printed on each metalised carbon strips and the following particulars shall be legibly and engraved/ embossed/pad printed on each Metal sheath/carrier of Metalised carbon Strips

- Grade of carbon strips.
- Identification of source of manufacturer, and
- Batch number, month and year of manufacture.

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ANNEXURE – IA

TECHNICAL DETAILS EXISTING OHE OF INDIAN RAILWAY)

Sl.No.		PARAMETERS
1.0	OHE	Simple Polygonal OHE (regulated)
2.0	Span	72M (Max.) on tangent track suitably reduced on curves. Maximum variation between two adjoining span is 18 Mtrs.
3.0	Tension	1000 kgf. for catenary and 1000 kgf. for contact wire.
4.0	Contact wire	107 mm^2 Hard drawn grooved copper (HDGC)
5.0	Catenary	95 mm^2 Cadmium copper
6.0	Maximum blow off	415 mm
7.0	Stagger of contact wire	200 mm on straight track& 300 mm on curves.
8.0	Relative movement of pantograph with reference to contact wire.	
i)	Dynamic	Normally the contact wire is within the 520 mm zone on either side of the track centre line i.e., 1040mm which is the flat zone of the pantograph. However, during wind conditions the contact wire may go beyond this flat zone extending up to 800 mm on either size of the centre line i.e., to cover a range of 1600 mm. (Taking into account other factors such as oscillations, loose joints etc.
ii)	Static	For heavy wind conditions 860mm from the centre line of pantograph is taken in to account.
9.0	Mid span sag	Partly 50mm to 100mm varying from span 27 Mts. to 72 Mts.
10.0	Condemnation size of contact wire	74mm^2 (reduction in vertical height from 12.24mm to 8.25mm)
11.0	Gradient of contact wire	The maximum contact wire gradient is 3mm per meter and permissible variation in gradient over 2 consecutive spans is 1.5 mm per meter. (Variation of 1.5mm/m on consecutive span.)
12.0	Spacing of droppers	First dropper 2.25m from support, second one is 4.50m/6.75m and thereafter the droppers are at 9m spacing.
13.0	Permissible uplift of contact wire	60 mm (at registration arm)

Annexure -IB

Design of OHE for Double Stack Container Trains

A. Max Moving Dimension on DFC

(a) For DFC

Width 3.66 Mts.
Height 6.810 Mts.

(b) For feeder Routes

Width 3.5 meter
Height 6.81 meter with double stack containers
Height 4.385 meter on other routes

Max. Width of Fixed structure 2.825 Mts.

B. OHE Parameters

Height of Contact wire at support	up to 7.570 Mts. from Rail Level
Height of Contact wire at mid span	7520mm from Rail level
Height of Double stack container	7.1 Mts. from RL (6.81+0.250+0.020)
Wind Load	155kgf/m^2
Speed	200 kmph

C. Minimum Vertical Clearance Under Over-line structure

Heavy overhead structure such as ROB	8050 mm
Light overhead structure such as FOB	8430 mm
Heavy overhead structure at turnouts	8430mm

D. Design of OHE

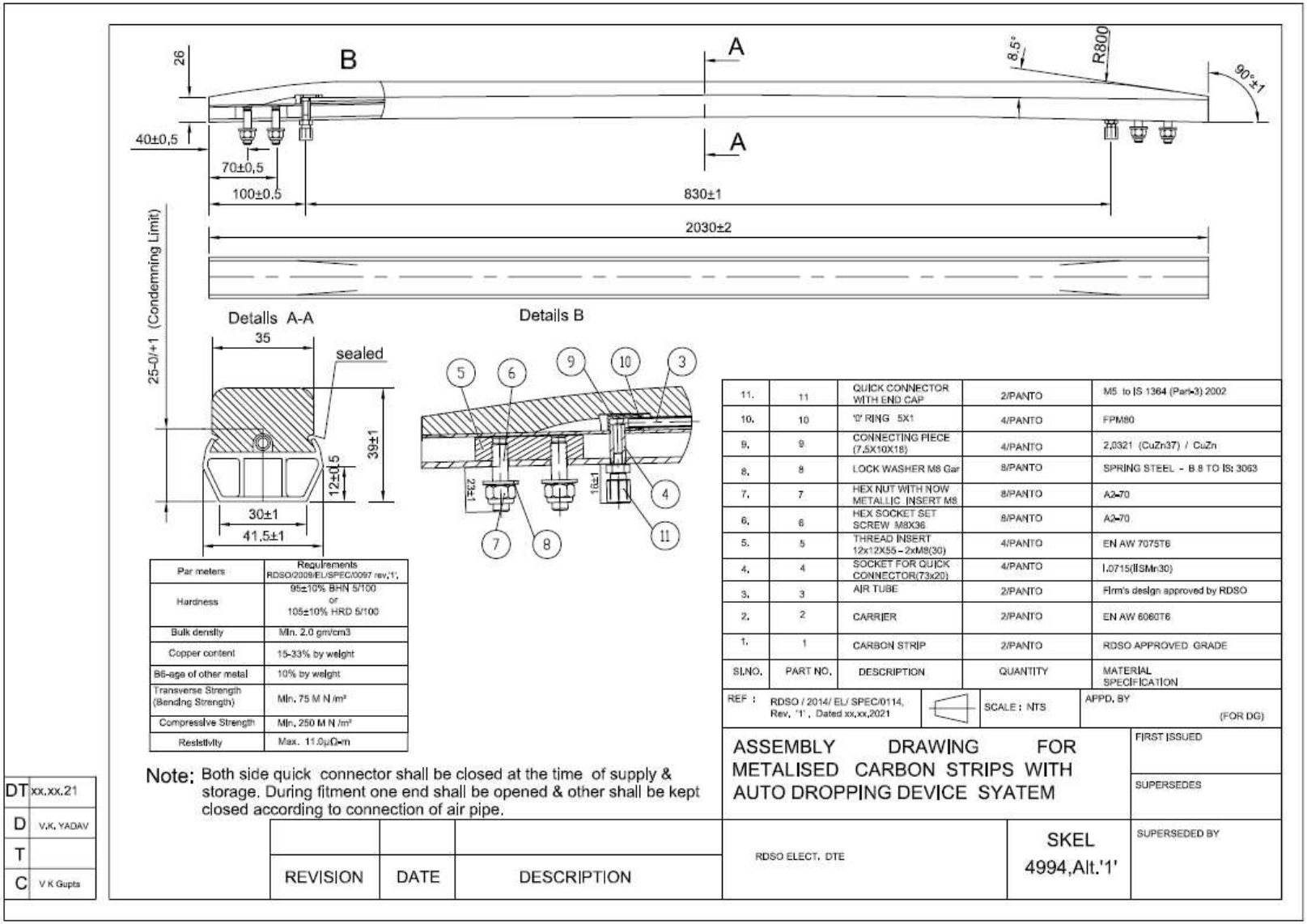
OHE Design for double stack container movement	Contact wire height	7.570Mts.
	Catenary wire height	8.970Mts.
	Mast length	11.4 Mts.
	Minimum implantation	2.8 Mts.
	Pre-sag	50 mm or 100 mm
	Span	Existing Spans (54 metres for wind load 155 kgf/Sq. m, 67.5 meters for wind load 105 kgf/Sq. m)
	Tension in contact	1000 kgf

