

Annexure 1.1:
General Technical Requirements
Signalling

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1 GENERAL

1.1 Purpose of the Document

- 1.1.1 The purpose of this document is to provide the General Technical Requirements (“GTR”) which form part of the minimum Requirements of the Passenger Rail Agency of South Africa (“PRASA”) for the Railway Signalling System (“RSS”) related Works that form part of the planning, design, supply, construction, installation, testing, commissioning and maintenance of a new fully integrated, functional, complete and future-proofed PRASA Train Control System (“PTCS”) in PRASA’s KwaZulu-Natal (“KZN”) service region (“the Project”) that the Bidder shall meet and deliver at the Bidder’s cost therefore within the Bid Price.

1.2 Executive Overview

- 1.2.1 Notwithstanding any other PRASA Requirements stated throughout the RFP, the Bidder shall uncompromisingly deliver the whole of the Works required to achieve successful delivery of the Project.
- 1.2.2 The Signalling Component of the Works is, at a minimum, summarised as follows:
- a) Provide a train control, remote control and interlocking System that complies with the Required Operational Capability (“ROC”) for the PRASA interlocking System.
 - b) Provide a Train Traffic Management System (“TTMS”) that complies with PRASA requirements
 - c) Provide associated trackside Signalling Equipment such as point machines, signals, Track Vacancy Detection (“TVD”), etc. that is compatible with the new interlocking System and which complies with the PRASA requirements and specification.
 - d) Resignal all PRASA railway lines with the new interlocking and wayside Equipment according to stated headways and flexibility.
 - e) Provide a Level Crossing (“LX”) controller that complies with PRASA requirements and specifications and upgrade the required Level Crossings in accordance to the latest standards.
 - f) Provide all required resources to deliver and maintain the Signalling Works.
 - g) Any other Signalling Works, activities and resources required to achieve a fully integrated, functional, complete and future-proofed PTCS and meet any other requirements and specifications as requested throughout the RFP or as otherwise instructed in writing by PRASA.

2 MINIMUM SYSTEM REQUIREMENTS

2.1 Railway Signalling System (“RSS”) Overview

2.1.1 The RSS shall, at a minimum, consist of the following elements:

- a) Train Control System (“TCS”).
- b) Train Traffic Management System (“TTMS”).
- c) Electronic Interlocking System (“EI”).
- d) Multi-aspect line side Signalling with flashing aspects.
- e) Track Vacancy Detection (“TVD”).
- f) Points Machines.
- g) Power Supply System (“PSS”).
- h) Communication with and power to Equipment.
- i) Level Crossing (“LX”) Controllers.
- j) Service and Diagnostic System (“S&D”).
- k) Train Control Officer (“TCO”) training simulator.
- l) Technical training simulator.
- m) Driver Advisory System (“DAS”).
- n) Data File Management Tool.

2.1.2 The RSS shall, at a minimum, comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.

2.1.3 The RSS shall be designed to have very limited exposure to theft and vandalism and shall have no or very limited copper.

2.1.4 The Bidder shall implement all necessary measures to protect the RSS, sub-Systems and all Equipment against at least the following threats:

- a) Theft and vandalism.
- b) Continues exposure to extreme direct sunlight and elevated temperatures.
- c) Continues exposure to high humidity.
- d) Coastal environmental conditions causing damaged such as corrosion.
- e) Incoming high voltages, spikes, Electromagnetic Compatibility (“EMC”) and fluctuating voltages.
- f) Intermittent flash flooding in low laying areas.
- g) Severe thunderstorms with extreme heavy lightning.

2.1.5 The Bidder shall earth the RSS properly, complying with all Standards, Specifications, Regulations and Procedures in the Main Technical References (“MTR”).

2.1.6 The Bidder shall, at a minimum:

- a) Install a new earth mat at all existing and new Equipment Rooms, unless expressly stated otherwise in the Particular Technical References ("PTR"), to obtain an earth resistance value of one ohm or less.
- b) Isolate all installed power cubicle metalwork from the building structure.
- c) Implement Earth Leakage Detectors ("ELD"), indications and reset Push Buttons ("PB") in all Equipment Rooms for all applicable voltage levels.

2.2 Train Control System ("TCS")

2.2.1 The interlocking shall be remotely operated from the Centralised Train Control Centre ("CTCC") by means of Man-Machine Interfaces ("MMI").

2.2.2 The Train Control Officer ("TCO") shall be able to remotely operate the interlocking and receive information back from the remote station. The MMI shall display the state of the interlocking, the field elements and sub-Systems.

2.2.3 The TCO workstations shall be scalable and it shall be possible to increase & decrease the area of control for each workstation depending on the workload requirements at a specific time.

2.2.4 It shall be possible to have several TCO workstations per interlocking, operate several interlockings from a single TCO workstation as well as control any interlocking from any workstation.

2.2.5 The TCS shall be able to provide at least the following functions:

- a) Manual Train Control.
- b) Train number capturing and stepping.
- c) Data logging.
- d) Automatic Train Routing ("ATR").
- e) Train scheduling.
- f) Train monitoring.
- g) Train timekeeping performance against timetable.
- h) Active communication of train position, train routing and time-keeping information to the Passenger Information System (PIS) used on the Region.
- i) Generate SPAD alarms.
- j) Electronic Authorisation Register.

2.2.6 The Bidder shall provide at least 13 TCO workstations.

- a) 11 Operational workstations.
- b) 2 Spare workstations to be used as fall back or for future expansion.

