

**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**



**TECHNICAL SPECIFICATION FOR**

**HIGH REACH PANTOGRAPH**



**A.C. ELECTRIC LOCOMOTIVES**

**Specification No: RDSO/2007/EL/SPEC/0054, Rev. '3'**

Approved by	Signature
PEDSE	ओमप्रकाश 22.5.19

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**Status of Revision**

S.N.	Date of Revision	Page no.	Revision	Reasons for Revision
1.	-	All	0	First Issue
2.	24.09.2012	3-12 & 22	1	Provision of ADD system and deletion of commercial conditions. Date effective: 24.09.2012
3.	04.11.2015	3, 4, 5, 7, 8, 9, 10, 11, 14, 19, 20, 24, 25 & 26	2	Provision of specification of Metallised Carbon Strips for ADD system for pantographs and revised panto pan profile & width, speed limit and working range.
4.	22.05.2019	All	3	Working height increment by 200mm and elimination/elaboration of clauses.



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**1.0 SCOPE :**

- 1.1. This specification applies to Pantograph for use on 25 kV, A.C., 50 Hz, Electric Locomotives for satisfactory operation up to speeds of 200kmph under contact wire heights varying from 4.58 up to 7.570meters from the rail level.
- 1.2. The pantographs shall be complete with all parts and accessories including Auto Drop Device (ADD) as per clause 4.9 of IEC-60494-1-2013 and Over Reach Detection (ORD) device necessary for its efficient operation. Over Reach Detection Device should get activated between 3.7m and 3.8m above locked down height to lower the pantograph. Control unit should be provided in machine room. Pantograph shall be with air bellow operated mechanism for raising and lowering preferably. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

**2.0 TERMINOLOGY:**

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

BG	: 1676 mm Broad Gauge used in IR
IS	: Indian Standard
IRS	: Indian Railways Standard
BS	: British Standards
IEC	: International Electrotechnical Commission
ISO	: International Standards Organization
OHE	: Overhead Equipment
ADD	: Auto Drop Device
ORD	: Over Reach Detection

**3.0 STANDARDS, SPECIFICATIONS ETC:**

- 3.1 Following Standards / RDSO circular have been referred in this specification:

IEC Publication	60494-1:2013 edition or latest edition	Railway application-Rolling Stock-Pantographs-Characteristics and tests Parts 1- Pantographs for Main line Vehicles.
IEC Publication	61373: 2010 or latest edition	Railway application-Rolling Stock equipment-Shock and Vibration
IEC Publication	62486 latest	Railway applications- Current collection systems- Technical criteria for the interaction between pantograph and overhead line (to achieve free access)



- 3.2 All relevant IEC, IS and BS specifications quoted in the appropriate clause of the specification will also apply except where modified/amended by the provisions of this specification.
- 3.3 Latest version/revision of the standards and specifications etc. shall be followed, unless specifically mentioned otherwise.

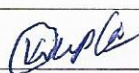
#### **4.0 GENERAL CONDITIONS:**

- 4.1 This specification is meant for use as guideline for development of high reach pantograph for AC Electric Locomotives for Dedicated Freight Corridors as well as on the existing OHE of the Indian Railways. Parameters of OHE and track of existing system and that of proposed dedicated freight corridor are given in Annexure-IA & Annexure-1B.
- 4.2 Manufacturers/suppliers are advised to familiarize themselves with the roof equipment layout of the all types of electric locomotives.
- 4.3 Once a prototype is approved, no Manufacturer/supplier shall change his source of supply or sub-vendor for purchased components and sub-assemblies without RDSO approval.
- 4.4 Manufacturer/supplier shall stencil/engrave/emboss/imprint identification marks indicating their monogram/brand names and the month and year of manufacture at a conspicuous place of main parts.
- 4.5 Technical guidance and assistance for proper operation and maintenance, trouble shooting, investigation and generally all aspects of technical liaison that may be required during the initial service trials period of one year shall also be organized by the Manufacturer/supplier.
- 4.6 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 Air bellow operated Pantograph and any other factor which may be cause such dispute. The responsibility to settle any issue lies with the Manufacturer/supplier.
- 4.7 Operating and maintenance manual containing essential technical information for understanding the principle of operation of the pantographs as well as for carrying out inspection, maintenance and overhaul shall be supplied. The manual shall be in English and one set of such manual shall be supplied with supply of every lot of 05 Pantograph or less. The manual shall be in A4 size sheet printed on one side in suitable folder. All drawings/sketches/ Photographs shall be in A4 /A3 size sheets only. The Manufacturer/supplier may follow his standard practices in regard to the preparation of such a manual, but the following information should be necessarily included:
- (a) General Assembly drawing including mounting details and overall dimensions.
  - (b) Explanation for operation and precautions.

