

Annexure 1.2:

General Technical Requirements

Train Control System (“ETCS Level 2”)

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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 Train Control System (“ETCS Level 2”) 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 ETCS Level 2 Component of the Works is, at a minimum, summarised as follows:
- a) Provide an ETCS Level 2.
 - b) Testing and validating of the interfaces of the ETCS Level 2 Equipment with the PRASA and TFR infrastructure and ETCS Level 2 equipped rolling stock.
 - c) Provide all Equipment required for the implementation of the ETCS Level 2 in accordance to PRASA’s specifications.
 - d) Implement the ETCS Level 2 in KZN.
 - e) Provide all required resources to deliver and maintain the ETCS Level 2 Works.
 - f) Any other ETCS Level 2 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 ETCS Level 2 Overview

- 2.1.1 The ETCS Level 2 shall comply with all relevant Standards, Specifications and Regulations as specified in throughout the RFP.
- 2.1.2 The ETCS Level 2 shall be based on ETCS Level 2 baseline 3, level 2 considering the highest available M_VERSION value at the contract award date. All European Union Agency for Railways (“ERA”) documents related to corresponding ETCS Level 2 baseline 3 (including latest Maintenance releases) at the Contract Award date shall be applicable.
- 2.1.3 The implementation of ETCS Level 2 shall allow packet switching based data transmission and the Bidder shall ensure the technical interoperability with the ETCS Level 2 on-board of the ETCS Level 2 equipped PRASA trains.
- 2.1.4 There shall be a Key Management Centre (“KMC”).
- 2.1.5 Figure 2.1.1 below gives a Systems context diagram to for the Design of the ETCS Level 2:

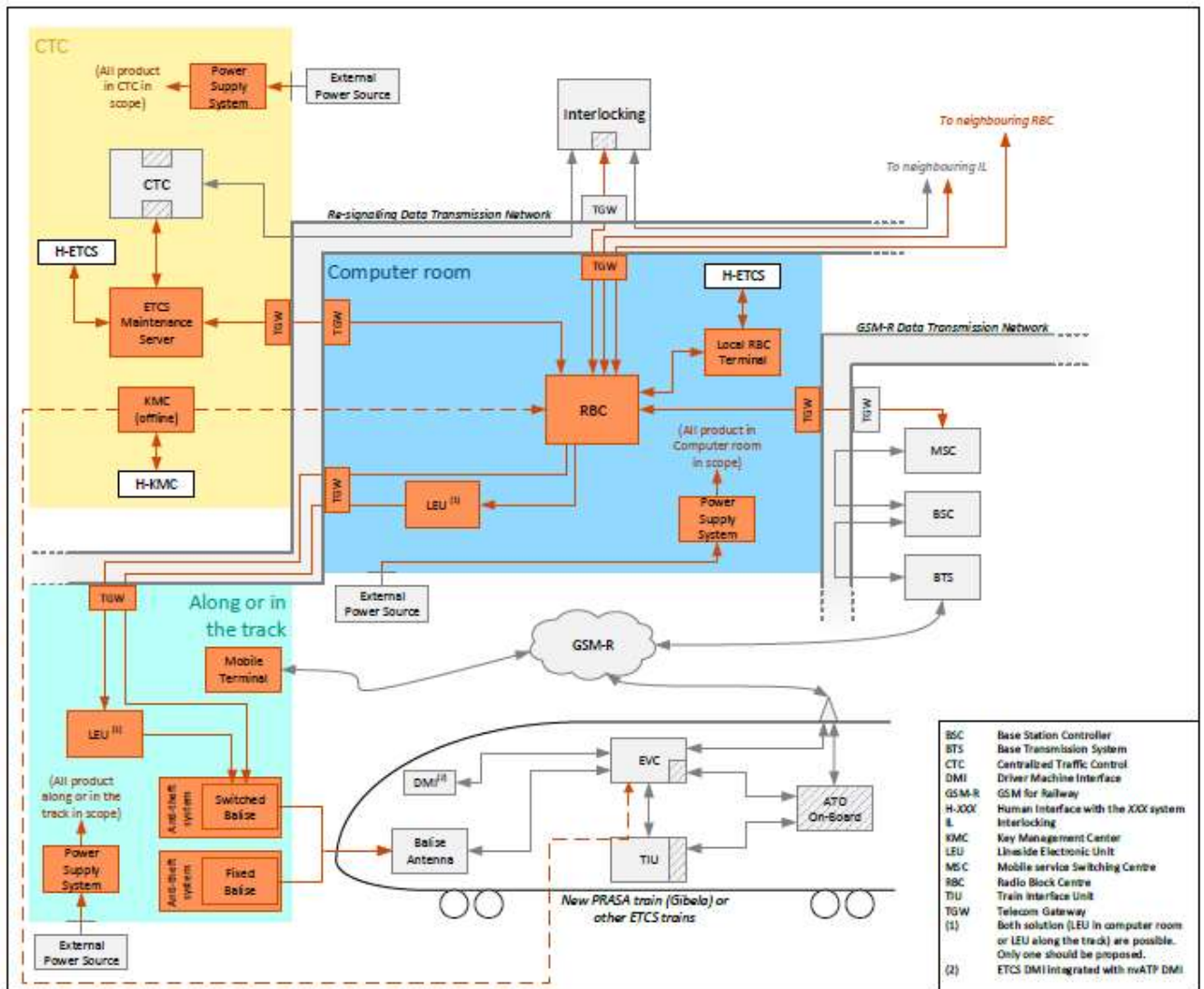


Figure 2.1.1: ETCS Level 2 Context Diagram

2.1.6 Safety:

- a) The ETCS Level 2 shall be designed and implemented to allow a safe In-Cab Signalling train operation, not requiring the driver to observe the line-side Signalling in nominal mode.
- b) The ETCS Level 2 shall not induce any additional risks on the personal safety of Track workers.
- c) The ETCS Level 2 shall avoid that a train being tripped at a signal at danger would reach the end of the overlap.
- d) The Permitted Speed shall consider and allow for any applicable speed restriction, permanent or temporary.

2.1.7 Operation:

- a) The implementation of ETCS Level 2 on the PRASA Network shall achieve an In-Cab Signalling System meaning that, when in Full Supervision (“FS”) mode, the driver is not required to observe lineside Signalling indications (boards, colour light signals, flags, etc.) with the exception of specific operational situations (example: the train is in Release Speed supervision while approaching a signal at danger).
- b) The implementation of ETCS2 on the PRASA Network must be customized to comply, as far as possible, with the existing PRASA operational principles and operating rules.
- c) The ETCS Level 2 modes shall be consistent with the line side Signalling.
- d) The information displayed on the Driver Machine Interface (“DMI”) shall be consistent with any stop aspect displayed on the line side signals.

2.1.8 Capacity:

- a) To cope with the possible evolution of the PRASA fleet and traffic growth expected in the future, the Design must allow the operation of the PRASA Network considering the current maximum traffic increased with 80% (estimation of the maximum traffic in 2040).
- b) The control area of each RBC shall use maximum 90% of the RBC geographical capacity to allow future adaptations of the PRASA Network.
- c) No reduction of the usable Track length in the stations shall be allowed.

2.1.9 Reliability, Availability, Maintainability, Safety and Security (“RAMSS”):

- a) The ETCS Level 2 shall be designed and implemented in such a way as to achieve the reliability, availability, maintainability, safety and security specified in the ETCS Level 2 URS.
- b) Train delays, caused by trackside Equipment failures, shall be avoided or limited to the minimum without jeopardizing the safety objectives.
- c) Alarms and events shall be reported to and recorded by the Maintenance System.
- d) Centralized management of parameter files (data files) shall be implemented to enable Maintenance staff to get access to the data files to be used during corrective Maintenance.
- e) The ETCS Level 2 shall be designed and implemented considering the substantial risk of theft and vandalism of any devices installed along the lines.
- f) The use of Eurobalises shall be minimised as much as possible without jeopardizing safety, performance and functionalities in nominal and degraded situations.
- g) The ETCS Level 2 shall be designed to have no or very limited copper.

- h) The Bidder shall implement measures to protect the ETCS Level 2, sub-Systems and all Equipment against at least the following threats:
- Theft and vandalism
 - Cyber threats
 - Continues exposure to extreme direct sunlight and elevated temperatures
 - Continues exposure to high humidity
 - Coastal environmental conditions causing damaged such as corrosion
 - Incoming high voltages, spikes, EMCs and fluctuating voltages
 - Intermittent flash flooding in low laying areas
 - Severe thunderstorms with extreme heavy lightning
 - The ETCS Level 2 shall be properly earthed, complying with all applicable standards and best practices. The Bidder shall therefore isolate all Power Cubicle metal work from the building structure where it is installed

2.1.10 Upgradability:

- a) The ETCS Level 2 subsystem shall be upgradable to fulfil new PRASA needs, compliant with the future ETCS Level 2 evolutions (new Maintenance releases or new baselines), during the ETCS Level 2 lifecycle such as:
- Semi-Automatic Train Operation (“SATO”)
 - Virtual (moving) Blocks
 - Etc.
- b) The ETCS Level 2 subsystem shall be upgradable to the future envisaged ETCS Level 3 System

2.2 Communication

- 2.2.1 The Communication System shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.2.2 The Radio Block Centre (“RBC”) shall communicate with the GSM-R Mobile Switching Centre (“MSC”) through the PRASA GSM-R data transmission Network, except if not acceptable for safety or performance reason to be described. In that case, the Bidder shall Design, Supply, install, Test and commission the necessary data transmission Network.
- 2.2.3 The Bidder shall be fully responsible for ensuring the safety integrity of the ETCS Level 2 when using the existing data transmission Network.
- 2.2.4 The Bidder shall ensure enough bandwidth and fibres are available for the ETCS Level 2 trackside.

- 2.2.5 The Bidder shall review the GSM-R transmission Network and make recommendations in terms of additional capacity required.
- 2.2.6 To connect the data transmission Network, the Bidder shall use and deliver Telecom Interface Equipment as specified in the GTR for telecommunications.
- 2.2.7 To connect the GSM-R data transmission Network, the Bidder shall use and deliver Telecom Interface Equipment as specified in the GTR for telecommunications.