- 2.2.7 Each TCO workstation shall consist of at least 6 24inch Visual Display Unit (“VDU”) monitors. The Bidder shall ensure ergonomic standards and best practices are met by designing and calculating the optimal number of VDU monitors for each workstation.
- 2.2.8 The Bidder shall provide at least 1 Train Control Section Manager Workstation equipped with at least 6 VDU monitors. The workstation shall provide the Train Control Section Manager with a duplicate view of all TCO workstations.
- 2.2.9 The Bidder shall provide at least 1 Train Control Duty Manager Workstation equipped with at least six (6) VDU monitors. The workstation shall provide the Train Control Duty Manager with a duplicate view of all TCO workstations but shall not allow control.
- 2.2.10 The TCS shall interface with and transfer indications, train number and ATR routing information to the adjacent TCS’s at the CTCC and/or adjacent CTCC’s. PRASA train numbers typically consist of 6 digits only while the TFR system typically uses 24 digits. Train numbers received to / from an adjacent TFR control centre must transfer, maintain and carry along the full information set of 24 digits whilst displaying only the first 6 digits. The adjacent TCS might consist of either:
- a) CS90 VDU.
 - b) CS90 VDU Warrant.
 - c) Desk and Diagram.

2.3 Train Traffic Management System (“TTMS”)

- 2.3.1 The TTMS is required for automatic Network management of the following train operations functions:
- a) Timetable management.
 - b) Customer communications.
 - c) Train Crew Rostering.
 - d) Train fleet Planning.
 - e) Train Routing.
 - f) Train operations safety assessment.
- 2.3.2 The TTMS shall be used to improve train services by automating the management tasks of train operators, minimising train delays and train cancellations.
- 2.3.3 The TTMS shall enable human intervention for train interruptions conditions using Windows GUI based platform.
- 2.3.4 The TTMS shall be integrated with the Passenger Information System–Railcom Passenger.
- 2.3.5 User Functionality Requirements:
- a) PRASA Railcom System shall be used to inform passengers at respective train station with real-time train schedules and related delays and cancellations by means of Audio announcements and visual digital displays.

- b) The train stations display boards shall display a synchronised 'master clock' provided via the train Signalling interlocking System.
- c) The System functionality shall comply with the following requirements specifications for ETCS Level 2 full implementation:
 - IEC 62290-1 Railway applications – Urban guided transport management and command/control Systems – part 1: System principles and fundamental concepts
 - IEC 62290-2 Railway applications – Urban guided transport management and command/control Systems – part 2: Functional requirements specification
 - ETCS Level 2 B3 MR1 - Interfaces
- d) Optimum route advice
- e) The TTMS shall be developed to have the capability to safely manage temporary speed restriction operations in a format required by ETCS Level 2 standards.
- f) The TTMS shall be capable of getting real time data information from the following:
 - Train detection information
 - Route status
 - Works site Occupation
 - Temporary speed restriction
 - Train information
 - Network time protocol
- g) Public Web and Google Play Store or similar based application shall be developed to provide TTMS train and location information for public information.
- h) The TTMS shall store data for more than 12 months, which can be retrieved by authorised personnel.
- i) The TTMS shall have Automatic route setting to set routes for trains in accordance with their run order when all the following conditions are fulfilled at a minimum:
 - No conflict is detected and unresolved
 - Train is at the required location, for safe and optimum train operation
 - Infrastructure resources are available
 - No effecting restrictions
 - Train controller allows automatic route setting operation
 - All assets that affect the train movement are under user's control

- Other conditions identified during the System safety assessment
- j) The TCO shall have the capability to enable or disable at any time the automatic train routing for a selected train, signal, route, line or area.
- k) The TCO shall also have the capability to override the requests issued by automatic train routing.
- l) When the following conditions are detected, the automatic train routing shall be automatically disabled so that the safety of the train management is maintained:
 - Train safety cannot be assured
 - Restrictions or Occupations protection is detected
 - Any integrity is compromised
 - Manual Signalling operation is used

2.4 Electronic Interlocking (“EI”)

- 2.4.1 The Bidder shall replace all existing interlockings with a new electronic interlocking (“EI”) platform with Train Control System (“ETCS Level 2”) interfacing capabilities.
- 2.4.2 Centralised or de-centralised EI Systems shall be considered.
- 2.4.3 If a centralised System is proposed, the Bidder shall clearly indicate which stations shall be grouped together and controlled by one interlocking. One interlocking controlling all Signalling elements in KZN shall not be acceptable.
- 2.4.4 The EI shall be a failsafe System.
- 2.4.5 The vital functions of the EI shall be certified as Safety Integrity Level 4 (SIL4), as defined in the relevant Standards, Specification, Regulations and Procedures in the MTR.
- 2.4.6 The EI shall be able to activate flashing aspects on LED signal light units.
- 2.4.7 The EI shall be able to provide the functionalities described in the ROC.
- 2.4.8 The EI shall be able to provide the indications described in the SATCOS symbol catalogue. The ETCS Level 2 indications shall be agreed on with PRASA and shall be the identical across all PRASA regions.
- 2.4.9 The EI shall be able to accept and execute the control functions described in the SATCOS command catalogue. The ETCS control functions as shall be agreed on with PRASA and shall be the identical across all PRASA regions.
- 2.4.10 The EI shall be able to interface to LX Controllers to give the “close” command at an appropriate moment and read the confirmation message that the protection is in place before allowing the protection signal to clear.
- 2.4.11 Only PRASA or TFR approved interlocking Systems shall be used.
- 2.4.12 Approved interlockings shall be adapted and validated to comply with the latest ROC and other requirements as stated throughout the RFP.

