Specification No: RDSO/2008/EL/SPEC/00 66 , Rev. '0'

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION FOR

PANTOGRAPH

FOR

AC FREIGHT ELECTRIC LOCOMOTIVES

Specification No: RDSO/2008/EL/SPEC/00 66, Rev. '0'

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RESEARCH DESIGNS AND STANDARDS ORGANISATION
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CONTENTS

1. SCOPE :

1.1. The Pantograph, acting as mobile current carrying equipment, mounted on the roof of the Electric Locomotive, from the overhead equipment under both static and dynamic conditions for transferring power to Locomotives.

1.2. This specification applies to Pantograph for use on 25 kV, A.C., 50 Hz, Electric Locomotives for satisfactory operation up to speeds of 120 kmph under catenary heights varying from 4.65 meters to 5.8 meters from the rail level.

1.3 The cost of pantograph, acting as a mobile interface of the locomotive is insignificant. But improper electromechanical interaction due to the mobile current carrying conductor may be detrimental for the Locomotive and fixed overhead line equipments are very costly. Hence designing a rugged and efficient pantograph is essential with adequately safe electromechanical properties for easy & smoother operation.

1.4 The 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.

1.5 This specification covers clauses, which call for agreement between the purchaser and the Contractor and supply of technical information by the Contractor at the time of submitting tenders.

1.6 The pantograph has to be single arm equipment aerodynamically neutral with a critical dynamic mass, frame damping and effective head suspension for a specific mean uplift force even when passing through different pattern of airflow. Due consideration is to be given for the design & mass of the main frame arrive to arrive at a critical value so that adequate resistance to torsion produced due to staggering of OHE, is reached without sacrificing the structural stiffness.

1.7 This design of Pantograph is suitable for present fleet of WAM-4, WCAM-1 (AC), WCAM-2(AC), WCAM-3 (AC), WAG-5, WAG7 and WAG9 class of Electric Locomotives.

2 TERMINOLOGY:

2.1 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.
Contractor	The person, firm or Company with whom the order for supply of the work has been placed
Sub Contractor	Any person, firm or company from whom the contractor may obtain any materials or fittings to be used for the Pantograph.
Inspecting Officer	Nominated person to inspect the Pantograph.
OEM	Original Equipment Manufacturer
BG	1676 mm broad gauge used in IR
IS	Indian Standard
IRS	Indian Railways Standard
IEC	International Electro technical Commission
ISO	International Standards Organization
OHE	Overhead Equipment

3.0 STANDARDS, SPECIFICATIONS ETC:

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

Standards	Specification	Description
IEC Publication	60494-1 :2002	Railway application-Rolling Stock-Pantographs-Characteristics and tests Parts 1-Pantographs for Main line Vehicles.
IEC Publication	61373: 1999	Railway application-Rolling Stock equipment-Shock and Vibration
IEC Publication	IEC 60168	Routine/type test of Porcelain insulators
RDSO technical Circular	ELRS/TC/0071–2001 (Rev'0')	Metallised Carbon Strip
IS Publication	IS 2544 – 1991	Test Parameters for Porcelain Insulators

3.2 Other 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 pantograph for AC freight Electric Locomotives for the existing OHE of the Indian Railways. Parameters of OHE and track of existing system are given in Annexure-I A.

Pantograph with spring operated or air bellow operated mechanism for Raising and Lowering can be acceptable.

4.2 Tenderer should have experience of manufacturing and supplying pantograph for electric loco application at least for last three years.

4.3 Tenderer is advised to familiarize themselves with the roof equipment layout of the existing freight locomotives.

4.4 The standard I.R.S conditions of contract will be applicable for the supply of the equipment.

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

4.6 Contractor shall engrave/emboss identification marks indicating their monogram/brand names and the month and year of manufacture at a conspicuous place on all the component of the pantograph.

4.7 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 service trials period of one year shall also be organized by the Contractor.

4.8 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 Pantograph and any other factor which may be cause such dispute. The responsibility to settle any issue lies with the Contractor.

5.0 WARRANTY:

5.1 The Contractor shall give a warranty on the pantograph and its components including maintenance spares of clear 24 months from the date of commissioning or 30 months from the date of supply, whichever is early. Any damage or defect noticed during this period due to defective design / material / workmanship shall be replaced by the Contractor free of cost.

6.0 SCOPE OF SUPPLY:

6.1 The deliverables include complete pantograph along with all its components including the control panel.

6.2 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 will be required to be supplied. The manual shall be in English and one set of such manual shall be supplied with supply of every lot of 10 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 Contractor 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) Principle of operation.