2.3 Trackside Balises

- 2.3.1 The Trackside balises shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.3.2 To ease the hiding and securing of the balise (protection against theft and vandalism), the Bidder shall investigate the possibility of using of ETCS Level 2 balises still smaller than the ETCS Level 2 reduced size balise, but compatible with a maximum train speed of 250 km/h.
- 2.3.3 The balises shall be able to work on ballasted and ballast-less track .
- 2.3.4 The Bidder shall submit a document about the feasibility of using smaller balises.
- 2.3.5 The Bidder shall deliver balises still smaller than the ETCS Level 2 reduced size balise if required by PRASA. If not, the Bidder shall deliver reduced size balise class B.
- 2.3.6 The colour of the balises shall be agreed by PRASA.
- 2.3.7 Programming of balises shall be possible without any wired connection to the balise.

2.4 Balise Fastening System

- 2.4.1 The Balise fastening System shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.4.2 To protect the balises against theft and vandalism, the balise shall be hidden inside a hollow or twin-block sleeper. The Bidder shall develop, Supply and install such sleepers.

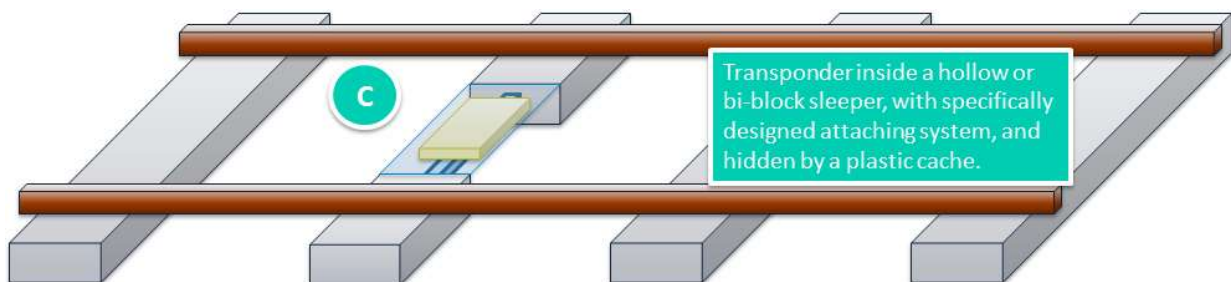


Figure 2.4.1 : Balise hidden in a sleeper

- 2.4.3 The installed balises shall not be damaged by on-Track Maintenance machinery.

- 2.4.4 Where it is not practical to hide the balise in a hollow or twin-block sleeper, the Bidder shall Supply, a fastening System, valueless for thefts and that can withstand vandalism, for the Installation of balise on the existing concrete sleepers or tubular Track. The fastening System might include a non-metallic cache as proposed on Figure 2.4.2.

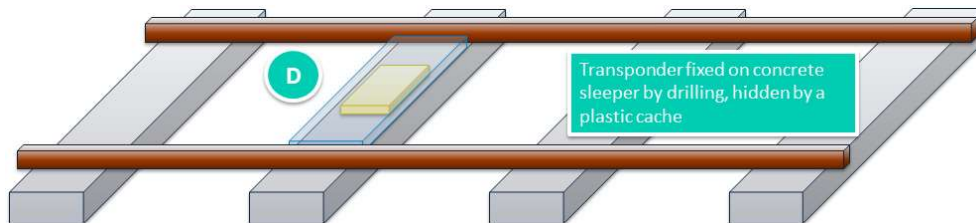


Figure 2.4.2 : Balise Installation on an existing sleeper

- 2.4.5 No balise shall be installed on wooden sleepers. For mainlines on wooden sleepers, the Bidder shall Supply and install new concrete sleepers for at least 15m on either side of the balise where required.
- 2.4.6 The balise fastening Systems shall be fully tested according to the applicable standards specified throughout the RFP to prove their suitability to be installed on Track run by freight and commuter trains at a maximum speed of 250 km/h.
- 2.4.7 The fastening Systems shall allow adjusting of the position of the balise to comply with the relevant requirements (the distance between the top of the rail and the reference mark of the balise).

2.5 Lineside Electronic Unit (“LEU”)

- 2.5.1 The LEU shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.5.2 The Bidder shall deliver a LEU that meet the requirements of UNISIG Subset 036, interface C towards the balise.
- 2.5.3 The Bidder shall avoid a direct interface between the LEU and the IL or the lineside signals.
- 2.5.4 The LEU shall interface directly with the Radio Block Centre (“RBC”).

2.6 Radio Block Centre (“RBC”)

- 2.6.1 The RBC System shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.6.2 The RBC generic program (core Software) shall be adapted to implement the rules and principles defined during the ETCS Level 2 Conceptual Design to be done by the Bidder.
- 2.6.3 The number of pre-programmed ETCS packets and messages in the RBC shall be minimised and the RBC shall calculate and build in real time as many ETCS packets and messages content as possible.