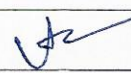
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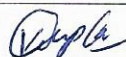


- (c) Diagrams of pneumatic and electrical connections.
  - (d) Drawings of wearing components indicating designed dimensions and their wear limits.
  - (e) Detailed instructions for inspection, maintenance and overhaul.
  - (f) Dimensional drawings and key drawings of such other parts which will be required for proper functioning of the pantograph.
  - (g) A complete spare part list with reference part/ drawing numbers and expected service life.
  - (h) Details of bearings and lubricants.
  - (i) The maintenance manual should explain maintenance activities, T&P and overhauling kits required according to the maintenance schedule being adopted for electric locomotives.
- 4.8 The Manufacturer /Supplier shall submit design details for scrutiny & approval and shall furnish the following:
- i) General assembly drawing including mounting details and overall dimensions.
  - ii) Principle of operation.
  - iii) Diagrams for pneumatic and electrical connections. Air connection should be from pan side and electrical connection i.e. current take off point should be from rear side of base frame near mounting insulator.
  - iv) Drawings of Air-Bellow, ADD system & over reach detection device, throttle valve, copper braids shunts, current collection strips, main frame, pan head, bow horns, Dampers, aero-foils and other important components.
  - v) The Bill of material indicating drawing no., quantity, sub-vendor/sources etc.
  - vi) Tests reports of critical component/parts such as air bellow, insulating tube, regulator/valves of control panel, wearing strips, damping arrangement etc.
- 4.9 The spares required for the purpose of schedule maintenance of the pantograph are to be submitted.
- 4.10 Complete list of spare parts recommended for-
- Replacement due to normal wear and tear; and
  - Emergency replacements for any breakage, damage etc.
- 4.11 The Manufacturer /Supplier shall list out the special tools, gauges and testing instruments/kits which will be required for inspection and maintenance of the pantograph.
- 4.12 The Manufacturer /Supplier shall furnish technical information/data of their product for evaluation as given at Annexure II.

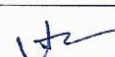
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4.13 If the Manufacturer /Supplier offers any better feature of pantograph than the features as specified in this specification shall be acceptable.

## 5.0 **CLIMATIC, ENVIRONMENTAL AND OPERATING CONDITIONS:**

### 5.1 Climatic and environmental conditions.

Atmospheric temperature	Under Sun: 70°C max. In shade: 50°C max. Temp. Inside working locomotive may reach 60°C. Minimum temperature: 5°C
Humidity	100% saturation during rainy season.
Altitude	1000 Mts. 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 thunder storms days/ year.	May be as high as 85 days
Coastal area	Equipment 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 micro Siemens /CM, wind pressure reaching 216 kgf/m <sup>2</sup> .



## 6.0 **MAIN FEATURES:**

- |                                        |   |                                                                                                                                       |
|----------------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------|
| i) Operating Voltage                   | : | a) Nominal - 25 KV, 50 Hz.<br>b) Maximum (Cont.) - 27.5 KV.<br>c) Short time Maximum - 30 KV for 10 Sec.                              |
| ii) Rated Current(For testing purpose) | : | 600 Amps. (Running Vehicle)<br>80Amps. (Standstill Vehicle)<br>100 Amps.( Maximum Standstill Vehicle)                                 |
| iii) Mounting                          | : | 4 supports (Indian Railway's existing arrangement of four support 807 mm along with length of loco x 1160 mm along the width of loco) |
| iv) Max. Extension                     | : | At least 3.7Meters from the locked down height                                                                                        |
| v) Working range                       | : | 0.15 Meters to 3.6 meters (for satisfactory current collection )                                                                      |
| vi) ADD system                         | : | As per IEC-60494 .                                                                                                                    |
| vii) ORD device                        | : | Should get activated between 3.7m and 3.8m above locked down height to lower the pantograph.                                          |
| viii) Max. Weight                      | : | 180 kg. Approx. (Without insulators)                                                                                                  |
| ix) Static Contact force               | : | 7 ± 1.0 kgf.                                                                                                                          |
| x) Max. speed                          | : | 200 kmph.                                                                                                                             |

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- xi) Overall length : 2100mm (Max.).  
(including shunt in folded condition) from rear panto mounting foot insulator
- xii) Total Contact forces : As per IEC-62486
- xiii) Wearing strip material : Metallised carbon strips as per RDSO's Specification No: RDSO/2009/EL/SPEC/0097, Rev. '1' or Specification No: RDSO/2009/EL/SPEC/0114, Rev.'0' suitable for ADD system. In case the design of the strip is different from above, prior approval shall be taken from RDSO.
- xiv) Max. Folded height : 295 mm. (so as to be within existing above mounting Maximum Moving Dimensions of rolling stock insulator followed in Indian Railways)
- xv) Compressed air : The compressed air supply in the loco may vary between 5.5 kg/cm<sup>2</sup> and 11 kg/cm<sup>2</sup>, depending upon the type of stock, compressor operation etc. Panto shall start lowering if the air pressure drops below 4.5 kg/cm<sup>2</sup>.
- xvi) Raising time for the pantograph to reach an extension of about 3.6 meters 6 to 15 seconds.
- xvii) Lowering time for the pantograph to fold on its stops from 3.6meters – less than or equal to 20 seconds. Break from the contact wire should be rapid and controlled throughout the remaining lowering operation. Folding on to the stops should be without any jerk.
- xviii) The resistance of pantograph between carrier i.e. from contact strip (Metalized Carbon) and power take off point on the base frame shall not exceed 10mΩ.
- xix) Adequate lowering effort and retaining force in the locked-down condition shall be ensured to lower and to retain the pantograph in the locked-down position without undue vibrations at speeds upto 200 kmph.