- 2.4.13 The Bidders shall allow for EI safety and functional improvements, validation and implementation thereof at PRASA's request or instruction for the duration of the Contract and at the Bidder's cost, irrespective of current requirements and specifications.
- 2.4.14 The Bidder may propose alternative EI solutions not already approved by PRASA or TFR for review and approval by PRASA, providing a detailed motivation regarding improvements with regards to safety, reliability, availability, affordability, anti-theft and vandalism or any other relevant factors.
- 2.4.15 The alternative EI solution shall be approved by PRASA only after successful validation and reliability testing in line with the ROC.
- 2.4.16 If the alternative EI solution is not approved by PRASA, for any reason whatsoever, PRASA shall have the right to immediately terminate the Contract, or instruct the Bidder to implement and already approved solution within the Contract period, without any consequence, liability and cost to PRASA.

2.5 Multi-Aspect (Flashing Aspects) Line Side Signalling

- 2.5.1 All signal assemblies and light units, unless specifically specified otherwise throughout the RFP, shall be replaced.
- 2.5.2 All dwarf signals (signals with main running aspects mounted close to ground level on main running lines) shall be eliminated.
- 2.5.3 The Bidder shall install/replace signal gantries where it is not possible to place ground signals due to space constraints (no clearance).
- 2.5.4 All signal aspects shall be clearly visible from the locomotive cab from at least 200m.
- 2.5.5 If it is not possible to achieve this visibility due to obstructions or other factors, the Bidder shall obtain special permission from PRASA to deviate from this standard.
- 2.5.6 The signals shall be equipped with Light Emitting Diode ("LED") type light units.
- 2.5.7 Only PRASA or TFR approved LED signal light units shall be used.
- 2.5.8 The Bidder shall implement measures to protect the signals against at least the following threats, in-line with the guidelines in the MTR:
- a) Theft/Vandalism of LED light units.
 - b) Theft/Vandalism of tail cables.
 - c) Pulling down/Cutting off signal post.
 - d) Damage to LED units and/or other Equipment by continues exposure to direct sunlight.
- 2.5.9 The Bidder shall, at a minimum, implement the following measures to detect, defer and delay any theft and vandalism attempts:
- a) Detection of any unauthorised movement at or near the signal post.
 - b) Audio alarm when unauthorised movement is detected

- c) Notification send to Security Command Room when unauthorised movement is detected.
- d) Signal unit housings to be manufactured of Material without any re-sell or repurpose value.
- e) Signal lenses to be protected to be able to withstand hard objects with hard impact.
- f) Cable between the signal base and the concrete base (biscuit) to be protected.
- g) Shortened signal ladders to restrict unauthorised access.

- 2.5.10 The Bidder may propose alternative line-side signalling and LED signal light unit solutions not already approved by PRASA or TFR for review and approval by PRASA, providing a detailed motivation regarding improvements with regards to safety, reliability, availability, affordability, anti-theft and vandalism or any other relevant factors.
- 2.5.11 The alternative line-side signalling, and LED signal light unit solution shall be approved by PRASA only after successful validation and reliability testing.
- 2.5.12 If the alternative line-side signalling and LED signal light unit solution is not approved by PRASA, for any reason whatsoever, PRASA shall have the right to immediately terminate the Contract, or instruct the Bidder to implement and already approved solution within the Contract period, without any consequence, liability and cost to PRASA.

2.6 Track Vacancy Detection (“TVD”)

- 2.6.1 TVD shall be done by means of Axle Counters (“AZ”).
- 2.6.2 Only PRASA or TFR approved AZs shall be used.
- 2.6.3 The TVD shall be able to provide the functionalities described in the Axle Counter ROC.
- 2.6.4 Approved AZ shall be adapted and validated to comply with the latest ROC and other requirements as stated throughout the RFP.
- 2.6.5 The Bidder shall implement the AZs and all other associated Works such as correcting of the bonding, removal of the block joints and jumper cables, etc. Allow for the removal of 1300 block joints.
- 2.6.6 AZs shall be suitable for placement on lines being used by any type of traction (Diesel electric, diesel hydraulic, steam, etc) and independent of the Track parameters.
- 2.6.7 The AZ shall be functional with vehicle speeds of up to 200 km/h.
- 2.6.8 Proper functioning shall be ensured for:
- a) Wheels made of steel or cast iron, having diameters of >300 mm and widths of >115 mm.
 - b) Wheelbases (axle distance) of > = 700 mm.
 - c) Rail profiles 48 Kg and UIC 60.

d) Rail current up to 1500 A.

2.6.9 The counting capacity of the AZ shall be more than 300 axles.

2.6.10 It shall be possible to normalise the AZ after miscounts. PRASA shall prescribe the railway-specific conditions for restoring the AZ to the normal position during the Design phase.

2.6.11 The Bidder shall implement measures to protect the AZs against at least the following threats, in-line with the guidelines in the MTR:

- a) Theft/Vandalism of Track side boxes and train detection point Equipment.
- b) Theft/Vandalism of AZ cables.
- c) Mechanical damage caused by parts of the running train reaching beyond the profile.