- 2.6.4 The Bidder, at the cost of the Bidder, shall be fully responsible for producing a safety case, certification with a PRASA nominated Notified Body (NoBo) and validating the complete System, including, but not limited to the RBC, interlocking, trackside Equipment, GSM-R and on-board Equipment, after adaptation of generic RBC program, according to requirements.
- 2.6.5 The Validation of RBC specific project's data files shall require limited effort as it should be limited to the Validation of the data related to the specific infrastructure description (Track configuration, curves, gradients, distances, Signalling elements).
- 2.6.6 The application configuration process shall never modify nor impact the Generic core Software of the RBC.
- 2.6.7 The RBC shall automatically do internal checks at start-up phase to avoid the loading of erroneous application configuration files during the life cycle.
- 2.6.8 The Bidder shall deliver before the Commissioning of the first Section a Software Configuration Program, and the instructions to use it, with which it is possible to read and check the version/configuration of the generic core Software and of the application Software (data preparation) and to compare those read version/configuration with the required ones.
- 2.6.9 The RBC delivered by the Bidder shall make it possible for PRASA staff, after having been trained, to modify the national values under their own responsibility. The procedure for doing this:
- a) Will exclude any possibility of modifying the core Software, the application Software or any other parameter.
 - b) Will not require any recompilation of the Software.
- 2.6.10 The Bidder shall demonstrate safety compliance of the RBC in case of degraded modes (e.g. RBC shutdown).

2.7 Key Management Center (“KMC”)

- 2.7.1 The Key Management Centre shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.7.2 The Bidder shall set up a Key Management System for PRASA.
- 2.7.3 The Bidder shall deliver a Key Management Center (KMC) Tool and the necessary documentation and processes (User Manual, procedures, etc.) to enable PRASA to perform all the necessary key management operations for the ETCS Level 2 entities (RBC and ETCS Level 2 on-board units).

2.8 Mobile Terminal

- 2.8.1 The Mobile Terminal shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.

- 2.8.2 PRASA has GSM-R mobile units to be used for the “Management of Track Possession” function. The Bidder shall develop and implement an interface to these units within the ETCS Level 2 System.
- 2.8.3 The Bidder shall provide a detailed description of the methodology (procedures to be applied) for “Management of Track Possession”.
- 2.8.4 The communication between the mobile terminals and RBC shall use the GSM-R Network.

2.9 ETCS Level 2 Maintenance Server and Local RBC Terminal

- 2.9.1 The ETCS Level 2 trackside subsystem shall include an ETCS Level 2 Maintenance server (“EMS”) from which it shall be possible to monitor the operation of the various Equipment and to get clear indication regarding any occurred incident or failure (description, location, and criticality).
- 2.9.2 The EMS shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.9.3 Each set of RBCs located in the same Equipment room shall be equipped with a Local RBC Maintenance Terminal (“LRT”), located at the same location than the RBC.
- 2.9.4 The LRT shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.
- 2.9.5 All alarms and events shall be reported (by the LRT) to the EMS.
- 2.9.6 The EMS and each LRT shall have a user-friendly human machine interface and shall be equipped with a printer.
- 2.9.7 The Bidder shall deliver the full set of documentation for the EMS and LRT (User manuals, procedures, etc.).

2.10 Juridical Recorder Unit (“JRU”)

- 2.10.1 The EMS and LRT shall include Juridical Recorder Units that shall record all the messages and packets, including their full content, exchanged between the RBC and the trains as well as the list of on-board events that trigger the transmission of the related messages.
- 2.10.2 The JRU shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.

2.11 Portable Maintenance Tools (Programming and Test Equipment)

- 2.11.1 In addition to the EMS and the LR, the Bidder shall Supply all the portable Maintenance Tools necessary to allow PRASA to achieve the required Maintenance tasks.
- 2.11.2 The Bidder shall identify and provide any other Maintenance portable Tools deemed necessary to maintain the ETCS Level 2 trackside subsystem.
- 2.11.3 The Bidder shall deliver to PRASA a wireless portable “balise Maintenance Tool” allowing at least (non-exhaustive list):

- a) To upload a balise default telegram in a balise.
- b) To read the balise default telegram contained in the balise.
- c) To read the telegram sent by a balise.

2.11.4 The Bidder shall deliver portable “LEU Maintenance Tool” allowing (non-exhaustive list), which can be integrated in the same Tool (non-exhaustive list):

- a) To upload telegrams in a LEU.
- b) Check the correct functioning of LEU.

2.11.5 The Bidder shall delivery all User Manuals and certifications applicable for the portable Maintenance Tools.

2.12 Cables

2.12.1 Wired interfaces of ETCS Level 2 shall be limited to the following:

- a) Power connections
- b) Network connections (LAN/WAN, RBC, Interlocking...)
- c) LEU and balises interfaces
- d) Earthing connections

2.12.2 Cables shall comply with all relevant Standards, Specifications and Regulations as specified throughout the RFP.

3 TECHNICAL CONCEPT

3.1 General

- 3.1.1 The Bidder shall propose a Preliminary Conceptual Design for the implementation of all the mandatory functions with the goal of avoiding the use of balises as far as possible and considering the requirements and guidelines contained in the URS and relevant specifications.
- 3.1.2 The Bidder shall provide feedback on the feasibility of the proposed guidelines to reduce the number of balises
- 3.1.3 The Bidder shall propose and describe any suitable innovative solution (e.g. replacement of balises by other devices; train location by satellite, etc.) and clearly state the feasibility and applicability (e.g. part/percentage of the geographical scope) where the solution could be implemented considering the requirements on the ETCS Level 2 System.
- 3.1.4 If deemed necessary, the Bidder shall produce any additional conceptual document to the ones already required.
- 3.1.5 The Bidder shall remain fully responsible for the conceptual generic Design that must ensure a safe implementation. In other words, the URS given shall only be considered as a first proposal for the generic Design and the Bidder shall:
- a) Consolidate the guidelines wherever needed.
 - b) Identify possible weaknesses or shortcomings in the URS and propose deviations accordingly.
 - c) Justify any deviation to the URS.

