

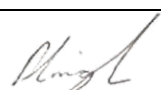
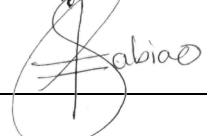


A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

SPECIFICATION FOR THE SUPPLY, COMMISSIONING AND SUPPORT FOR AN AUTOMATED PANTOGRAPH EARLY WARNING HOOK-UP DETECTION AND PREVENTION SYSTEM WORKING UNDER 3 kV DC, 25 kV AC and 50 kV AC CONDITIONS

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LIST OF AMENDMENTS TO THE SPECIFICATION

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1. SCOPE

- 1.1. This specification covers the requirements for the supply, commissioning and long-term support for an Automated Pantograph Early Warning Hook-up Detection and Prevention System. The system must be interchangeable and must function under the following electrical conditions:
 - 1.1.1. 3 kV DC
 - 1.1.2. 25 kV AC
 - 1.1.3. 50 kV AC
- 1.2. The system is intended to:
 - 1.2.1. Detect degraded or non-conforming Overhead Track Equipment (OHTe) sections in advance.
 - 1.2.2. Prevent pantograph damage or failure by triggering pre-emptive lowering.
 - 1.2.3. Record and communicate diagnostic and visual data to maintenance teams.
- 1.3. This specification contains a schedule of requirements (Appendix A) which must be completed by the relevant Transnet Representative. Bidders must consult Appendix A and ensure any products being offered are compliant.
- 1.4. This specification contains a locomotive vehicle gauge diagram (Appendix B) which shows the general dimensions between the locomotives and the infrastructure around it.

2. DEFINITIONS

Cam	A specially designed mechanical component used to convert the rotational motion of the main lifting arm of the pantograph into a linear displacement
Pantograph	Apparatus that collects current on one or more contact wires [EN 50206-1:2010]
Collector head	Part of the pantograph supported by the frame which includes contact strips, horns and may include a suspension [EN 50206-1:2010]
Contact strip	Replaceable wearing part of the collector head which interfaces with the overhead contact line system [EN 50206-1:2010]
ADD	Automatic Dropping Device
DC	Direct Current
AC	Alternating Current
OHTe	Overhead Track Equipment
IP	Ingress Protection
OV	Over Voltages
OEM	Original Equipment Manufacturer
TFR – TM	Transnet Freight Rail – Technology Management
SANAS	South African National Accreditation System

3. NORMATIVE REFERENCES

Unless otherwise specified, all materials used, equipment developed and supplied shall comply with the latest edition of the relevant International Electro-technical Commission (IEC), International Organization for Standardization (ISO), South African National Standards (SANS) or Transnet publications.

3.1. IEC STANDARDS

- 3.1.1. IEC 62497-1: Railway Applications – Insulation Coordination – Part 1: Basic requirements for clearance and creepage distances for electrical and electronic equipment.

3.2. ISO STANDARD

- 3.2.1. ISO 9001: Quality Management Systems – Requirements.

3.3. SANS STANDARD

- 3.3.1. SANS 60529-1: Degrees of protection provided by enclosures (IP code)

3.4. BS EN STANDARD

- 3.4.1. BS EN 61373: Railway Applications – Rolling stock equipment – Shock and vibration tests.
- 3.4.2. BS EN 50367: Railway Applications – Current collection systems – Technical criteria for interaction between pantograph and overhead line.
- 3.4.3. BS EN 50206-1: Railway Applications – Rolling stock – Pantographs – Characteristics and tests for mainline vehicles.
- 3.4.4. BS EN 50388: Railway Applications – Power supply and rolling stock – Technical criteria for interoperability.

3.5. TRANSNET PUBLICATIONS

- 3.5.1. RSE/TE/SPC/0030: Handling, storage, packaging, preservation, and delivery of pantographs.
- 3.5.2. RSE/TE/SPC/0029: Performance Specification for Pantographs operating at 3 kV DC, 25 kV AC, and 50 kV AC.