(c) Explanation for operation and precautions before use,

(d) Diagrams of pneumatic and electrical connections.

(e) Drawings of wearing components indicating designed dimensions and their wear limits.

(f) Drawings of Main raising spring/ Air-Bellow, throttle valve, copper braids shunts, current collection strips, main frame, lower arm, upper arm, damper (if used), pan head, bow horns, aero-foils and other important components.

(g) The Bill of material indicating drawing no, sub contractor etc.

(h) Detailed instructions for inspection, maintenance and overhaul.

(i) Dimensional drawings and key drawings of such other parts which will be required for proper appreciation of the functioning of the pantograph.

(j) A spare part list with reference numbers. This may also include items which may be required only in emergencies such as breakages, damages etc.

(k) Tests reports of critical component/parts such as Air bellow/Main raising spring, insulated hose tube, regulator/valves of control panel, servomotor, damping arrangement etc.

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

6.4 Priced list of recommended spares for maintenance of the pantograph for two years shall be provided, along with recommended maintenance schedule. This will also form part of the total cost of the tender for each type of pantograph separately.

6.5 The Tenderer shall list out the special tools, gauges and testing instruments/kits if any which will be required for inspection and maintenance of the pantograph.

6.6 Individual prices for the items included in the above list should also be furnished separately.

7.0 CLIMATIC, ENVIRONMENTAL AND OPERATING CONDITIONS:

7.1 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: 0°C
Humidity	100% saturation during rainy season.
Altitude	1000 m 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	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 150 kg/cm^2.

8.0 MAIN FEATURES:

i) Operating Voltage :
a) Nominal - 25 KV, 50 Hz.
b) Max. (Cont.) - 27.5 KV.
c) Short time Max. - 30 KV for 10 Sec.

ii) Rated current : 400 Amps.

iii) Mounting : 4 support (Indian Railway's existing arrangement of four supports)
Mounting dimensions
807 mm along the length of loco,
1160 mm along the width of loco.

iv) Max. Extension : 2460+0 /-20mm from the locked down height

v) Working range : 0.25 meters to 2.0 meters.
(for satisfactory current collection)

vi) Weight : 235 kg. Approx. (Without insulators)

vii) Static up-thrust : 7 ± 0.4 kgf.

viii) Max. speed : 120 kmph.

ix) Aerodynamic effort at maximum speed. : 3 to 5 kgf.

x) Total dynamic mass : As low as possible (the value to be furnished by the Tenderer)

xi) Wearing strip material : Metallised carbon strips as per RDSO's technical circular no. ELRS / TC / 0071-2001 (Rev. '0' or latest)

xii) Max. Folded height : 275±5 mm.

xiii) Pan length : 1800±5

xiv) Compressed air supply : The compressed air supply in the locomotive may vary between 5.5 kg/cm^2 to 11 kg/cm^2, depends upon the type of locomotives. Panto shall start, lowering if the air pressure drops below 3.5 kg/cm^2.

xv) Pantograph Raising time for full extension 6 to 10 seconds.

xvi) Pantograph Lowering time up to fold on its stops from full extension to be less than or equal to 10 seconds.

xvii) Break from the contact wire when Lowering should be rapid up to 200mm and controlled throughout the remaining lowering operation. Folding on to the stops should be without any jerk.

xviii) The resistance of pantograph between carrier and power take off point shall not exceed **2 mΩ**.

xix) Adequate lowering effort and retaining force in the lowered condition shall be ensured to lower lowering and to retain the pantograph in the lowered position without undue vibrations at speeds up to 130 Kmph.

9.0 TECHNICAL REQUIREMENTS:

9.1 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.

9.2 The pantograph shall be suitable for bi-directional use. The performance in either direction shall be within stipulated parameters.

9.3 The pantograph shall be suitable for satisfactory operation up to 130 Kmph under existing Indian conditions of power supply, track and overhead equipment, the salient technical data of which are given in Annexure – 1

9.4 Electrical clearance of 320 mm (minimum) shall be maintained between live portion of pantograph and earth portion of its assembly after fitment on locomotive.

9.5 The pantograph shall be of lightweight, robust and compact, suitable for use under catenary, where height of the catenary varies from 4.65 meters to 5.8 meters from the rail level.

9.6 The construction of the pantograph shall be such that all the parts are easily accessible for inspection and maintenance.

9.7 The pantograph horn profile should be as close to the horn profile as per SKEL 4682 Alt '0'.

9.8 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 for which is enclosed with this specification (Drawing No. SKEL.3870).

9.9 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.