3.2 Functions Requirement Specification (“FRS”)

- 3.2.1 The Bidder shall submit a document “Functional Requirement Specification (“FRS”)”. The document shall define and document all the ETCS Level 2 functions to be implemented and all the information required and described in the URS.
- 3.2.2 The Bidder shall, at a minimum:
- a) Analyse the transposition of all PRASA Lineside Signalling information into In-Cab Signalling indication and, if necessary, complete the list of the functions to be implemented. In other words:
 - Any type of coloured signal must be considered and translated in ETCS Level 2
 - Any other indication (e.g.: boards) must be considered and if necessary, translated in ETCS Level 2
 - b) Identify and list the specific operational situations that require the driver to look outside.

- 3.2.3 The Bidder shall analyse and compare the diverse options to implement each function considering all the PRASA requirements and guidelines.
- 3.2.4 The Bidder shall detail all the Euroradio messages sequences between the on-board unit and the ETCS2 trackside for each ERTMS/ETCS Level 2 generic function, in a format to be agreed by PRASA.
- 3.2.5 The Bidder shall define in detail all Signalling conditions (i.e. linked to interlocking, information from trains [e.g.: requirement for the implementation of the positioning report from the trains]) required to perform each ETCS Level 2 function.

3.3 Specific Study: “Stop if in SR” Through GSM-R (Managed by the RBC)

- 3.3.1 The Bidder shall submit a specific document “Implementation of the “Stop if in SR” function by GSM-R” to:
 - a) First step: fully analyse the feasibility and the efficiency (reliability, safety etc.) of such implementation considering the corresponding guidelines.
 - b) Second step (only if satisfactory results for step 1): evaluate the benefits of such implementation on all line (among other number of LEU and balises that could be saved).

3.4 System Architecture Description

- 3.4.1 For the Design and the configuration of the ETCS Level 2 trackside subsystem (and the management of the MA), the Bidder shall take into account the System delays, in nominal and degraded situation, and other characteristics of the whole Signalling Systems. This means including the Electronic Interlocking (“EI”) and the Lineside Signalling Equipment, being installed, and considering the specific implementations as in the PTR to ensure the best performance (Capacity, Safety and Punctuality).
- 3.4.2 The Bidder is responsible for identifying the necessary characteristics (information) and relevant delays (i.e. necessary for the Design), to comply with the above.
- 3.4.3 The time difference between the signal aspect change and the corresponding DMI update shall be reduced as much as possible for safety and ergonomic reasons. The Bidder shall calculate that time difference for each.
- 3.4.4 The Bidder shall submit a document “System Architecture Description” defining and documenting (non-exhaustive list):
 - a) The generic architecture, with all Equipment to be delivered, and all their interface with other Equipment.
 - b) The Apportionment of the functions in the various Equipment
 - c) The Generic Rules to be applied for the dimensioning (number of needed balises, RBC and LEU if any) for the Installation to cope with the performance requirements (capacity, availability, punctuality, etc.).

- d) Generic rules and fully justified criteria for determining, for any Track layout to be equipped with ETCS Level 2, where (location) ETCS Level 2 balises (and possibly LEU) are required to implement all the functions and to cope with the performance requirements.
- e) The evidence that the requirements as mentioned above are fulfilled, the corresponding analysis and all information related to those requirements.

3.5 Programming Rules

3.5.1 The Bidder shall submit a document “Generic programming Rules” defining (non-exhaustive list):

- a) How each ETCS Level 2 packet and ETCS Level 2 message, in the frame of this project, shall be built.
- b) When (i.e. under which conditions) each packet and message must be sent to/received from a train.

4 DEVELOPMENT AND VALIDATION

4.1 Development/Engineering Plan

- 4.1.1 The Bidder shall, as part of the Bid, submit a Development/Engineering Plan that covers all the activities, processes, methods and Tools to be put in place to ensure that the delivered ETCS Level 2 subsystem meets all its requirements. This plan shall mention the technical, references and sources used for the Design, Testing and Verification and Validation of the ETCS Level 2 subsystem and its integration in the PRASA context.
- 4.1.2 The Development/Engineering Plan shall cover the following aspects:
- a) Typical (Generic development) to customize the ETCS Level 2 implementation to the South-African Context and define the principles and Design rules to be applied to each subproject.
 - b) The adaptations of the ETCS Level 2 products to fit the South African context.
 - c) The production Engineering and the Testing (processes, activities and Tools) for the execution of the Project.
- 4.1.3 The Bidder shall be auditable by PRASA on establishment and effective implementation of processes and activities provided in the Development/Engineering Plan.
- 4.1.4 The Bidder shall review and upgrade the Development/Engineering Management Plan on request by PRASA and fully apply the approved Development/Engineering Management Plan.