4. SERVICE CONDITIONS

4.1. Environmental conditions

Altitude	: 0 - 1980 m above sea level
Relative humidity	: Up to 100%
Ambient temperature	: -10° C to +55° C
Wind pressure	: 750 Pa
Lightning conditions	: 20 ground flashes/km ² per annum
Pollution	: Frost, Heavily salt laden with industrial pollutants including diesel-electric locomotive emissions

5. MECHANICAL SERVICE CONDITIONS AND REQUIREMENTS

- 5.1. The system must withstand the shock and vibration caused by the OHTE interacting with the pantograph collector head and as per the requirements of BS EN 61373.
- 5.2. All components installed on the exterior and interior sections of the locomotive must be suitably designed for IP.
- 5.3. All components installed on the exterior and interior sections of the locomotive must be suitably designed for OV.
- 5.4. All cables or wiring connecting the exterior sections to the interior sections must be suitably designed for all electrical voltages as contained in section 6 below. These cables or wires must be housed within a structure which enables it to be electrically connected and “Earthed” directly to the locomotive roof using a suitably designed shunt strap with a minimum diameter of 18 mm (Braided strap).
- 5.5. For the roof section, the components must be housed within a structure which enables it to be electrically connected and “Earthed” directly to the roof using a suitably designed shunt strap with a minimum diameter of 18 mm (Braided strap).
- 5.6. Self-cleaning and self-calibrating components/systems that can function for a period of up to 90 days without any physical interventions or visual inspections.
- 5.7. All components, securing mechanisms, hardware, systems, maintenance activities and housings must be designed to be fit for purpose.

6. ELECTRICAL SERVICE CONDITIONS AND REQUIREMENTS

- 6.1. The system shall be suitably designed to operate under the following electrical conditions:

Nominal System Voltage	50kV AC	25.0 kV AC	3.0 kV DC
Highest Permanent System Voltage	60kV AC	27.5 kV AC	3.9 kV DC
Lowest Voltage of System	28kV AC	22.5 kV AC	2.4 kV DC
Normal outdoor earth clearances	550 mm	320 mm	150 mm
Normal indoor earth clearances	550 mm	320 mm	150 mm

7. TECHNICAL AND FUNCTIONAL REQUIREMENTS

7.1. OHTE Condition Detection

- 7.1.1. The early warning detection function must be capable of detecting a non-conforming section of OHTE due to, but not limited to, incidents of vandalism, wear and tear, non-electrified sections, etc.
- 7.1.2. The system must be capable of sending an electrical signal to the pantograph control unit and commanding the pantograph to lower to its housed position before the locomotive enters the non-conforming section of OHTE.
- 7.1.3. The system shall detect anomalies at a minimum distance of 120 meters ahead of the locomotive when travelling at 80 km/h
- 7.1.4. The detection range shall ensure sufficient time to trigger and complete the pantograph lowering process, assuming a pantograph lowering duration of 5 seconds.
- 7.1.5. The system shall automatically issue a lowering command with a minimum 5-second lead time before reaching the non-conforming section, based on train speed and detection distance.
- 7.1.6. The pantograph shall be fully lowered before the locomotive reaches any section identified as non-electrified, damaged, or obstructed.
- 7.1.7. The system shall detect non-conformances or anomalies in the OHTE and surrounding vicinity such as, but not limited to, broken droppers, trees or foliage protruding or approaching the fixed infrastructure components and OHTE protruding or approaching into the pantograph collector head working envelope.
- 7.1.8. The system shall be capable of identifying OHTE that is below the top of the carbon contact strip and moving toward the collector head. An example of this would be at overlaps and cross overs where there is a second contact wire coming to interface with the collector head.
- 7.1.9. The system shall be capable of monitoring the positions of all the OHTE in contact with the pantograph collector head.