	Tension in catenary	1000 kgf
	Tension length	1.5 km
	Foundations: FOS	> 2.5
Common components	Masts, Conductors, Auto-tensioning devices, Insulators, Steel tubes, All fittings.	
Merging with existing OHE	Mainline OHE: 5.5 M	Max. 5.8 m
	High Reach OHE	Max. 7.570m
	Difference	1.77 m.
	C.W. gradient in OHE for merging with existing lines	@10mm/m

ANNEXURE-II

Shed	Loco No.	Provided in single or both pantograph	Date of material received	Date of fitment	Average wear rate per 10,000 Kms.	Cases of failures, if any	Remarks, if any

ANNEXURE – III



Par meters	Requirements RDSO/2009/EL/SPEC/0097 rev,'1',
Hardness	95±10% BHN 5/100 or 105±10% HRD 5/100
Bulk density	Min. 2.0 gm/cm3
Copper content	15-33% by weight
B6-age of other metal	10% by weight
Transverse Strength (Bending Strength)	Min. 75 M N /m²
Compressive Strength	Min. 250 M N /m²
Resistivity	Max. 11.0μΩ-m

SI.NO.	PART NO.	DESCRIPTION	QUANTITY	MATERIAL SPECIFICATION
11.	11	QUICK CONNECTOR WITH END CAP	2/PANTO	M5 to IS 1364 (Part-3) 2002
10.	10	'O' RING 5X1	4/PANTO	FPM80
9.	9	CONNECTING PIECE (7.5X10X18)	4/PANTO	2.0321 (CuZn37) / CuZn
8.	8	LOCK WASHER M8 Gar	8/PANTO	SPRING STEEL - B 8 TO IS: 3063
7.	7	HEX NUT WITH NOW METALLIC INSERT M8	8/PANTO	A2-70
6.	6	HEX SOCKET SET SCREW M8X36	8/PANTO	A2-70
5.	5	THREAD INSERT 12x12X55 – 2xM8(30)	4/PANTO	EN AW 7075T6
4.	4	SOCKET FOR QUICK CONNECTOR(73x20)	4/PANTO	I.0715(IISMn30)
3.	3	AIR TUBE	2/PANTO	Firm's design approved by RDSO
2.	2	CARRIER	2/PANTO	EN AW 6060T6
1.	1	CARBON STRIP	2/PANTO	RDSO APPROVED GRADE

REF : RDSO / 2014/ EL/ SPEC/0114, Rev. '1', Dated xx.xx.2021 | SCALE : NTS | APPD. BY (FOR DG)

Note: Both side quick connector shall be closed at the time of supply & storage. During fitment one end shall be opened & other shall be kept closed according to connection of air pipe.

ASSEMBLY DRAWING FOR METALISED CARBON STRIPS WITH AUTO DROPPING DEVICE SYATEM

FIRST ISSUED | SUPERSEDES | SUPERSEDED BY

RDSO ELECT. DTE | SKEL 4994,Alt.'1'

REVISION	DATE	DESCRIPTION

DT	xx.xx.21
D	V.K. YADAV
T	
C	V K Gupta

repared by	Checked by	Issued by