4.2 ETCS Level 2 Development

- 4.2.1 The Bidder shall define the conceptual design for the implementation of ETCS Level 2 customised for the PRASA Network and develop a generic application for PRASA.
- 4.2.2 The Bidder shall deliver a full conceptual design for the implementation of the ETCS Level 2 trackside sub-System to be overlaid on the IL subsystems in the different PRASA Regions (Gauteng “GP” & Western Cape “WC”).
- 4.2.3 The Bidder shall allow for unlimited concept and design changes until the System is adapted to PRASA’s absolute satisfaction.
- 4.2.4 The Bidder shall provide adapted products to fit the PRASA needs and necessary design and testing environment to start the rollout.
- 4.2.5 The Bidder shall setup the Tools needed for rollout of the ETCS Level 2, including at least:
- a) A development centre, fully customised to be used for the production Engineering for the new PTCS
 - b) A laboratory test environment at a location to be agreed on with PRASA
- 4.2.6 The Bidder shall submit at least the following designs and reports to PRASA for approval as part of the ETCS Level 2 development:

- a) Generic RAM plan
- b) Driving ergonomics proposal
- c) Assessment and Certification plan
- d) Environmental Plan, including evidence of product compliance by an independent laboratory
- e) EMC Plan
- f) Earthing Concept
- g) Procedure for KMAC keys approval
- h) Generic Application FRS
- i) System Architecture Description
- j) Implementation of the Stop if in SR function by GSM-R (First step)
- k) Curve and Gradient Modelling Process
- l) Measurement Strategy, processes and Tools
- m) ETCS Level 2 Generic Programming Rules
- n) All safety analyses and studies
- o) Generic Hazard Log Report with measures implemented
- p) Overall Test Plan
- q) Migration Strategy Document
- r) Laboratory Test Environment Description
- s) Generic Application Safety Case
- t) Generic Product Safety Cases and certificates
- u) Principles Validation Report
- v) ETCS simulator user manual and other Equipment user manuals
- w) All assessment reports
- x) Intermediate Statement of Conformity
- y) Draft ISA Discrepancies Register
- z) Draft NoBo Discrepancies Register
- aa) Draft ETCS Policy, procedures and standards, aligned with PRASA standards
- bb) Integration of ETCS Training Modules (Integrated into current RSS training simulators).

4.2.7 The Bidder shall, at the Bidder's cost and within the Contract Period, allow for all ETCS Level 2 safety and functional improvements, validation and implementation thereof throughout the duration of the Contract at PRASA's request or instruction and irrespective of the requirements and specifications stated in the RFP.

4.3 Level 1 Validation: Generic Product Validation

- 4.3.1 The ETCS Level 2 System, sub-Systems and Equipment shall have undergone a Generic Product Validation by an Authorised Institute recognised by a Main Railway Organisation.
- 4.3.2 The Bidder shall submit all necessary Validation certificates with detailed relevant documentation (Safety and Performance standards, etc) to PRASA for review and acceptance by the Employer's Independent Safety Assessor.

4.4 Level 2 Validation: Functional Product Validation

- 4.4.1 The ETCS Level 2 System, sub-Systems and Equipment shall have been or shall be required to be validated by the Employer's Independent Safety Assessor for compliance to the specified safety and functional requirements.
- 4.4.2 The Bidder shall submit all relevant System/Equipment designs, specifications and reports to PRASA for acceptance by PRASA's Independent Safety Assessor.
- 4.4.3 The Bidder shall Design and implement a Validation model(s) at the Bidder's Project office, able to simulate all specified functional requirements for Validation.
- 4.4.4 The ETCS Level 2 System, sub-Systems and Equipment shall be validated and approved by the Employer's Independent Safety Assessor prior to implementation.

5 ENGINEERING

5.1 General

- 5.1.1 The Bidder shall submit to PRASA for acceptance, a full description of the Engineering process for the Design and the generation of the specific data files (for the RBC, balises and possibly LEU), from the collect of data to the data file generation, highlighting:
- a) All Engineering and verification sub-processes.
 - b) All Engineering and verifications activities.
 - c) The inputs and outputs for each activity.
 - d) All necessary Equipment and Tools (among others the ETCS Level 2 generation Tool), the personnel involved (functional role, skills and qualification) and the necessary independence between roles.
- 5.1.2 For each section, the Bidder shall also submit at least the following documents to PRASA for acceptance prior to commencement of the work:
- a) Specific RAM Plan
 - b) Specific Safety Plan
 - c) Specific Verification and Validation Plan
 - d) Specific Application System Requirements ("SRS")
 - e) KMC Documentation

5.2 Design

- 5.2.1 Prior to the Design of each Section the Bidder shall gather and identify the necessary basic data of the area to be fitted by ETCS Level 2 including, but not limited to:
- a) Track layout configuration.
 - b) Lineside Signalling layout, Equipment and indications overlaid on the Track layout.
 - c) Powerless sections change of traction current.
 - d) Level crossings.
 - e) Big metals masses.
 - f) Locations of cold movement departure.
 - g) Possible locations of splitting and joining.
 - h) End of shunting movement locations to be possibly protected with ETCS Level 2.
 - i) Locations where specific Track conditions should be implemented:
 - Non stopping area
 - Tunnel non stopping area

- Change of allowed current consumption
- Radio hole

j) Switch off regenerative brake, eddy current brake, magnetic shoe brake.