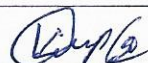
## 7.0 TECHNICAL REQUIREMENTS:

- 7.1 The pantograph and its mounting arrangement shall be of robust design for traction duty and shall withstand satisfactorily the vibrations and shocks normally encountered in service. It should be easy to maintain.
- 7.2 The pantograph shall be suitable for bi-directional use. The performance in either direction shall be within stipulated parameters.
- 7.3 The pantograph shall be suitable for satisfactory operation upto 200 kmph under existing OHE as well as high reach OHE as per Indian conditions of power supply, track and overhead equipment, the salient

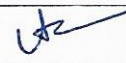
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technical data of which are given in Annexure-1A as well as in the Dedicated freight Corridor for which tentative details are given in Annexure – 1B.

- 7.4 Electrical clearance of 250 mm (minimum) shall be maintained between live portion of pantograph and earth portion of its assembly after fitment on locomotive.
- 7.5 The pantograph shall be of light weight, robust and compact, suitable for use under existing OHE as well as under the OHE of the Dedicated Freight Corridor, where OHE contact wire height varies from 4.58 to 7.570 meters from the rail level.
- 7.6 The construction of the pantograph shall be such that all the parts are easily accessible for inspection and maintenance.
- 7.7 The pantograph horn profile should be as close as possible to the horn profile of SKEL-4992 Alt. '0' for High Reach pantographs. In case the design of the pan profile different from existing profile prior approval shall be taken from RDSO.
- 7.8 The pantograph shall be mounted on 4 insulators on the roof of the loco, the approximate height of these insulators being 360 mm. These mounting insulators will, however, be arranged by the purchaser. The fixing arrangement of the pantograph shall suit these insulators the drawing of panto mounting insulator for which is enclosed. (Drawing No. SKEL.3870.) In case the design of the insulator is different from above, prior approval shall be taken from RDSO.
- 7.9 As all moving parts of the pantographs are likely to be used as current carrying conductors, all joints shall be provided with copper braided shunts of adequate cross section.
- 7.10 The operation of the pantograph should be preferably through air bellow. However designer may offer alternate operating system and prior approval shall be taken from RDSO.
- 7.11 Interfaces of dissimilar metals are to be avoided to the extent possible, if however, this is not possible at some location, suitable plating of the dissimilar metals shall be carried out to avoid any electrolytic action taking place.
- 7.12 Painting: The pantograph sections/assemblies/sub-assemblies shall be made from scale free pickled and oiled steel. These shall be grit/sand blasted before application of rust preventive primer followed by Powder coating/Polyurethane painting of orange (RAL 2005) with a thickness of minimum 80 microns of synthetic resin paint. Any air-reservoir incorporated in the pantograph assembly shall have primer and paint applied to the inner surfaces complying with standard schedule for coating of internal surfaces of the air reservoir. Complete details of painting may be furnished by firm.
- 7.13 The pantograph offered shall consist of the following main part.
  - i) A welded section base.



- ii) A light weight articulated system bearing the bow and ensuring its contact with the catenary system under a specified pressure with a minimum variation in this pressure for any variation in the height of the contact wire which may be between 4.58 m – 7.57 m. A curve showing the pantograph extension and contact force during raising and lowering shall be submitted by the firm. The articulation system should be designed to allow a maximum extension of 3.7meters. Adequate damping of the main frame shall also be ensured.
  - iii) A pneumatic control system allowing the control from the driver's cab for the raising and lowering of the pantograph. A good quality sintered bronze filter should be provided in control box.
  - iv) A mechanism to slow down the pantograph at stroke ends when lowering and raising without shock.
  - v) A bow on a suitably damped resilient suspension to ensure good contact while negotiating contact wire irregularities. The bow profile shall be as per the drawing No. SKEL 4992 Alt. '0' (Enclosed) or as per the firm's drawing approved by RDSO.
  - vi) The panto pan main strips shall be as per RDSO's Specification No: RDSO/2009/EL/SPEC/0097, Rev. '0' & drawing No. SKEL-4303 (Rev.6) for Metallised Carbon Strip or Specification No: RDSO/2009/EL/SPEC/0114, Rev. '0' suitable for ADD system & Drawing No. SKEL-4994 Alt. '0'. In case of other design metallised carbon strips are required suitable for ADD system, complete details are to be submitted for approval.
  - vii) All vital parts of the pantographs including air bellows, dampers, air connecting tubes etc. should be proven in similar application. Test reports of such vital components shall be submitted by the Manufacturer/supplier during design review.
  - viii) The pantograph shall be fitted with suitable aerofoil if required, to minimize the effect of aerodynamic forces at high speeds for good current collection.
  - ix) High tensile hardware and fasteners of Stainless Steel Grade A2-70 shall be used. Prior approval shall be taken from RDSO, if any other type is proposed.
- 7.14 High ambient temperature and high relative humidity should be kept in mind while selecting the air bellows.
- 7.15 Welding: Firm shall submit welding procedure.
- 7.16 Small locked down longitudinal length of the pantograph shall be preferred.