9.10 The raising of the pantograph should be either through metallic spring or through direct air actuation.

9.11 Interfaces of dissimilar metals are to be avoided to the extent possible, if however, this is not possible at some

location, suitable plating or bimetallic plate of the dissimilar metals shall be carried out to avoid any electrolytic action taking place.

10.0 PAINTING:

The pantograph sections/assemblies/sub-assemblies shall be made from scale free pickled and oiled steel. These shall be grit blasted before application of rust preventive primer followed by spray/flow coating 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. The Panto shall be painted with "light gray" as per IS 5 clause 631.

11.0 HARDWARE AND FASTENERS:

High tensile of M/s. GKW, M/s. Unbrako, M/s. Sundaram Fastener, M/s. LPS with antirust protection or Stainless Steel Grade A2-70 shall be used. Spring washer of Forbes make shall only be used.

12.0 OPERATING DEVICE

12.1 MAIN SPRING:

Raising spring being a vital component of the pantograph, following factors should be kept in mind while selecting the raising spring for the Pantograph:-

i) The deflection Vs. load characteristics of the springs at the time of manufacture.

ii) Stress relieving of the springs subsequent to the manufacture.

iii) Scragging test to ensure no permanent set in the springs or change of the characteristics as originally manufactured and specified.

iv) Fatigue failure test of the raising springs to incorporate the effects of :

- Locomotive Track vibration.
- Vibration superimposed on raising springs by the undulations of the catenary.
- Current in the springs during operation.

v) There should be no permanent set or changes in the spring characteristics during long period of springs stored in full stretch, e.g. when Pantograph is not used (in lowered condition), or when pantograph is stored for longer duration before installation.

12.2 AIR BELLOW:

Air raised Pantograph, high ambient temperature and high relative humidity should be kept in mind while selecting the Air Bellows. Fowling details are to be submitted:-

- Diameter of the Air bellow.
- Minimum length in collapsed position.
- Maximum length in full extension.
- Stroke length.
- Minimum operating pressure.
- Total volume of air required for full extension.
- Graph showing Thrust//Stroke at different pressure.

13.0 WELDING:

Complete welding details including welding procedure, type of welding, welding electrode etc. to be submitted.

14.0 INSPECTIONS & TESTS:

i) The Pantograph shall be subjected to type and routine test as per IEC 60494 –1 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. The routine test shall be witnessed by the authorized representative of the Purchaser.

iii) The detailed test plan shall be submitted by the Contractor along with detailed 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 Contractor by the purchaser to enable him to incorporate the necessary improvements before bulk production is commenced free of costs.

v) Any additional tests, trials, if considered necessary, shall also be arranged by the Contractor free of costs.

vi) The Contractor 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 & Contractor. Certain tests shall be carried out at the time of renewal of registration. Level of tests shall be decided by RDSO based upon design changes, if any, brought out during the intervening period or large scale failure of the equipment necessitating the tests.

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.

TEST REPORTS:

a. 06 copies of the type test report, suitably enclosed in a cover with punched holes, duly signed by the representatives of Contractor and RDSO, shall be supplied in standard 'A4' size sheets.

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

15.0 APPROVAL OF SAMPLES:

i) Technical/Design documents and drawings along with the prototype sample to be furnished.

ii) Clause wise comments of the technical specifications.

iii) The proposed method of Indigenization, transfer of technical know how may also be intimated in case any collaboration is agreed.

iv) Technical specification to be provided as schedule of guarantee in the format provided as indicated in Clause 16.

16.0 DEVIATIONS :

To improve the performance of the pantograph, if any deviation is suggested, full particulars with justification is to be furnished with the provision of inter changeability of the existing pantograph.

17.0 SCHEDULE OF GUARANTEE & TECHNICAL PARTICULARS

01.	Manufacture's Name	
02.	Country of manufacture	
03.	Type designation	
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 Sec.	
08.	Raising time in Sec.	
09.	Servomotor mounting live/ earth potential	
10.	Distance between mounting centre: 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 in BHN - Width in mm - Thickness in mm - Length in mm - Profile - Condemning size in mm - Distance between collector strips in mm - Fixing arrangement of	

	collector strip.	
12.	Folded height of the pantograph (without insulator) in mm	
13.	Weight of the pantograph excluding mounting insulators in Kg.	
14.	Dynamic mass of the collector head and main frame separately.	
15.	Type of bearing and housing	
16.	Material of shunts	
17.	Working compressed air pressure in Kg/cm²	
18.	(a) Static pressure in Kg (b) Variation over the working range in mm	
19.	Aerodynamic pressure at maximum speed & characteristics showing variation with speed in both the direction.	
20.	Transverse flexibility for a given force (to be specified by supplier)in mm	
21.	Max. angle of tilt of the collector head in º	
22.	Drawing & technical details of - Pantograph - Servomotor /Air bellow if provided. - Throttle valve - Main raising spring - Main frame - Collector head	
23.	Complete details of Air spring including material , working pressure, air quantity required for complete expansion	
24.	Characteristics graph showing the	