5.2.2 The Bidder shall submit the following designs and reports to PRASA for approval before implementation:

- a) Detailed Design report, demonstrating:
- The architecture fulfils the Design guideline for the implementation of all necessary functions
 - The capacity requirements are fulfilled. In particular, the maximum possible traffic (number of trains) allowed by the Design shall be clearly stated and compared with the current traffic and the expected traffic growth
 - All occurrences for the functions have been identified
- b) Layout of all necessary balise groups and LEUs for the implementation of all necessary spot functions and determination of the exact location of each balise and LEU.
- c) Cable Plans.

5.2.3 The Bidder submit the following designs and reports to PRASA for acceptance before implementation:

- a) Architecture Design
- b) Book of Circuits.
- c) Report regarding the necessary number of RBC (and RBC terminals), among other considering the requirements on the Capacity.
- d) RAM Analysis
- e) Implementation of the Stop if in SR function by GSM-R (Second step).
- f) Track Data collected
- g) Specific safety and risk analysis
- h) Intermediate Hazard Log
- i) Earthing Plan
- j) Detail Design System Interface Description ("SyID")

5.3 Distance, Curve and Gradient Data Measurement and Related Modelling Processes

5.3.1 The Bidder shall be responsible for the execution of measurement and processing of the distance, curve and gradient data for the ETCS Level 2 Design.

- 5.3.2 The measurement and the processing of the distance, curve and gradient data shall rely on automated Equipment and processes (e.g. measurement Equipment to be installed on train). In other words, manual measurement by geometers shall be avoided as much as possible (i.e. only reserved for the Track areas that could not be accessed by the measurement train) to reduce human error in the process.
- 5.3.3 The measurement and the modelling of the distance, curve and gradient data shall ensure a high accuracy of the measurements and an integrity level compliant with the global SIL4 requirement for the ETCS Level 2 trackside subsystem.
- 5.3.4 In case of necessary manual measurements by geometers, enough Redundancy of the measurements (e.g. measurements to be done by at least 2 independent teams of geometer) shall be implemented to comply with the safety and accuracy requirements.
- 5.3.5 The modelled curve and gradient profile shall be optimized to match the measured curve and gradient profile as much as possible, ensuring the safety and preserving the performance. For this purpose, the modelled curve and gradient profile related to a MA shall be composed of several segments (maximum 5) if necessary. PRASA holds the right to check the modelled curve and gradient profile compared with the measured curve and gradient profile and to require more segments (maximum 5 segments in total for a MA).
- 5.3.6 The Bidder shall submit to PRASA for acceptance a specific document “Curve and Gradient Modelling Process” giving a detailed description for the curve and gradient modelling process and demonstrating that it is safe and that its implementation on the PRASA networks ensures the required performance.
- 5.3.7 The Bidder shall submit to PRASA for acceptance a specific document “Measurement Strategy, Processes and Tools” aiming at demonstrating that the full process comprising the measurement strategy, the combined measurement devices, the data processing’s and the human interventions, shall generate all the necessary distance, curve and gradient data compatible with the global SIL4 requirement for the ETCS Level 2 trackside.
- 5.3.8 The Bidder shall submit to PRASA for acceptance, a description of the proposed measurement and modelling solution:
- a) Description of the proposed Equipment and the processes
 - b) High-level description of the curve and gradient modelling process
 - c) Evidence in term of safety and accuracy (error on the measurement). The Bidder shall explain how curve, gradient and distances measurement and modelling processes are compliant with the global SIL 4 requirement for ETCS Level 2 trackside
- 5.3.9 The Bidder shall not start any measurement campaign before the documents “Curve and Gradient Modelling Process” and “Measurement Strategy, processes and Tools” are accepted by PRASA.
- 5.3.10 The Bidder shall perform measurement campaigns to gather all necessary curve and gradient and distance information for each Section.

- 5.3.11 The Bidder shall be fully responsible for Planning and organizing the measurement campaigns and shall liaise with PRASA Operation if train runs/Track possessions are required.
- 5.3.12 The Bidder shall submit the request for each measurement campaign at least 60 working days in advance.
- 5.3.13 The measurement campaign organizations to be set up by the Bidder shall include the definition of the succession of paths to be run by the measurement train, if applicable.
- 5.3.14 The Bidder shall submit to PRASA for agreement, the program of each measurement campaign (if applicable, i.e. train path in case a measurement train is used).
- 5.3.15 If the measurement campaign requires a train:
- a) The train and the driver shall be rented from PRASA by the Bidder
 - b) PRASA shall be in charge of operating the Network during the measurement campaign
- 5.3.16 The Bidder shall be fully responsible for the proper Installation configuration and execution of measurement/data acquisition of the measurement Equipment on the PRASA train.
- 5.3.17 For each measurement campaign, the Bidder shall produce a “Measurement Campaign Report” document:
- a) Describing the measurement campaign and the processing of the data, gathering necessary information for traceability purpose (Equipment references, and people involved) for each task.
 - b) Containing the measurement campaign results (curve, gradients and distance), after processing, in a format understandable and reusable (electronic data) for PRASA.
 - c) Demonstrating that the process has been properly applied, ensuring that the final gradient, curve and distance data are compliant with the SIL4 requirement.
- 5.3.18 The Bidder shall deliver each “Measurement Campaign Report” document within one month after the execution of the corresponding measurement campaign.