7.2. Pantograph Condition Monitoring

- 7.2.1. The system must be capable of identifying chips on the side face of the pantographs carbon contact strips which exceed a width of 3 mm.
- 7.2.2. The system must be capable of identifying cracks on the side face of the pantographs carbon contact strips which exceed a width of 3 mm.
- 7.2.3. The system must be capable of identifying cracks which run from the top to the bottom of the carbon portion.
- 7.2.4. The system shall detect the formation of steps in the carbon contact strip deeper than 1 mm. This must be achieved by monitoring the immediate sections of carbon on either side of the 1 mm deep step.
- 7.2.5. Pantograph Flip or Excessive Tilt Detection - The system shall detect abnormal rotational movement or angular deviation of the pantograph frame (commonly referred to as “flip” or “tilt”) that exceeds predefined safe operating limits. Deviations from normal pantograph geometry in pitch, roll, or yaw shall trigger fault recording and alert classification
- 7.2.6. Pantograph Height Monitoring - The system shall continuously measure and log the operational height of the pantograph from the top of rail (TOR) to the carbon contact strip using calibrated laser, radar, or visual triangulation methods.
The system shall detect anomalies such as:
 - 7.2.6.1. Gradual drift outside of calibrated operating range
 - 7.2.6.2. Sudden deviation indicating mechanical failure or incorrect OHTE geometry
- 7.2.7. End Horn Contact Detection (Insulated and Metalised) - The system shall detect all physical contact between the collector head end horns and OHTE.
Detection must:
 - 7.2.7.1. Differentiate between the metalised segment and the insulated segment of each end horn
 - 7.2.7.2. Use stored geometric profiles for each pantograph model in service
 - 7.2.7.3. Trigger an alert when contact occurs in the insulated region or when horn contact precedes strip contact during OHTE engagement
- 7.2.8. Dynamic Force Measurement - The system shall monitor real-time vertical, horizontal and lateral contact forces between the pantograph and the overhead contact wire:
 - 7.2.8.1. Vertical force shall be tracked to detect loss of contact or excessive uplift
 - 7.2.8.2. Horizontal force shall be tracked to detect impacts between the collector head and obstructions on the OHTE
 - 7.2.8.3. Lateral force shall be used to detect misalignment, excessive sway, or improper OHTE stagger

7.2.8.4. All force data shall be timestamped and GPS-logged

7.2.8.5. Sudden force spikes exceeding threshold values shall trigger diagnostic logs and potential maintenance flags

7.2.9. The system shall be capable of detecting all contact between the metalised portion of the collector head end horn and the OHTE. The metalised end horn dimensions will be provided for each of the different pantograph collector heads the system will be monitoring.

7.3. Arcing and Sparking Detection

7.3.1. The system must be capable of identifying arcing and sparking between the pantograph and the OHTE which exceeds 5 ms (0.005 seconds) using high-speed video and/or current signature analysis.

7.3.2. Log arcing frequency to support IEC 62486-based evaluation of electrical contact loss rate.

7.3.3. Flag sections with >0.2% arcing as requiring infrastructure inspection.

7.4. Video Surveillance and Analytics

7.4.1. The system shall record HD video ($\geq 1080p$ resolution) of pantograph–OHTE interface at up to 120 FPS.

7.4.2. The video footage shall include time stamps, date stamps and GPS coordinate stamps which shall be positioned away from the primary viewing to ensure that critical sections of the footage are not obstructed during playback.

7.4.3. The system shall be capable of recording the pantograph and OHTE interaction and keeping that video footage stored for a period of 10 days; support playback without full download.

7.4.4. The system shall allow the download of 10 days of video footage within a maximum duration of 4 hours under standard transfer conditions (e.g., 1 Gbps Ethernet or USB 3.0).

7.4.5. The video footage shall be clear and usable, and shall support a zoom capability of at least 10× while maintaining a legible level of detail and image clarity suitable for diagnostic analysis.

7.4.6. The video playback before or after downloading must be capable of being viewed using Windows Media player. No OEM applications will be used for downloading or viewing video footage.

7.4.7. The tenderer should ensure that the stored video footage remains compatible with Windows Media Player or an equivalent standard playback platform for a minimum of 10 years

7.4.8. The video footage shall be clear and usable during both daytime and nighttime recording and an additional light source shall be provided by the tenderer to ensure

adequate illumination. The tenderer may provide alternatives if a light source is not being utilised.