	- Variation of standard deviation of total contact force with speed - Variation of % contact loss with speed - The lowering effort to be used as a function of development. - Variation in static up thrust as a function of extensions.	
25.	Details of aero-foils, dimensions material & mounting arrangement if used.	
26.	Type of damping provided for collector head and main frame, if used any.	

18.0 TESTS FOR PANTOGRAPH

S. N.	Particulars	Tests (Ref. Clause IEC– 60494-1)		
		Type Test	Routine Test	Consistency Type Test
01.	General Tests	6.2	6.2	6.2
	• Visual Inspection	6.2.1	6.2.1	6.2.1
	• Weighing	6.2.2	-	*
	• Collector Head Length	6.2.3	6.2.3	6.2.3
	• Collector Head Height	6.2.3	6.2.3	6.2.3
	• Collector Head Width	6.2.3	6.2.3	6.2.3
	• Head Profile	6.2.3	-	-
	• Length of contact strips	6.2.3	6.2.3	6.2.3
	• Housed Height	6.2.3	6.2.3	6.2.3
	• Maximum Extension	6.2.3	6.2.3	6.2.3
	• Electrical Thickness	6.2.3	6.2.3	6.2.3
	• Distance between mounting points	6.2.3	6.2.3	6.2.3
	• Identification	6.2.4	6.2.4	6.2.4
02.	Operating Test	6.3	6.3	6.3
	• 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	6.4	-	*
	withstanding Test	6.4.1	-	*

	• Raising/Lowering Operation • Collector head Suspension	6.4.2	-	*
04.	Resistance to withstanding of vibration (IEC 61373 Category 1 Class A) • Measurement of natural transverse frequency of the pantographs. • Transverse vibration test.	6.4.3 6.4.3.1 6.4.3.2	- - -	* * *
05.	Resistance to withstanding shocks	6.5	-	*
06.	Transverse Rigidity Tests	6.6	-	*
07.	Air Tightness Tests on operating device Servo motor cylinder/air bellow	6.7	6.7	6.7
08.	Measurement of degree of freedom/rotation of pantograph head	6.8	6.8	6.8
09.	Measurement of housing force	6.9	-	6.9
10.	Measurement of total uplift force (Wind tunnel test)	6.10	-	*
11.	Measurement of total Contact force (Wind tunnel test)	6.11	-	*
12.	Heating test	6.13	-	*
13	Current Collection Test	Annexure - III		*

***** Test to be carried out if any problem observed during field service or any change in basic design.

19.0 TEST PARAMETERS FOR PORCELAIN INSULATORS (As Per IS 2544 – 1991)

S. N.	Particulars	Test Values	Tests Ref. Clause IEC - 60168	
			Type Test	Routine Test
01.	Power frequency dry withstand test	≥120 kvrms	30	-
02.	Power frequency dry flashover test	≥130 kvrms	30	-
03.	Power frequency wet withstanding test	≥80 kvrms	31	-
04.	Power frequency wet flashover test	≥88 kvrms	31	-
05.	Impulse voltage withstand test	≥200 kvp	29	-
06.	Power frequency puncture test	1.3 times the actual dry flashover voltage.	-	-
07.	Long duration dry withstand test	-	-	-
08.	Temperature cycle test	-	-	-
09.	Porosity test	-	-	-
10.	Tensile strength test	3000 kg	32	-
11.	Compressive strength test	3000 kg	32	-
12.	Bending strength test	1000 kg	32	-
13.	Verification of dimensions	-	-	-
14.	Visual examination	-	-	42

ANNEXURE - I

TECHNICAL DETAILS EXISTING OHE OF INDIAN RAILWAY

Sl.No.	Item	Details
1.0	OHE	Simple Polygonal OHE (regulated)
2.0	Span	72M (Max.) on tangent tract 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 tract & 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 centerline 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 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 centerline 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)