**8.0 INSPECTIONS AND TESTS :**

- i) The Pantograph shall be subjected to type and routine test as per IEC 60494-1: 2013 at the manufacturer's premises or at mutually decided venue where all the facilities should be made available for carrying out the prototype test. The type test shall also include Wind tunnel test, shock and vibration test and current collection test. This will be followed by an extensive field trial for a period of at least six months.
- ii) The type test shall be witnessed by the authorized representative of RDSO/CLW. The routine test shall be witnessed by the authorized representative of the Purchaser.
- iii) The detailed test plan shall be submitted by the Manufacturer/supplier along with design documents for review and finalization by the Purchaser in consultation with RDSO.
- iv) Any shortcoming or defect noticed during the type test and field trials shall be pointed out to the Manufacturer/supplier by the purchaser to enable him to incorporate the necessary improvements before bulk production is commenced.
- v) Any additional tests, trials, if considered necessary, shall also be arranged by the Manufacturer/supplier free of costs.
- vi) The Manufacturer/supplier shall provide appliances required by the inspecting official free of cost, for inspection and testing of the whole unit as well as components if required.
- vii) Type test will be performed on one unit of given design to verify that product to meet the requirements specified and agreed upon between users & Manufacturer/supplier, subject to agreement between user and Manufacturer/supplier some or all the type tests shall be repeated once in five (05) years by RDSO, so as to confirm the consistency of quality of the product. This will be part of revalidation of Manufacturer/supplier approval. The Manufacturer/supplier shall repeat all the type tests after Five years without any additional cost. The five (05) years will be counted from the date of successful completion of type test of the prototype unit. Wind tunnel test and shock & vibration tests will be repeated if there is any design change or performance related issue.
- viii) RDSO may conduct surprise check on manufacturing process and quality control along with any of the test to ensure quality of product and its conformance to this specification.
- ix) TEST REPORTS:
  - a. 10 copies of the type test report, suitably enclosed in a cover with punched holes, duly signed by the representatives of Manufacturer/supplier and RDSO, shall be supplied in standard 'A4' size sheets with punched holes for filing.



- b. 06 copies of the routine test report, suitably enclosed in a cover with punched holes, duly signed by the representatives of Manufacturer/supplier and Purchaser, shall be supplied in standard 'A4' size sheets with punched holes for filing.

### 8.1 SCHEDULE OF TESTS ON PANTOGRAPH

Sl. No.	Particulars	Tests (Ref. Clause IEC- 60494-1)		
		Type Test	Routine Test	Consistence type tests
01.	General Tests (Verification with Firm's Drawings approved by RDSO/CLW)	6.2	6.2	6.2
	• Visual Inspection	6.2.1	6.2.1	6.2.1
	• Weighing	6.2.2	-	6.2.2
	• Dimensions	6.2.3	6.2.3	6.2.3
	✓ Collector Head Length			
	✓ Collector Head Height			
	✓ Collector Head Width			
	✓ Head Profile			
	✓ Length of contact strips			
	✓ Housed Height			
	✓ Maximum Extension			
	✓ Electrical Thickness			
	✓ Distance between mounting points			
	• Identification	6.2.4	6.2.4	6.2.4
	• Functional check of ADD	6.2.5	6.2.6	6.2.5
02.	Operating Test	6.3	6.3	6.3
	• Measurement of Nominal Static force	6.3.1	6.3.1	6.3.1
	• Checking Operating System	6.3.2	6.3.2	6.3.2
03.	Mechanical Endurance withstanding Test	6.4	-	6.4
	• Raising/Lowering Operation	6.4.1	-	6.4.1
	• Collector head Suspension	6.4.2	-	6.4.2
04.	Resistance to vibration	6.4.3	-	-
	• General (IEC 61373 : 2010 Category 1 Class A)	6.4.3.1	-	-
	• Measurement of natural transverse frequency of the pantographs.	6.4.3.2	-	-
	• Transverse vibration test.	6.4.3.3	-	-
	• Vertical vibration test	6.4.3.4	-	-
05.	Resistance to withstanding shocks	6.5	-	-
06.	Transverse Rigidity Tests	6.6	❖	6.6

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07.	Air Tightness/ Leakage Tests on Air Bellow	6.7	6.7	6.7
08.	Measurement of degrees of freedom of collector head	6.8	6.8	6.8
09.	Measurement of housing force	6.9	❖	6.9
10.	Total mean uplift force <sup>#</sup> (Wind tunnel test)	6.10	-	-
11.	Current Collection Test <sup>*</sup>	6.11	-	-
12.	Current Heating test	6.12	-	6.12

❖ One sample of each lot will be tested for Transverse Rigidity Tests & Measurement of Housing Force.