- 7.4.9. After an incident and during the video footage downloading, the system shall be capable of locating relevant portion of the video footage using the time and date or the GPS coordinates.
- 7.4.10. Using a laptop and during the video footage downloading, the system shall be capable of locating relevant portion of the video footage using the time and date or the GPS coordinates.
- 7.4.11. The stored video must not be capable of being edited, deleted and must be password protected. Three (3) sets of passwords must be recoverable and changeable by three (3) Transnet representatives who will be given the title of "System Administrator" and who will have all the necessary end user permissions.

7.5. Real-Time Obstacle and Intrusion Detection

7.5.1. Use stereoscopic or triangulation-based imaging to identify:

- 7.5.1.1. Vegetation encroachment
- 7.5.1.2. Fallen branches
- 7.5.1.3. Dislodged OHTE hardware
- 7.5.1.4. Suspended debris or foreign objects

7.5.2. Obstacle detection must operate up to 80 km/h and trigger alerts for:

- 7.5.2.1. Lateral or vertical intrusion into pantograph dynamic envelope
- 7.5.2.2. Sudden change in sway or ride profile indicating mechanical issues

7.6. Data Handling and Fault Classification

7.6.1. All raw data generated and monitored by the system, excluding video footage, shall be classified into the following three (3) severity categories, each with a defined retention period:

- 7.6.1.1. Low – Data shall be retained for a period of 10 days.
- 7.6.1.2. Medium – Data shall be retained for a period of 360 days.
- 7.6.1.3. High – Data shall be retained for a period of 60 days.

7.6.2. Data classified as medium severity shall be exported as a separate file and used to monitor the rate of degradation over time.

7.6.3. Data classified as high severity shall be exported as a separate file and used to monitor both the rate of degradation and the corrective interventions performed to address the associated faults.

7.7. User Configuration and Access Control

7.7.1. The system shall provide configurable end-user parameters, including but not limited to:

- 7.7.1.1. Adjusting fault detection thresholds and limits;
- 7.7.1.2. Updating notification contact lists (email addresses and mobile numbers);

7.7.2. Assigning secondary users with individual passwords and limited access rights for:

- 7.7.2.1. Data access;
- 7.7.2.2. Video downloading;
- 7.7.2.3. System calibration;

7.7.3. Routine maintenance tasks.

7.8. Power Management and Autonomous Operation

7.8.1. The system shall safely shut down when the locomotive's main power is turned off and shall automatically restart when power is restored.

7.8.2. The system shall not rely on the locomotive's internal battery system. It shall incorporate its own independent backup power source to complete shutdown procedures and retain data integrity.

7.9. Data Continuity and GPS Independence

7.9.1. The system shall maintain operational functionality and data logging even in the event of GPS signal loss. During such periods, data entries shall be timestamped using internal date and time references to ensure continuity.

7.10. Fault Notification and Alerts

7.10.1. Upon detection of a high-severity fault, the system shall instantly transmit two types of alerts (e.g., SMS and email or data message) to up to five (5) designated Transnet representatives for immediate intervention.

7.11. Each alert message shall include the following information:

7.11.1. Locomotive identification number;

7.11.2. GPS location;

7.11.3. Date and time of detection;

7.11.4. A concise, two-word fault description.

7.12. System Performance and Speed Range

7.12.1. The system shall perform all its detection, monitoring, and notification functions effectively across a speed range of 0 km/h to 100 km/h, with an accuracy level of $\pm 3\%$ or better.

8.0 ADDITIONAL REQUIREMENTS

8.1 The tenderer must include training for a maximum of 10 Transnet Representatives on the system and the maintenance activities to be carried out.

8.2 The tenderer must include telephonic or electronic technical support and 20 onsite visits for the system for a period of 10 years.

8.3 The repairs to the system that cannot be done onsite at Transnet facilities will be returned to the tenderer at a local address (Within South Africa).

8.4 The tenderer must make available all spare parts that may be needed for the systems continued operation for a period of 10 years. The spare parts list will be discussed and agreed to with a Transnet representative after a period of 3 years of the system being in operation and considering all the parts that were used.