Sl.No.	Item	Details
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 – II

TECHNICAL DETAILS EXISTING TRACK OF INDIAN RAILWAY

Sl. No.		Details	
1.	Gauge	Broad gauge system of the Indian Railways– 1676 mm.	
2.	Track Structure	Minimum standard of 90R rails on sleepers M+4 density and 200 mm depth of balla cushion below sleepers (which may consist of least 75 mm clean and the rest in caked u condition). On consolidation and stab formation. On high speed routes 52 kg ra with M+7 sleeper density have been used partly	
3.	Sharpest curve and turnout	174 radius. The locomotive is also checked for To be negotiated passage in both direction over standard BG 1 in 8 ½ turnouts.	
4.	Permissible tract tolerance	Following are the track geometry standards for various track parameters on Indian Railways BG route as obtained from track recording cars	
		BG (high speed)	**BG (main line)**
5.	Unevenness	6mm general and 10 mm at isolated spots.	15 mm
6.	Twist	2.0 mm/m with Isolated spots of 3.5mm/m.	3.5 mm/m
7.	Gauge Variation	+6mm -3mm	± 6 mm
8.	Alignment (versine cord of 7.2 m)	5 mm in general with isolated 7 mm on curves and 10mm on straight.	7 mm

ANEXURE - III

CURRENT COLLECTION TEST

(A) Brief Records:

1. Loco No.
1. Nature of Loads
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 during night for knee leading and knee trailing position of the pantograph. 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 with in 6 to 10 seconds up to 1.5 Mtr.
02.	Lowering time	.....Seconds	Maximum 10 seconds from the height of 1.5 Mtr.(The panto should disengage with catenary rapidly up to 300 mm from static position)
03.	Static balancing Height leveled Balancing	.....Meters	Load of 7 kg to be applied on the pan and to observe the level of the pan should horizontal (By sprit level) at different heights 0.5 Mtr.,1 Mtr., 1.5 Mtr., 1.75 Mtr. and 2 Mtr. position and in every position panto should be statically balanced with the above load of 7 kg.

Sl. No.	Tests/ Checking	Obtained Value	Remarks
04.	Condition of Panto Metalised Strips		New Panto strips to be provided and make & lot no. of strips to be recorded. Strips to be conditioned so that ends are chamfered & surface is smooth.
05.	Setting of impulse counter	Initial count… Final count… No. of Disconnections i) Due to neutral section ii) Due to Panto	Impulse counter to be connected across Q30 coll. The impulse counter records the no. of disconnection through VCB/DJ, neutral section, Panto bouncing or otherwise. No disconnection should occur due to pantograph.
06.	Tilting of pan head	7° ±1 °	By angle protector

(C) Tests during Run as Light Engine:

The Pantograph shall first be tested on light engine run at maximum permissible speed of the locomotive and current & Voltage should be recorded along with the proforma shown in Annexure 1. The light engine test shall be conducted for at lest 50 kms before full load trials can be undertaken. At the end of light engine run check the condition of pantograph [as described in para (E)] shall be checked & further test be conducted if found satisfactory.

(D) Current Collection Test on Load:

The pantograph, after successful light engine run should be tested for full train load at the maximum permissible speed of the train, for at least 150 kms and following observation should be recorded.

S . N.	Tests	Value	Remarks
01.	Recording of sparks	As per Annexure--	-------
02.	General Behaviors	--------	Visual checking to be made during run. No abnormality should occur.
03.	Test Method	--------	a) Conventional method by fixing mirror in rear cab. b) Recording of current collection by video camera.