2.6.12 The Bidder shall, at a minimum, implement the following measures to detect, defer and delay any theft and vandalism attempts:

- a) Detection of any unauthorised movement at or near the AZ track side Equipment housing, heads and cables.
- b) Audio alarm when unauthorised movement is detected.
- c) Notification send to Security Command Room when unauthorised movement is detected.
- d) Trackside Equipment to be installed in a concrete silo with concrete lid, buried and concreted to restrict unauthorised access, while allowing access for maintenance. The Bidder shall provide all required Tools and Equipment to open and close the silos during maintenance.
- e) Detection of unauthorised access to silos, either via the lid or by breaking the housing.
- f) Audio alarm and releasing of pepper spray when unauthorised access is obtained.
- g) Protection of AZ head by means of protective housing able to withstand hard objects with hard impact.
- h) Cable connecting the head to the trackside Equipment to be:
 - Buried at 950mm, with access to track side Equipment from directly under the silo and access to head directly under railway track, through ballast
 - Protected with Nextube or similar, with no visible or accessible cable between trackside Equipment and head

2.6.13 The Bidder may propose alternative TVD solutions not already approved by PRASA or TFR for review and approval by PRASA, providing a detailed motivation regarding improvements with regards to safety, reliability, availability, affordability, anti-theft and vandalism or any other relevant factors.

- 2.6.14 The alternative TVD solution shall be approved by PRASA only after successful validation and reliability testing.
- 2.6.15 If the alternative TVD solution is not approved by PRASA, for any reason whatsoever, PRASA shall have the right to immediately terminate the Contract, or instruct the Bidder to implement and already approved solution within the Contract period, without any consequence, liability and cost to PRASA.

2.7 Points Machine

- 2.7.1 The Bidder shall replace all existing points machines and install new points machines as required for new turnouts, unless specifically specified otherwise throughout the RFP.
- 2.7.2 The Bidder shall Supply point machines complete with support cradles, rodding, drive, detection, tie-plate, number plate, etc.
- 2.7.3 The Bidder shall provide 2 x new wooden sleepers per turnout when installing new points machines on turnouts embedded on wooden sleepers, and to allow for the tamping of such sleepers by qualified Perway personnel.
- 2.7.4 Only PRASA or TFR approved 380v AC point machines shall be used.
- 2.7.5 The Bidder shall implement all necessary measures to protect the points machines against at least the following additional specific threats, in-line with the guidelines in the MTR:
- a) Theft/Vandalism of covers/lids.
 - b) Theft/Vandalism of tail cables.
 - c) Theft/Vandalism of point machine Equipment.
 - d) Unauthorised cranking or methods of cranking.
- 2.7.6 The Bidder shall, at a minimum, implement the following measures to detect, defer and delay any theft and vandalism attempts:
- a) Detection of any unauthorised movement at or near the points machine.
 - b) Audio alarm when unauthorised movement is detected.
 - c) Notification send to Security Command Room when unauthorised movement is detected.
 - d) Points machines to be secured with vandal proof lid and locking mechanism.
 - e) Detection of unauthorised access to points machine, either via the lid or by breaking the housing.
 - f) Audio alarm and releasing of pepper spray when unauthorised access is obtained.
 - g) Cable between points machine and junction box to be:

- Buried at 950mm, with access to the junction box from directly underneath junction box and access to the points machine from directly underneath points machine through the ballast
- Protected with Nextube or similar, with no visible or accessible cable
- Solutions with points machines installed in middle of the gauge will be preferred

- 2.7.7 The Bidder may propose alternative Points Machine solutions not already approved by PRASA or TFR for review and approval by PRASA, providing a detailed motivation regarding improvements with regards to safety, reliability, availability, affordability, anti-theft and vandalism or any other relevant factors.
- 2.7.8 The alternative Points Machine solution shall be approved by PRASA only after successful validation and reliability testing.
- 2.7.9 If the alternative Points Machine solution is not approved by PRASA, for any reason whatsoever, PRASA shall have the right to immediately terminate the Contract, or instruct the Bidder to implement and already approved solution within the Contract period, without any consequence, liability and cost to PRASA.

2.8 Power Supply Systems (“PSS”)

- 2.8.1 All Signalling Equipment Rooms shall be equipped with two independent supplies derived from the national grid and the PRASA owned Electrical Network.
- 2.8.2 The Bidder shall Design and implement secondary supplies to all Equipment Rooms where the secondary supply does not exist, as described in the relevant GTRs and PTRs.
- 2.8.3 The Bidder shall Design, provide, implement, Test and commission all diesel generator sets as a backup at critical stations and provide a minimum of 20 generators.
- 2.8.4 The Bidder shall Design, provide, implement, Test and commission a PSS to derive all power required for the RSS and Equipment from this Supply.
- 2.8.5 The PSS shall be an Uninterrupted Power Supply (“UPS”) based System, with adequate battery backup to operate the complete RSS for at least 8 hours should the incoming power supply be lost.
- 2.8.6 The Bidder shall implement measures to protect the PSS against at least the following additional specific threats, in-line with the guidelines in the MTR:
- a) Theft/Vandalism of batteries.
 - b) Theft/Vandalism of cables and Equipment.
 - c) Damage due to excessive heat.
 - d) Damage due to incoming high current, spikes, EMCs and voltage fluctuations.
- 2.8.7 The Bidder shall, at a minimum, implement the following measures to detect, defer and delay any theft and vandalism attempts:

- a) Detection of any unauthorised entrance to the room in which the power supply System is installed, either via the door or breaking through the wall.
- b) Notification send to Security Command Room when unauthorised movement is detected.
- c) Audio bomb alarm and releasing of pepper spray when unauthorised access is obtained.