\* Current collection test shall be carried out as Annexure-II

# Test will be conducted at 1.6m extension from locked down height.


## 9.0 SCHEDULE OF GUARANTEE AND TECHNICAL PARTICULARS

01.	Manufacture's Name	
02.	Country of manufacture	
03.	Type of pantograph	
04.	Extension for satisfactory current collection	
05.	Speed potential in KMPH (Range of speed and optimum speed for specified current collection.)	
06.	Current Rating in Amp.	
07.	Lowering time in Seconds.	
08.	Raising time in Seconds.	
09.	Air bellow mounting (whether at live/ earth potential)	
10.	Distance between mounting centres: Lengthwise in mm (Parallel to track) Widthwise in mm (Perpendicular to track)	
11.	Detailed drawing of the collector strips including bow strips indicating the following data: ❖ Material ❖ Hardness ❖ Width in mm ❖ Thickness in mm ❖ Length in mm	

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	<ul style="list-style-type: none"> <li>❖ Profile</li> <li>❖ Condemning size in mm</li> <li>❖ Distance between collector strips in mm</li> <li>❖ Fixing arrangement of collector strip.</li> </ul>	
12.	Folded height of the pantograph in mm (without mounting insulator)	
13.	Weight of the pantograph excluding mounting insulators in Kg.	
14.	Type of bearing and housing	
15.	Material of flexible copper shunts, diameter of stranded wire, diameter of single wire, resistance of single wire per meter, calculated area of braid, finish of copper braid and copper lugs.	
16.	Working air pressure in Kg/cm <sup>2</sup> Minimum Maximum	
17.	(a) Static force in Kg. (b) Variation over the working range in mm.	
18.	Transverse flexibility for a given force in mm.	
19.	Maximum angle of tilt of the collector head in degree.	
20.	Drawing & technical details of <ul style="list-style-type: none"> <li>❖ Pantograph Assembly</li> <li>❖ Pan Assembly</li> <li>❖ Air Bellow</li> <li>❖ Control box</li> <li>❖ Steel rope/ chain</li> <li>❖ Cam</li> <li>❖ Main frame</li> <li>❖ Collector head</li> <li>❖ Insulated hose</li> <li>❖ Damper</li> <li>❖ ADD&amp; ORD</li> <li>❖ Bearings</li> <li>❖ Shunts</li> </ul> 	
21.	Complete details of Air Bellow including material, working pressure, air quantity & air pressure required for complete expansion of Pantograph, operating Temperature, Nominal diameter of air bellow, Stroke length, Operational angle etc.	
22.	Details of Aero-Foils, dimensions material & mounting arrangement if used.	
23.	Type & details of damping device provided for collector head and main frame.	



**ANNEXURE - IA****TECHNICAL DETAILS (EXISTING OHE & TRACK OF INDIAN RAILWAY)****1. Over Head Equipment (OHE)**

- |      |                              |                                                         |
|------|------------------------------|---------------------------------------------------------|
| i)   | OHE                          | Simple polygonal OHE (regulated)                        |
| ii)  | Span                         | 72M (Max.) on tangent tract suitably reduced on curves. |
| iii) | Tension                      | 2000 Kgf. for catenary and contact wire together.       |
| iv)  | Contact wire                 | 107 mm <sup>2</sup> Hard drawn grooved copper (HDGC)    |
| v)   | Catenary                     | 65 mm <sup>2</sup> Cadmium copper.                      |
| vi)  | Max. blow off                | 415 mm                                                  |
| vii) | Max. Stagger of contact wire | 200 mm on straight tract & 300 mm on curves.            |

- 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 center 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 upto 800 mm on either side of the center 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 center line of pantograph is taken in to account.                                                                                                                                                                                                                                                                                                              |
| iii) | Mid span sag.                       | 50 mm to 100mm for span varying from 27 Mts. to 72 Mts.                                                                                                                                                                                                                                                                                                                                                 |
| iv)  | Condemnation size contact wire      | 74mm <sup>2</sup><br>(Reduction in thickness from 12.24mm to 8.25mm)                                                                                                                                                                                                                                                                                                                                    |
| v)   | Gradient of contact wire:           | Max. 3mm / Mt. restricted to a max. (Variation of 1.5mm/m on consecutive span.)                                                                                                                                                                                                                                                                                                                         |
| vi)  | Spacing of droppers                 | First dropper 2.25 Mts. from support. Second Dropper 9.0m or 11.25 Mts. from the support. All other dropper spaced 9 Mts.                                                                                                                                                                                                                                                                               |
| vii) | Permissible uplift of contact wire: | 60 mm (at registration arm)                                                                                                                                                                                                                                                                                                                                                                             |

**2. Track**

i)	Gauge	Broad gauge system of the Indian Railways-1676 mm
ii)	Track Structure	Minimum standard of 90R rails on sleepers to M+4 density and 200 mm depth of ballast cushion below sleepers (which may consist of at least 75 mm clean and the rest in caked up condition). On consolidation and stable formation. On high speed routes 52 kg rails with M+7 sleeper density have been used partly
iii)	Sharpest curve and turnout To be negotiated	174 radius. The locomotive is also checked for passage in both direction over standard BG 1 in 8 ½ turnouts.

- Permissible track tolerance :Following are the track geometry standards for various track parameters on Indian Railways BG route as obtained from track recording cars.