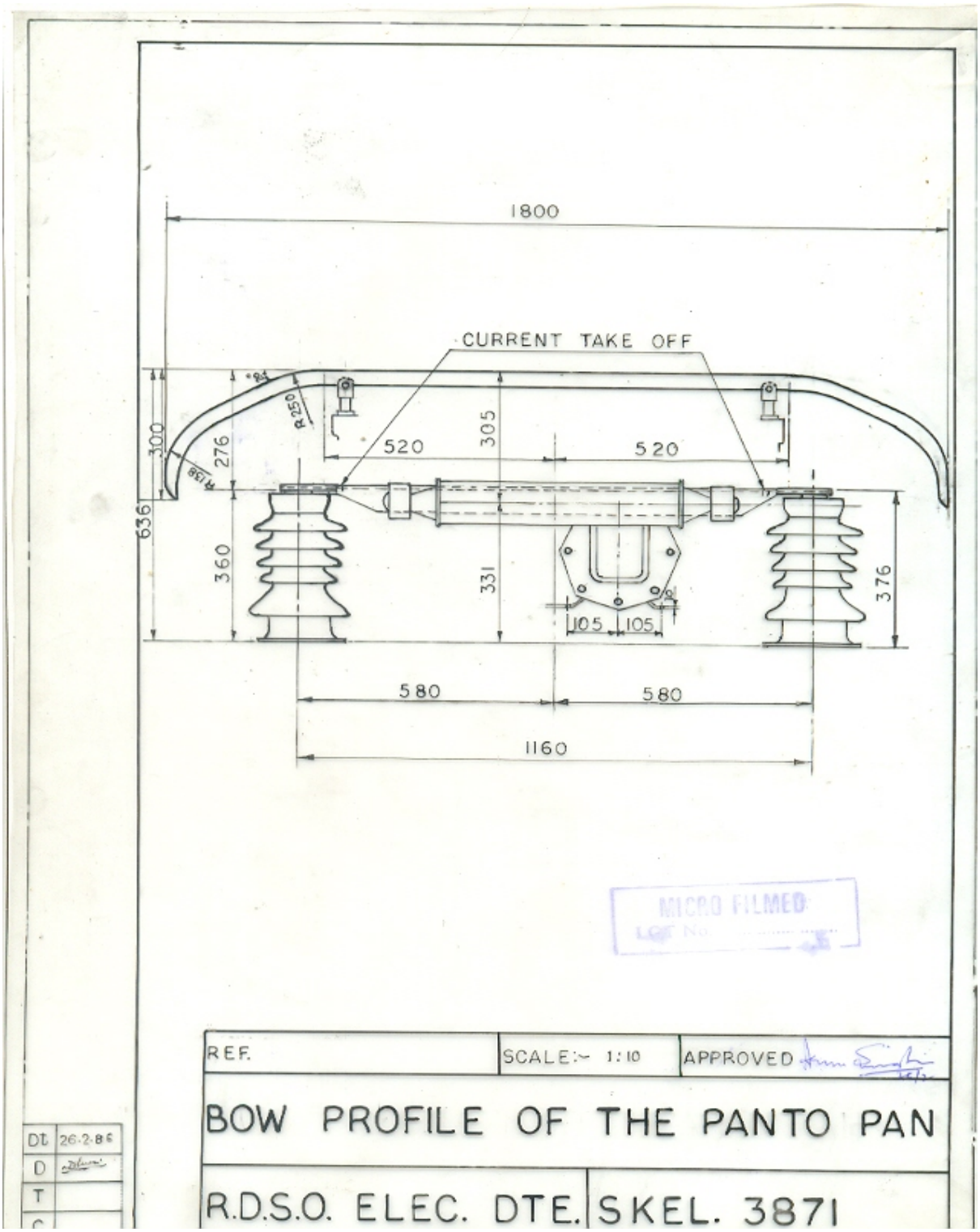
(E) Test after Completion of Run:

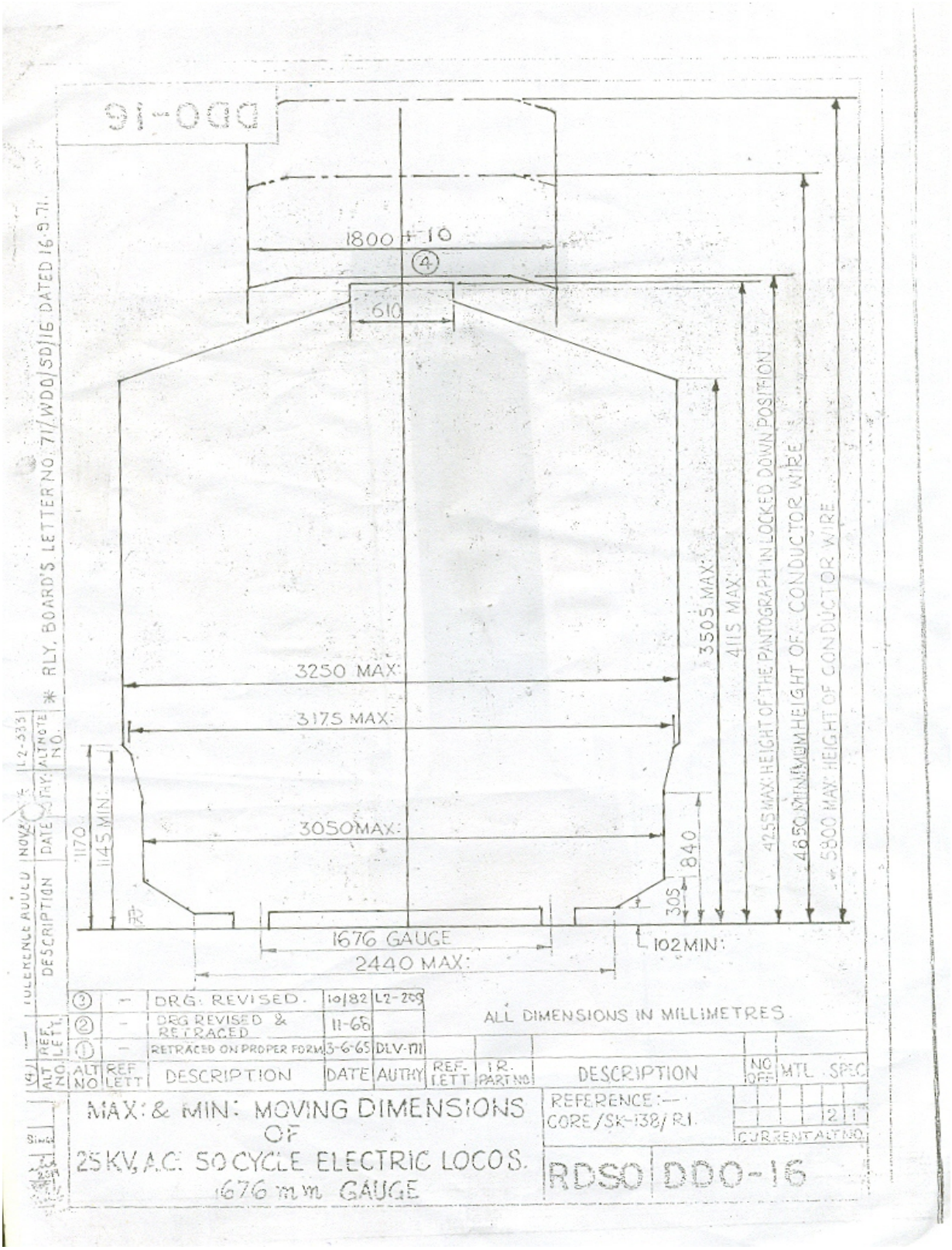
Sl . No.	Tests/ Checking	Obtained Value	Remarks
01.	Checking of panto & strips conditions		Visual checking to be done by experienced person. There should not be any abnormality.
02.	Checking of raising time, lowering time and static balancing		As per Test Schedule (B) 1, 2 & 3
03.	Collection of copper debris on the panto pan/roof of the locomotive		No appreciable debris should be accumulated.

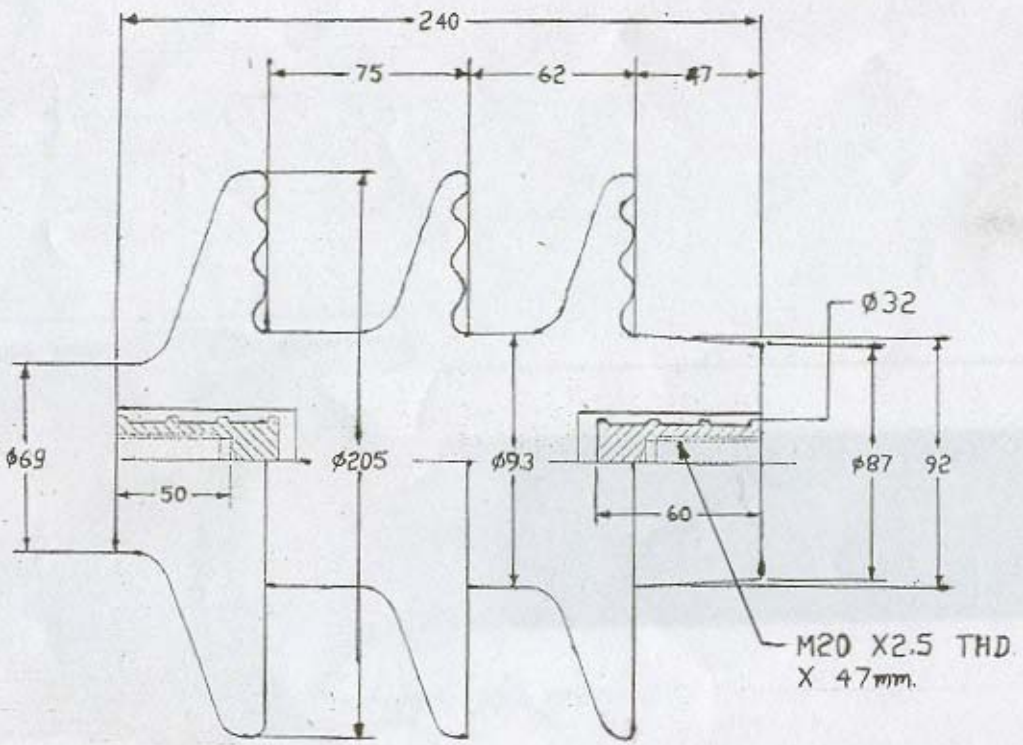
(F) Compression of Current Collection Test with Standard/ Stabilized Pantograph:

The current collection result of the new prototype pantograph and the established pantograph shall be comparable for successful trial of prototype pantograph.