2.9 Communication with and Power to Line Side Equipment

- 2.9.1 The Bidder shall install new fibre, signal communication and signal power cables for the whole of the Works.
- 2.9.2 The Bidder shall Design the System to minimise or eliminate the use of copper cable.
- 2.9.3 The Bidder shall implement alternatives to copper cables, such as wireless, fibre, aluminium alloy or other valueless cables where possible.
- 2.9.4 Communication between Equipment Rooms shall be done over Optic Fibre Cable ("OFC").
- 2.9.5 All cables shall comply with standard Railway Signalling specifications.
- 2.9.6 Cables shall not exceed 1km in length. The Bidder shall create an additional termination point where a cable length exceeds 1km between termination points.
- 2.9.7 The Bidder shall show cable joint and their GPS coordinates on the cable plan.
- 2.9.8 The Bidder shall provide all resources, including qualified track masters, required for supervising cross trenching.
- 2.9.9 The Bidder shall implement measures to protect all cables and communication Equipment against at least the following additional specific threats, in-line with the guidelines in the MTR:
 - a) Theft/Vandalism.
 - b) Damage due to excessive heat.
 - c) Damage due to environmental factors
 - d) Damage due to veld fires.
- 2.9.10 The Bidder shall, at a minimum, implement the following measures to detect, defer and delay any theft and vandalism attempts:
 - a) Detection of any unauthorised movement at or near the cables.
 - b) Audio alarm when unauthorised movement is detected.
 - c) Notification send to Security Command Room when unauthorised movement is detected.
 - d) Cables to be buried at 950 mm with cables concreted in the middle of at least 300mm concrete.

2.10 Level Crossing Controllers (“LX”) Controllers

- 2.10.1 The Bidder shall classify all Level Crossings within the boundaries of the Site according to the latest SANS 3000-2-2-1 standard.
- 2.10.2 The Bidder shall upgrade all Level Crossings to the standard as required in the latest SANS 3000-2-2-1 standard.

2.11 Service and Diagnostic System (“S&D”)

- 2.11.1 The RSS shall provide for a local and remote link to an S&D. The S&D shall record events for Maintenance and statistical purpose.
- 2.11.2 The S&D shall be accommodated in the CTCC building at Rosburgh.
- 2.11.3 The S&D shall analyse, link and evaluate interlocking indications such as status, fault, and event indications, and identify any assumed System faults.
- 2.11.4 The faults shall be stored in a database together with additional information such as place of disturbance, processing status, TCO, timestamp of occurrence, etc.
- 2.11.5 Eliminated faults shall be stored for statistical evaluation at a later stage.
- 2.11.6 The S&D shall display faults as lists. Time and place of occurrence processing status, train controller and assumed reason of any selected fault shall be displayed.
- 2.11.7 Repair instructions relevant to the selected fault shall be displayed.

2.12 TCO Training Simulator

- 2.12.1 The Bidder shall provide a TCO Training simulator facility.
- 2.12.2 The facility shall include at least four TCO workstations, a Section Manager Workstation and an Instructor workstation.
- 2.12.3 It shall be possible to simulate all train control functions and train movements required for the successfully training of TCOs.
- 2.12.4 The simulator shall react exactly as the actual System shall react to any TCO or System inputs.
- 2.12.5 It shall be possible to simulate signal, Telecommunication and ETCS Level 2 System failures.
- 2.12.6 The instructor workstation shall have the facility to place trains and System failures on any of the TCO workstations.

2.13 Technical Training Simulator

- 2.13.1 The Bidder shall provide a Technical Training simulator facility.
- 2.13.2 The facility shall include a complete integrated signal, Telecommunication and ETCS Level 2 System.
- 2.13.3 The facility shall include at least one physical Installation of all Equipment that forms part of the solution provided by the Bidder.

- 2.13.4 It shall be possible to simulate all System and Equipment failures identified as part of the FMECA.
- 2.13.5 The simulator shall react exactly as the actual System shall react to any System or Equipment failures or external input.

2.14 Driver Advisory System (“DAS”)

- 2.14.1 The Bidder shall provide a Driver Advisory System.
- 2.14.2 The DAS shall monitor the train speed and location against the current schedule, calculate an optimal safe speed based on the trains specific characteristics and provide the advisory speed to the driver.
- 2.14.3 The DAS shall be interfaces with the TTMS to enable the provision of information updates to trains in near real time.
- 2.14.4 The DAS shall:
- a) Calculate recommended energy-efficient speed profiles which allow trains to meet the schedule and which are consistent with Infrastructure geography, line speeds (including speed restrictions) for the given train and the train characteristics and capabilities.
 - b) Collate dynamic information.
 - c) Monitor train progress towards the next station, changing the recommended speed profile as required.
 - d) Determine maximum permissible speed.
 - e) Display advisory information to the driver.
 - f) Receive updates to train schedules and speed restrictions.
 - g) Provide train location, speed information and expected arrival times to the TTMS.

2.15 Data File Management Tool

- 2.15.1 The Bidder shall deliver a Data File Management Tool. The minimum outputs of this Tool shall be:
- a) To manage the configuration of the whole PTCS Installation in the region by recording the applicable data files (configuration files) versions of all Equipment commissioned for the PTCS implementation
 - b) To put at the disposable of the PRASA Maintenance staff the right (not an obsolete one) data file (i.e. the data file for the concerned Equipment) to be used for any specific corrective Maintenance action.
- 2.15.2 The Data File Management Tool shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.15.3 Description of Data File Management Tool shall be submitted to PRASA for acceptance.

- 2.15.4 The Bidder shall deliver the necessary documentation to use the Data File Management Tool properly (Users Manuals, procedures, etc.) to PRASA.