	<b>BG (high speed)</b>	<b>BG (main line)</b>
1. Unevenness	6mm general and 10 mm at isolated spots.	15 mm
2. Twist	2.0 mm/m with isolated spots of 3.5mm/Mts.	3.5 mm/Mts.
3. Gauge Variation	+6mm -3mm	± 6 mm
4. Alignment(versine cord of 7.2 m)	5 mm in general with isolated 7mm on curves and 10mm on straight	7 mm



**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<sup>2</sup>

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, 67.5meters 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





**ANEXURE - II****CURRENT COLLECTION TEST****(A) Brief Record:**

1. Loco No.
1. Nature of Load
2. Name & Designation of the person observing the tests
  - a) TRD
  - b) Loco Shed
  - c) Supplier
  - d) RDSO
3. Serial No. of Pantograph & Make
4. Date & time of commencement of test
5. Kilometers traveled
  - a) Kilometers starts
  - b) Kilometers finish
6. Date & time of completion of test
7. Type of OHE
8. The test should be done with light engine or train during night for knee leading and knee trailing position of the pantograph for at least 50 kms preferably at maximum permissible speed and record the data in proforma shown (D) below. Also the weather at the time of the test should be noted down.

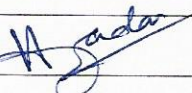
**(B) Test Before Commencement of Run:**

Sl. No.	Tests/ Checking	Obtained Value	Remarks
01.	Raising time	.....Seconds	Should be within 15 seconds.
02.	Lowering time	.....Seconds	Maximum 20 seconds (The panto should disengage with contact wire rapidly in initial travel from static position)
03.	Static balancing	.....	At any height within working range, panto should be statically balanced with the weight of 7 kg.
04.	Condition of Panto Metallised Strips	.....	Condition of Panto strips and make to be recorded. Strips to be conditioned so that ends are chamfered & surface is smooth.
05.	Tilting of pan head	.....	By angle protector should be $7^{\circ} \pm 1^{\circ}$

**(C) Test after Completion of Run:**

Sl. No.	Tests/ Checking	Obtained Value	Remarks
01.	Checking of panto &		Visual checking to be done.

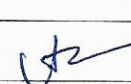
Prepared by



Checked by



Issued by





	strips conditions		There should not be any abnormality.
02.	Checking of raising time, lowering time and static balancing		As per Test Schedule (B) 1, 2 & 3
03.	Collection of copper debris on the panto pan/roof of the locomotive		No appreciable debris should be accumulated.

**(D) Proforma for Current Collection Test**

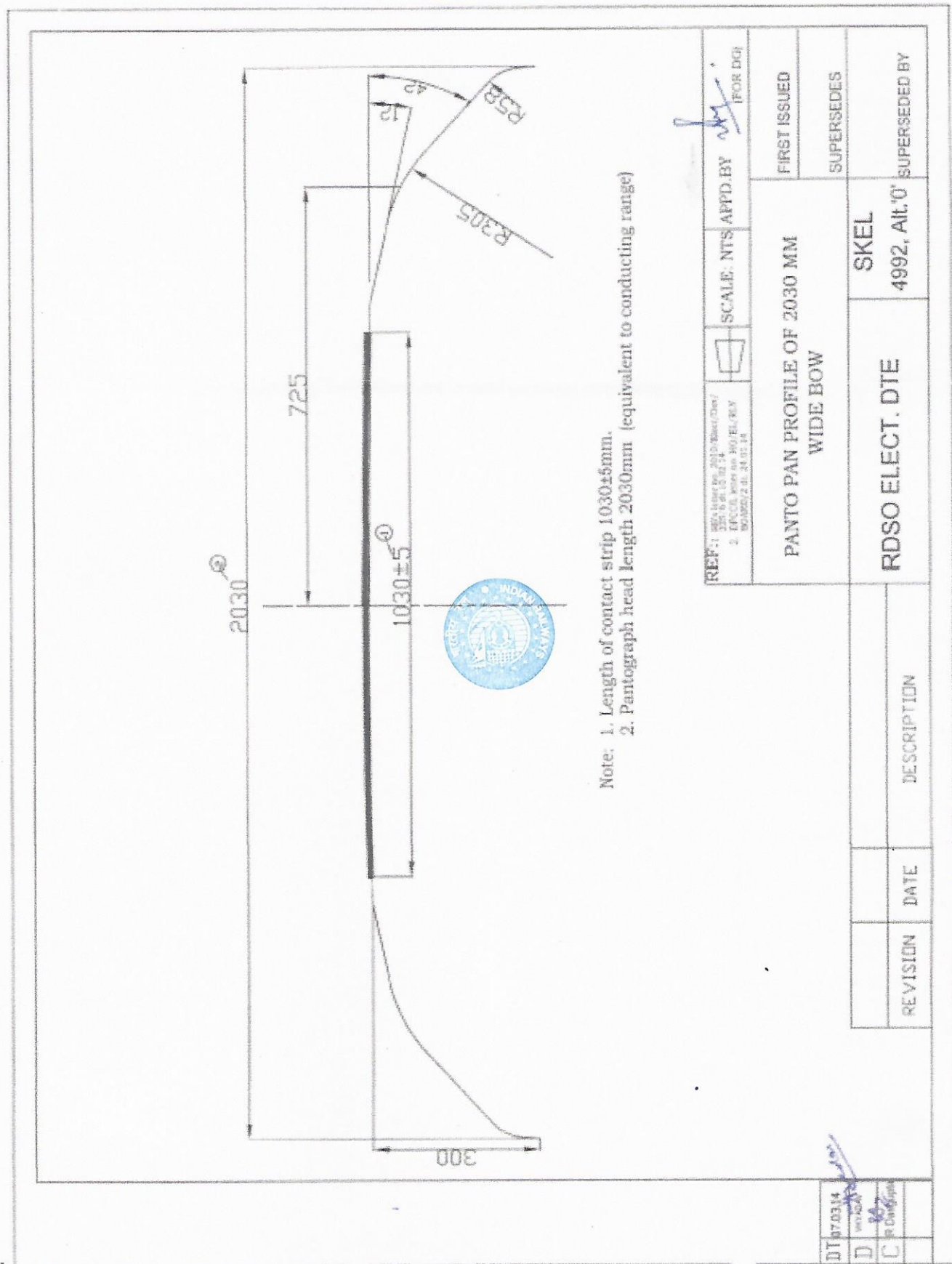
Km No./ Mast Location	Station	Speed (kmph)	Low Spark	Medium Spark	High Sparks