CHAMFER
FIXING STUD CYRS TO SUIT HOLES IN EXISTING PAN HEAD
6.5+1.0 -0.5
'A'
1049±2
992
825
765
635
505
375
245
115
10
60°
102±2
33 ± 0.6
CONDEMNING LIMIT 3.5
8.5±1.0
42.0±0.5
VIEW AT 'A'- 'A'
NOTE-1. ALL DIMENSIONS ARE IN mm.
2. THREE PIECE/ONE PIECE DESIGN CAN BE OFFERED WITH OR WITHOUT STEEL END PIECES.
3. OVERALL DIMENSION SHALL BE MEASURED WITH STEEL END PIECES, IF PROVIDED.
4. IN CASE OF THREE PIECE DESIGN, THE MEAN LENGTH OF INDIVIDUAL PIECE SHALL BE 316, 318, AND 316 WITH TOLERANCE OF ±2mm.
5. MAXIMUM TIGHTENING TORQUE FOR PART (4) 2.5 kg-m.
6. ALL THE 09 Nos. FIXING BOLTS (ITEM Nos.5) SHALL HAVE ADEQUATE LATERAL PLAY TO AVOID BREAKAGE OF STRIP DUE TO UNEVEN STRESS DURING FITMENT.
REF:-
5 BOLT M8 X 25 L 9
4 HEX. NUT M8 9
3 SPRING WASHER (10.5 X 8.5 X 1.5 THICK) 9
2 STEEL SHEATH (10/1.5 THICK) 1/3
1 CARBON STRIP 1/3
PART NO. DESCRIPTION QTY.
SCALE:- NTS
APPROVED
ASSEMBLY DRAWING FOR METALLISED CARBON STRIP
RDSO ELEC DTE SKEL-4303 (REV.4)
4 27.4.2001 NOTE No.2,6,7,10 REMOVED, WORD MAX. ADDED IN NOTE No.5
3 25.1.2000 DRG./DIMENSIONS CORRECTED, NOTE REVISED.
2 16.8.1999 DRG./DIMENSIONS CORRECTED, NOTE REVISED.
1 26.9.1998 DRG./DIMENSIONS CORRECTED, TOLERANCES ALDED.
REVISION DATE DESCRIPTION
6.97 A1


1800
CURRENT TAKE OFF
R250
300
276
138
520
305
520
636
360
331
376
105
105
580
580
1160
MICRO FILMED
REF.
SCALE:- 1:10
APPROVED
BOW PROFILE OF THE PANTO PAN
R.D.S.O. ELEC. DTE.
SKEL. 3871
Dt 26-2-86
D
T
C


91-000
1800 ± 10
610
3505 MAX:
4115 MAX:
4255 MAX: HEIGHT OF THE PANTOGRAPH IN LOCKED DOWN POSITION
4650 MINIMUM HEIGHT OF CONDUCTOR WIRE
5800 MAX: HEIGHT OF CONDUCTOR WIRE
3250 MAX:
3175 MAX:
3050MAX:
1170
1145 MIN:
840
305
1676 GAUGE
2440 MAX:
102 MIN:
* RLY. BOARD'S LETTER NO. 71/WDO/SD/16 DATED 16-9-71.
ALL DIMENSIONS IN MILLIMETRES
DRG. REVISED. 10/82 L2-333
DRG REVISED & RETRACED 11-66
RETRACED ON PROPER FORM 3-6-65 DLV-111
DESCRIPTION DATE AUTHY REF. LETT I.R. PART NO DESCRIPTION NO OFF MTL SPEC
MAX: & MIN: MOVING DIMENSIONS OF 25 KV, A.C. 50 CYCLE ELECTRIC LOCOS. 1676 mm GAUGE
REFERENCE:— CORE/SK-138/R1.
RDSO DDO-16



INSULATOR FOR CONNECTING ROD

NOTE:

1. TOLERANCE LIMIT AS PER IS: 2102 LATEST PUBLICATION.
2. THE INSULTOR SHALL BE PROCURED FROM RDSO APPROVED SOURCES.
3. THE ELECTRO MECHANICAL TESTS AS PER IS: 2544/1973 AMENDMENT '4'-1991 INSULATOR.
4. GENERAL TOLERANCE: AS PER IS: 2102 LATEST PUBLICATION.