3 VALIDATION

3.1 Level 1: Generic Product Validation

- 3.1.1 All RSS sub-Systems and Equipment shall have undergone a generic product Validation by an Authorised Institute recognised by a Main Railway Organisation.
- 3.1.2 The Bidder shall submit all necessary Validation certificates with detailed relevant documentation (Safety and Performance standards, etc.) to PRASA for review and acceptance by PRASA's Independent Safety Assessor.

3.2 Level 2: Functional Product Validation

- 3.2.1 All RSS sub-Systems and Equipment shall have been, or shall be required to be, validated by PRASA's Independent Safety Assessor for compliance to the specified safety and functional requirements.
- 3.2.2 The Bidder shall submit all relevant System/Equipment designs, specifications and reports to PRASA for review and final acceptance by PRASA's Independent Safety Assessor.
- 3.2.3 The Bidder shall Design and implement a Validation model(s) at the Bidder's Project office, able to simulate all specified functional requirements for the purpose of Validation.
- 3.2.4 PRASA's Independent Safety Assessor shall validate and approve all Signalling sub-Systems and Equipment prior to implementation.

4 ENGINEERING

4.1 Design

- 4.1.1 All designs shall comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.
- 4.1.2 The RSS shall, at a minimum, be designed for:
- 2.5-Minute headways at the current maximum line speed of 90km/h, considering actual line speed and permanent speed restrictions.
 - 2.5-Minute or better headways at a maximum line speed of 120km/h, considering practical line speed.
 - Physical implementation of headways as specified throughout the RFP.
 - The Bidder shall do thorough studies and run simulations to optimise the RSS Design in accordance with the current and future line speed and headway requirements.
- 4.1.3 Placement of signals shall allow for future upgrading of turnouts from secant to tangential sets.
- 4.1.4 Design of input and output cards shall be such that the impact of a single point of failure shall be limited to 1 mainline only in areas with multiple/parallel lines.
- 4.1.5 Design and allocation of axle counter evaluators and heads shall be such that impact of a single point of failure shall be limited to 1 mainline only in areas with multiple/parallel lines.
- 4.1.6 The Bidder shall submit the following designs and reports to PRASA for review and final approval by PRASA before implementation:
- Signal Line plan.
 - Headway simulation report.
 - Cable plan and Cable Route plan.
 - Control sheet.
 - Typical Wiring diagrams.
 - Book of Circuits for temporary and permanent interfaces to foreign interlockings.
 - Train Control Diagram and MMI layout
- 4.1.7 The Bidder shall submit the following designs and reports to PRASA for acceptance before implementation:
- Book of Circuits (BOC), containing at least the following information:
 - Revision history
 - Equipment room layout and earthing
 - Cabinet layouts

- Circuit diagrams
- Relevant typical circuits

4.2 VDU Configuration and Data Engineering

- 4.2.1 The Bidder shall do all VDU configuration and data Engineering locally.
- 4.2.2 The Bidder shall do the VDU configuration using the approved Train Control Diagram.
- 4.2.3 PRASA to review and approve the VDU Configuration prior to Commissioning.
- 4.2.4 Data Engineering to be done and tested according to the approved Control Sheets

4.3 Manufacturing and Assembly

- 4.3.1 Manufacturing and assembly shall comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP
- 4.3.2 The Bidder shall manufacture all Equipment locally as far as possible.
- 4.3.3 The Bidder shall assemble all Equipment locally.
- 4.3.4 The Bidder shall submit a detailed Quality Management Plan ("QMP") for the Manufacturing and Assembly process to PRASA for acceptance.

5 CONSTRUCTION

5.1 General

- 5.1.1 Signal Construction work shall comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.
- 5.1.2 Signal Construction work shall only be performed by PRASA approved signal companies.
- 5.1.3 The Bidder shall submit method statements for all signal Construction work to be performed to PRASA for review and approval before commencement of the work.
- 5.1.4 The person(s) responsible for the construction shall not have been involved in any Design, manufacturing or assembling activities relating to the System, sub-System or Equipment.
- 5.1.5 All Construction work on or near the railway line shall be performed under Occupation-between-trains ("OBT") or Total Occupation conditions.
- 5.1.6 The Bidder to perform all the Construction work, except if expressly stated otherwise in the GTRs or PTRs.
- 5.1.7 The outdoor Installation shall cover all signal Works and enabling Civil, Electrical, telecommunications and other Works.

6 TESTING AND COMMISSIONING

6.1 General

- 6.1.1 All Testing and Commissioning activities to comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.

6.2 Factory Acceptance Testing (“FAT”)

- 6.2.1 All relevant Signalling Systems, sub-Systems and Equipment shall undergo and pass FAT before shipping to site.
- 6.2.2 The Bidder shall be responsible for all FAT.
- 6.2.3 All FAT shall be conducted at factory(s) at which the Plant and Materials are manufactured and assembled and by a railway Signalling Engineer or technologist, registered with the Engineering Council of South Africa (“ECSA”) as a professional Engineer or professional technologist and who has undergone training for the specific System, sub-System or Equipment and have experience in FAT.
- 6.2.4 The person(s) responsible for the FAT shall not have been involved in any Design, manufacturing or assembling activities relating to the System, sub-System or Equipment to be tested.
- 6.2.5 The Bidder shall submit a FAT Method Statement to PRASA for acceptance before any FAT commence. The Method Statement shall clearly indicate:
- a) All Systems, sub-Systems and Equipment that shall be included in the FAT and which shall be omitted.
 - b) Specification against which the FAT shall be conducted.
 - c) Method of conducting the FAT for each System, sub-System and Equipment.
 - d) Details, including experience reports, of people which shall be conducting the FAT.
- 6.2.6 The Bidder shall invite PRASA to all FAT taking place at least 40 working days prior to commencing of the FAT. Should PRASA not be able to attend, PRASA shall give the Bidder permission to continue or request the dates for the FAT to be changed. PRASA shall not be held liable for any delays caused by this unavailability.
- 6.2.7 The Bidder shall submit all duly signed FAT Test certificates and associated Test sheet to PRASA for information purposes, prior to Commissioning.
- 6.2.8 PRASA accepts no accountability nor liability for any FAT conducted, despite any checks done or inputs given by any of PRASA's agents.