Prepared by

Checked by

Issued by

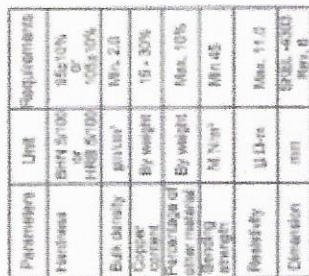


Prepared by

Checked by

Issued by





Land clearing requires an additional 30 miles be surveyed. If you start tomorrow, the clearing has to be completed by the end of the month.



1. ALL DIMENSIONS ARE IN MM.
2. THREE PIECE / ONE PIECE DESIGN CAN BE OFFERED WITH OR WITHOUT STEEL END PIECES.
3. OVERALL DIMENSIONS SHALL BE MEASURED
- 4 IN CASE OF THREE PIECE DESIGN THE MEAN LENGTH OF INDIVIDUAL PIECE SHALL BE 316, 318 AND 116 WITH TOLERANCE OF  $\pm 2\text{mm}$ .
5. MAXIMUM TIGHTENING TORQUE FOR PART (A) 2500-NM.
6. ALL THE NINE NOS FIXING BOLTS (ITEM NO.8) SHALL HAVE ADEQUATE LATERAL PLAY TO AVOID BRAKEAGE OF STRIP DUE TO UNEVEN STRESS DURING FITMENT.
7. COPPER PLATING/SPRAYING
8. CORROSION PROTECTION PLATING (THICKNESS MINIMUM)

VIEW AT A-A

5	Rev 00126.	9
4	Rev. 00116 (15 Feb 1993)	8
3	Suppl. Header (10 Jul 93) 01 00 00 0001 1994	7
2	Sheet strip 1.51 x 2.34m	6
1	CARBON STRIP	5
PART NO.		4
Spec. No. RD500005/1		3
SPECIFICATION '1'		2
SCALE NTS		1
APPRO BY		
FIRST ISSUED		
SUPERSEDES		
SHEET 4003 (Rev 0)		
SUPERSEDED BY		
RD50ELECT. DTE		
4303 (Rev 0)		

6	29.08.2013	Note 3N-8 added. A properties of metallised carbon strip revised.
5	01.05.2009	Properties of metallised carbon strip added.
4	27.04.2001	Note No. 2, 6, 7, 10 removed. Word Max. added in Note No. 5
3	25.01.2000	Dwg. 1 Dimension Corrected. Note Revised.
2	18.08.1999	Dwg. 1 Dimension Corrected. Note Revised.
1	26.09.1998	Dwg. 1 Dimension Corrected. Tolerance Added.
DESIGNER	DATE	REVISION

DT	20.08.13
D	V.K. Yadav
C	MC Mahant



DT 07.06.14		D 14/06/14		C 14/06/14	
Prepared by <i>A. Jindal</i>		Checked by <i>Rupla</i>		Issued by <i>U</i>	

Part No	Part Name	Description	Quantity	Material Specification
11	QUICK CONNECTOR WITH END CAP		2PANTO	MS to IS 1364 (Part-3) 2002
10	W RINGS SKT		4PANTO	FR350
9	CONNECTING PIECE (7.5X10X10)		4PANTO	2022 (10.25X7) C220 21 50 3P
8	LOCK WASHER 8X8 GPH		4PANTO	8X8 TO BS 3083
7	PER NUT WITH NON METALLIC INSERT 10X		8PANTO	A2 70
6	HEX SOCKET SET SCREW M10X8		8PANTO	A2 70
5	THREAD INSERT 12X10X5.5 248020		4PANTO	EN 10736
4	SCREW FOR QUICK CONNECTOR 17 8005		4PANTO	1.97111.100.001
3	AIR TUBE		2PANTO	Firm's design approved by RDSO
2	CARRIER		2PANTO	EN 100015
1	CARBON STRIP		2PANTO	RDSO APPROVED GRADE

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REF: RDSO/2007/EL/SPEC/0054 Rev. '3', Dated 07.05.2014