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- 8.5 Any spare parts being deemed obsolete by the supplier will not result in the system becoming unusable by Transnet and it will therefore be for the tenderer to ensure that the system can run for a 10 year period.

9.0 COMMISSIONING

- 9.1 The tenderer must commission the system for all three (3) electrical conditions.
- 9.2 Representatives of Transnet reserve the right to be present at all commissioning activities, fault finding activities and any other activities relevant to this systems introduction within Transnet.
- 9.3 Complete commissioning of the system and resolutions of all issues will be limited to a period of 90 days and this 90 day period begins on the first day the system is installed on a locomotive for in-service testing.
- 9.4 The way forward will reside completely with representatives of Transnet if the 90 day period has lapsed and the commissioning of the system has not been completed. The successful commissioning of the system will be based on the requirements of this specification.
- 9.5 Transnet shall only sign off the system acceptance report following successful testing, commissioning and discussions between the relevant Transnet representatives and the tenderer.

10.0 CALIBRATION AND MAINTENANCE REQUIREMENTS

- 10.1 The tenderer must provide calibration certificate from a SANAS accredited body or OEM certificate of conformity, to be submitted with the system during the hand over.
- 10.2 If no SANAS accredited calibration laboratory in South Africa exists that can perform the calibration under their accreditation then a non-SANAS accredited calibration laboratory that is traceable to international and national standards is allowed, if a written authorisation is given by a Transnet representative.
- 10.3 The tenderer must also advise on calibration requirements as well as local SANAS approved calibration laboratories where necessary.
- 10.4 The tenderer must indicate the maintenance required to ensure that the system functions satisfactorily.

11.0 DOCUMENTATION AND TRAINING REQUIREMENTS

- 11.1 The tenderer must provide all drawings and technical documentation written in English.
- 11.2 All units indicated in the documentation shall be in metric system.
- 11.3 The file containing documents and drawings should be numbered for easy identification and reference purposes.
- 11.4 Transnet reserves the right to require any additional information: manuals, catalogues, drawings, etc. that may contribute to complete the information supplied by the manufacturer.
- 11.5 The tenderer must submit type test certificates and documentation that shows safety integrity.
- 11.6 The tenderer must provide design and type test certificates to verify conformance to the requirements and these must be submitted with tender documents.

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- 11.7 The Tenderer must describe the necessary training programme available for the maintenance and operation of the system offered as well as the costs.

12.0 QUALITY ASSURANCE

- 12.1 The tenderer must have a quality management system certified to ISO 9001 requirements. A valid certificate shall be submitted with the tender.
- 12.2 The scope of activities indicated in the certificate must cover the scope of work called for in the specification (i.e. repair, upgrade, replace, testing and commissioning).
- 12.3 The tenderer must submit preliminary quality control plan clearly indicating hold points during the repair, upgrade, testing, commissioning and transportation of the system.

13.0 PACKAGING, STORAGE AND HANDLING

- 13.1 To prevent damage to sensitive equipment, the system components shall be protected from damage during transportation, handling and storage.

14.0 GUARANTEES AND DEFECTS

- 14.1 The successful tenderer must provide all information regarding guarantees and warranties in writing.
- 14.2 The tenderer must guarantee that the system conforms to Transnet's requirements and is fit for purpose.
- 14.3 The tenderer must accept liability for makers' defects, which may appear in design, material and workmanship.
- 14.4 The system and all associated components must be guaranteed to be free of manufacturing and material defects for a period of at least 12 months from the date of commissioning and acceptance by Transnet.

END

APPENDIX A: SCHEDULE OF REQUIREMENTS

(To be completed by Transnet Representative)

1	Name of depot / Department	Technology Management
2	Quantity of complete systems required	1
3	Training – number of personnel	10
4	Special requirements	None

Completed by:	
Capacity:	
Signature:	
Date:	

APPENDIX B: LOCOMOTIVE VEHICLE GAUGE DIMENSIONS