6.3 Site Acceptance Testing (“SAT”)

- 6.3.1 All relevant Signalling Systems, sub-Systems and Equipment shall undergo and pass SAT before Commissioning.
- 6.3.2 The Bidder shall be responsible for SAT.

- 6.3.3 The SAT shall be conducted by a railway signal Engineer or technologist, registered with the Engineering Council of South Africa (“ECSA”) as a professional Engineer or professional technologist and who has undergone training for the specific System, sub-System or Equipment and have experience in SAT.
- 6.3.4 The person(s) responsible for the SAT shall not have been involved in any Design, manufacturing, assembling, FAT or Installation activities relating to the System, sub-System or Equipment to be tested.
- 6.3.5 The Bidder shall submit a SAT Method Statement to PRASA for acceptance before any SAT commence. The Method Statement shall clearly indicate:
- a) All Systems, sub-Systems and Equipment shall be included in the SAT and which shall be omitted.
 - b) Specification against which the SAT shall be conducted.
 - c) Method of conducting the SAT for each System, sub-System and Equipment.
 - d) Details, including experience reports, of people which shall be conducting the SAT.
 - e) Where practical, all SAT shall be done under OBT conditions, prior to the final Testing and Commissioning Occupation.
- 6.3.6 The Bidder shall invite PRASA to all SAT taking place at least 40 working days prior to commencing of the SAT. Should PRASA not be able to attend, PRASA shall give the Bidder permission to continue or request the dates for the SAT to be changed. PRASA shall not be held liable for any delays caused by this unavailability.
- 6.3.7 The Bidder shall submit all duly signed SAT Test certificates and associated Test sheet to PRASA for information purposes, prior to Commissioning.
- 6.3.8 The PRASA accepts no accountability nor liability for any SAT conducted, despite any checks done or inputs given by any of PRASA's agents.

6.4 Final Testing and Commissioning

- 6.4.1 Final Testing and Commissioning shall be done by a PRASA approved Test and Commissioning Engineer provided by the Bidder.
- 6.4.2 Once the Bidder is convinced the Bidder shall be ready for Final Testing and Commissioning, he shall agree with PRASA on a suitable date for the activity, at least 90 working days prior to proposed date.
- 6.4.3 The Bidder shall submit a comprehensive Final Testing and Commissioning Method Statement to PRASA for approval before any Commissioning commence.
- 6.4.4 The Bidder shall be responsible to provide a complete Testing and Commissioning team as per the Method Statement, as well as all Tools and Equipment required for introducing, Testing and Commissioning of the System.

- 6.4.5 The members of the Bidder's Testing team shall have not been involved in any Design, manufacturing, assembling, FAT or SAT activities relating to the System, sub-System or Equipment for which that member is responsible during the final Testing and Commissioning.

7 DECOMMISSIONING, DISMANTLING AND REMOVAL

7.1 General

7.1.1 The Bidder shall, at a minimum, ensure that:

- a) The Decommissioning, dismantling and removal shall comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.
- b) The Bidder shall be responsible for the Decommissioning, dismantling and removal of all old railway Signalling Equipment.
- c) The Bidder shall remove all visible signal cable and all visible steel and/or concrete signal bases including signal biscuits.
- d) All buried signal cable may be abandoned.
- e) The Bidder shall submit a Method Statement for the Decommissioning, dismantling and removal of all Equipment to PRASA for approval before commencing any work.
- f) The Bidder shall dispose of the Equipment according to the process described in the RFP.
- g) The Bidder shall complete the Decommissioning and removal of visible signal cable within 14 calendar days after the Commissioning of any Section.
- h) The Bidder shall complete the Decommissioning, dismantling and removal of outdoor Signalling Equipment no later than 30 calendar days after the Commissioning of any Section.
- i) The dismantling and removal of indoor signal Equipment shall not run behind more than one phase after the Signalling work.

8 MAINTENANCE

8.1 Overview

- 8.1.1 The Bidder shall Design the RSS in such a manner to minimize Maintenance requirements and ensure overall maintainability.
- 8.1.2 The Bidder shall continue to function properly if maintained according to the current Maintenance strategy.
- 8.1.3 The Bidder shall develop a new improved Maintenance strategy. The new Maintenance strategy shall require less Maintenance and less Maintenance personnel.
- 8.1.4 Any RSS failure shall be self-announcing and shall lead to a predetermined safe state.
- 8.1.5 The System shall incorporate a remotely accessible fault logging and analysis ability, to allow a fast and appropriate response to any normal, or abnormal, situation.
- 8.1.6 It shall be possible to mend RSS breakdowns in a very short time and with a minimum impact on operations.