SCALE: NTS APPD BY *[Signature]* FOR DGI

ASSEMBLY DRAWING FOR METALISED CARBON STRIPS WITH AUTO DROPPING DEVICE SYSTEM

FIRST ISSUED

SUPERSEDES

REVISION	DATE	DESCRIPTION

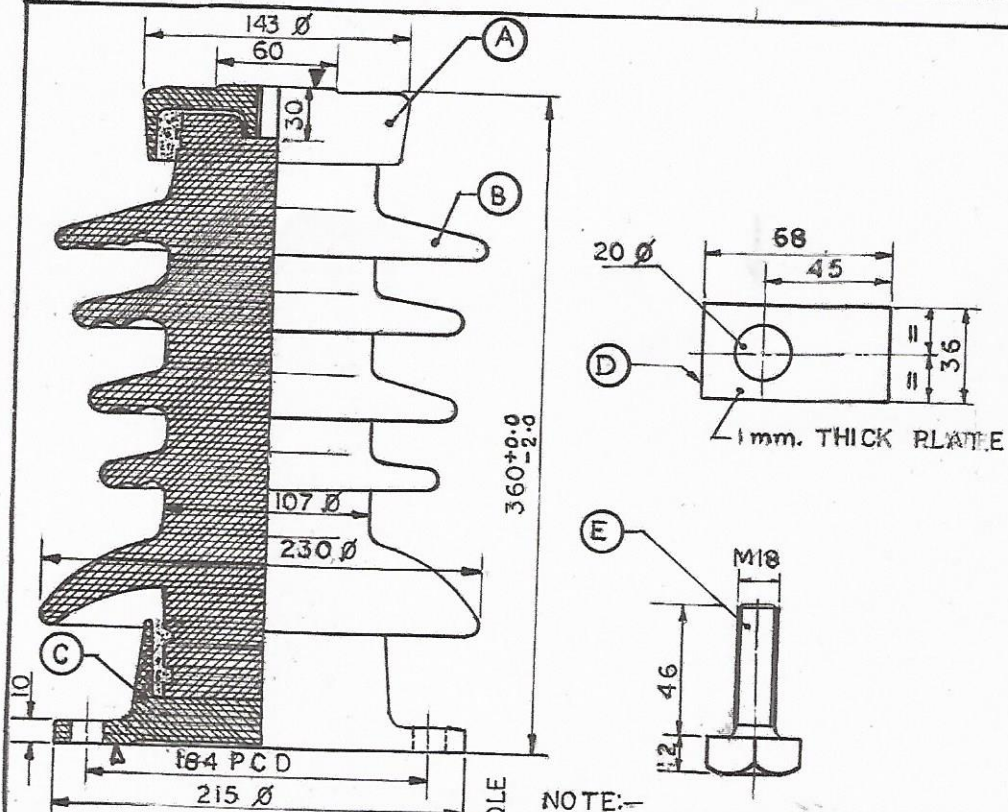
  

RDSO ELECT. DTE		SKEL	SUPERSEDED BY
		4994, AIL '0'	

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

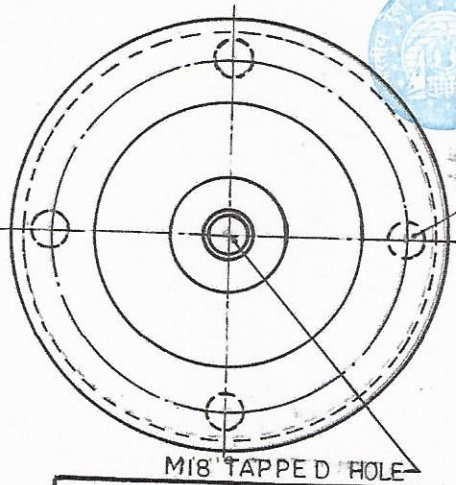
Parameters	Requirements
Hardness	RDSO/2007/EL/SPEC/0054 Rev. '3' 95±10% BHN 5/100 or 105±10% HRB 5/100
Bulk density	Min. 2.0 gm/cm <sup>3</sup>
Copper content	15-33% by weight
Age of other metal	10% by weight
Transverse Strength (Bending strength)	Min. 45 MN / m <sup>2</sup>
Resistivity	Max. 11.0 mΩ-m





## NOTE:-

1. ALL DIMENSIONS ARE IN mm
2. UNLESS SPECIFIED, A TOLERANCE OF 0.030 ± 0.3 SHALL BE TAKEN ON ALL DIMENSIONS.
3. PART No. C & D ADDED ON 24.5.76.



E	HEX. HEAD SCREW SIZE- M18	1	IS:1364 STEEL
D	LOCK PLATE	1	IS:1079 M.S.
C	MOUNTING BASE	1	IS: 2108 MALLEABLE CAST IRON
B	INSULATOR	1	IS: 131 PORCELAIN
A	CAP	1	IS:2108
PART No.	DESCRIPTION	QTY.	SPEC/MAT.

REF: CLW-SK.No.

CLW/E5/SK2/AC/I-1

SCALE:-1:2

APPROVED

PANTO MOUNTING INSULATOR

R.D.S.O. ELEC. DTE. SKEL. 3870

DT	26-2-86
D	
T	
C	