8.2 First Level Maintenance

- 8.2.1 The Bidder shall perform First Level Maintenance for each Section that has been tested, commissioned and handed over to PRASA from the date of interim hand over to the Completion Date thereafter for 730 calendar days commencing on the Completion Date for the whole of the Works until PRASA issuance of the Performance Certificate thereafter PRASA shall take over Maintenance.
- 8.2.2 First Level Maintenance shall, at a minimum consist of:
 - a) A detailed Maintenance and lifecycle financial model.
 - b) Pre-defined preventative Maintenance.
 - c) Pre-defined corrective Maintenance based on visual inspection of faulty Equipment.
 - d) Modular replacement of faulty Equipment, without the need for any Software or hardware configuration.
 - e) Visual condition assessment.
- 8.2.3 It shall be possible to replace faulty modules, including element controllers without the need to stop the System or turn the power off.
- 8.2.4 The Bidder shall ensure that the transition of Maintenance responsibilities from the Bidder to PRASA (commencing 90 working days prior to the expiry of the Bidder's total Maintenance period) shall be effortless, that there shall be enough training of PRASA personnel. The Bidder shall further ensure that all documentation, policies, procedures and the like relating to the successful continuation of Maintenance, by PRASA, is transparently and effectively handed over to PRASA.

8.3 Second Level Maintenance

8.3.1 The Bidder shall perform Second Level Maintenance for each Section that has been tested, commissioned and handed over to PRASA from the date of interim hand over to the Completion Date thereafter for 730 calendar days commencing on the Completion Date for the whole of the Works until PRASA issuance of the Performance Certificate thereafter PRASA shall take over Maintenance.

8.3.2 Second Level Maintenance shall, at a minimum, consist of:

- a) A detailed Maintenance and lifecycle financial model.
- b) Pre-defined corrective Maintenance based on System diagnostics.
- c) Modular replacement, with the need for basic Software or hardware configuration.
- d) Condition assessment by means of diagnostic Tools and Equipment.

8.3.3 The Bidder shall ensure that the transition of Maintenance responsibilities from the Bidder to PRASA (commencing 90 working days prior to the expiry of the Bidder's total Maintenance period) shall be effortless, that there shall be enough training of PRASA personnel. The Bidder shall further ensure that all documentation, policies, procedures and the like relating to the successful continuation of Maintenance, by PRASA, is transparently and effectively handed over to PRASA.

8.4 Third Level Maintenance

8.4.1 The Bidder (with assistance from PRASA) and the Original Equipment Manufacturer ("OEM") (under management of the Bidder and for whom the Bidder shall ensure availability and compliance), shall perform Third Level Maintenance for each Section that has been tested, commissioned and handed over to PRASA from the date of interim hand over to the Completion Date thereafter for 730 calendar days commencing on the Completion Date for the whole of the Works until PRASA issuance of the Performance Certificate thereafter PRASA shall take over Maintenance.

8.4.2 Third Level Maintenance shall, at a minimum, consist of:

- a) A detailed Maintenance and lifecycle financial model.
- b) Undefined and irregular corrective Maintenance based on advanced System diagnostics.
- c) Modular replacement, with the need for advanced Software or hardware configuration.
- d) System configuration changes to accommodate infrastructure upgrades and layout changes.

8.4.3 The Bidder shall do local Supplier Development, training and certifying local Suppliers to perform third level Maintenance on the System further ensuring comprehensive inclusion of the OEM throughout the process.

- 8.4.4 The Bidder shall train and develop a minimum of 2 local suppliers further ensuring comprehensive inclusion of the OEM throughout the process.
- 8.4.5 The Bidder (with direct support from the OEM) shall ensure that the transition of Maintenance responsibilities from the Bidder and the OEM to PRASA (commencing 90 working days prior to the expiry of the Bidder's total Maintenance period) shall be effortless, that there shall be sufficient training of PRASA personnel. The Bidder shall further ensure that all documentation, policies, procedures and the like relating to the successful continuation of Maintenance, by PRASA, is transparently and effectively handed over to PRASA.

8.5 Fourth Level Maintenance

- 8.5.1 The Bidder and the OEM (under management of the Bidder and for whom the Bidder shall ensure availability and compliance), shall perform Fourth Level Maintenance for each Section that has been tested, commissioned and handed over to PRASA from the date of interim hand over to the Completion Date thereafter for 730 calendar days commencing on the Completion Date for the whole of the Works until PRASA issuance of the Performance Certificate thereafter the OEM shall take over Maintenance (under supervision from PRASA).
- 8.5.2 Fourth Level Maintenance shall, at a minimum, consist of:
- a) System upgrades
 - b) Changes to the System's core Software
 - c) Component level corrective Maintenance
- 8.5.3 The Bidder shall ensure that the OEM contractually commits to having representation, and providing all necessary Maintenance and/or support, in South Africa for a minimum period of at 240 calendar months post the Bidder's Maintenance, Warranty and Defects Liability period.

9 WARRANTIES

9.1 General

- 9.1.1 The Bidder shall, take interim Warranty responsibility and liability for each Section of that has been tested, commissioned and handed over to PRASA from the date of interim hand over to the Completion Date.
- 9.1.2 The Bidder's full Warranty responsibility and liability period shall be 730 calendar days commencing on the Completion Date for the whole of the Works until PRASA issuance of the Performance Certificate.
- a) Warranties shall, for all Signalling related Works (including, but not limited to, the PTCS and EI) at a minimum, be valid and cover:
 - Replacement of all faulty Plant and Materials, Components and labour for all Maintenance Levels described elsewhere in this document
 - Tracking and tracing and correcting of any Software faults
 - b) Failures caused by the environmental and infrastructure conditions as specified throughout the RFP including, but not limited to:
 - Any Plant and Materials or Components damaged due to exposure to extreme direct sunlight and elevated temperatures
 - Any Plant and Materials or Components damaged due to continues exposure to high humidity
 - Any Plant and Materials or Components failure due to corrosion