5.4 ETCS Level 2 Data Preparation

- 5.4.1 All ETCS Level 2 data preparation shall be done locally.
- 5.4.2 The ETCS Level 2 data generation (RBC data, balise data and LEU data if any) shall be automated (ETCS Level 2 data generation Tool) to:
- a) Avoid systematic human error.
 - b) Achieve quick data generation.
- 5.4.3 The ETCS Level 2 data generation Tool shall be customized to suit PRASA (context, Track layout, Lineside Signalling principles, operation of the Network; etc) and the programming rules resulting from the ETCS Level 2 conceptual detailed Design for the implementation on the PRASA Network.

- 5.4.4 The ETCS Level 2 automated data generation process shall use as input:
- a) The specific Signalling and Track layouts to be encoded in the Tool.
 - b) The results of the measurement campaign (distances, curves and gradients) to be imported, with an automated process, in the Tool.
- 5.4.5 The Bidder shall ensure a correct mapping between the encoded Signalling and Track layout and the measurement campaign data.
- 5.4.6 The Bidder shall submit to PRASA for acceptance a description of the content of a typical RBC data file highlighting with accurate and detailed information how far the data must be processed during the data preparation and shall clearly indicate:
- a) Which ETCS Level 2 packets must be built during the data preparation.
 - b) Which ETCS Level 2 packets must not, because they are built in real time by the RBC in operation.
- 5.4.7 The Bidder shall, as part of the Bid and in the Project Programme plan indicate an estimation of the necessary duration to get a validated ETCS Level 2 data generation Tool, ready to be used in the frame of the project.
- 5.4.8 For all the packets/messages that need to be built during the data preparation (in other words, all the packets that are not built in real time by the RBC), the Bidder shall submit a document, to PRASA for acceptance, identifying and indicating:
- a) All packets/messages that shall completely automatically generated by the ETCS Level 2 data generation Tool.
 - b) All packets/messages that shall be partially automatically generated ETCS Level 2 data generation Tool.
 - c) All packets/messages that shall be built manually.
- 5.4.9 The Bidder shall not start the Data Engineering Section if all the necessary Track data (distances, curves and gradients) has not been collected through a measurement campaign.
- 5.4.10 The Bidder shall fully apply the Engineering Production Processes to produce the verified data files for RBC, balises and LEU, if any, with the required level of quality.
- 5.4.11 The Bidder shall generate all the KMAC keys for and allocate them to the new PRASA trains to be delivered.
- 5.4.12 The Bidder shall be responsible for sending the Key Message Authentication Code ("KMAC") keys to be loaded in the new PRASA trains.
- 5.4.13 The KDC to liaise with shall be communicated to the Bidder during the contract execution.
- 5.4.14 In the frame of the data preparation, the Bidder shall load each RBC with all the KMAC keys associated to all the new PRASA trains technically able to run on the area covered by the concerned RBC (i.e. the train is compatible with the Overhead Traction Equipment [3 kV DC or 25 kV AC]).

- 5.4.15 At the end of the Data Engineering Section, the Bidder shall produce a “Sectional Data Engineering Report” document that shall be submitted to PRASA for acceptance.
- 5.4.16 Each Sectional Data Engineering Report shall demonstrate that the processes of production and of verification for all the produced data files have been fully and correctly applied. The staff involved for each operation shall be recorded as well as the references of the Design environment (Tools versions, etc...).

6 CONSTRUCTION

6.1 General

- 6.1.1 ETCS Level 2 Construction work shall comply with all relevant Standards, Specifications, Regulations and Procedures as specified throughout the RFP.
- 6.1.2 Construction work shall only be performed by PRASA approved companies.
- 6.1.3 The Bidder shall submit method statements for all ETCS Level 2 Construction work to be performed to PRASA for review and approval, before commencement of the work.
- 6.1.4 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.
- 6.1.5 The Bidder shall submit at least the following additional documentation to PRASA for acceptance, before commencement of the work:
- a) Specific Test Specifications for the ETCS trackside static SAT
 - b) Interoperability Constituents Certificates
 - c) Products description
 - d) Products installation directives
- 6.1.6 All Construction work on or near the railway line shall be performed under Occupation-between-trains ("OBT") or Total Occupation conditions.
- 6.1.7 The Bidder to perform all the Construction work, except if expressly stated otherwise in the GTRs or PTRs.
- 6.1.8 The outdoor Installation shall cover all ETCS Level 2 Works and enabling Signal, Civil, Electrical, telecommunications and other Works.
- 6.1.9 Each LRU being installed shall be provided with its "functional identification" as per the ETCS Level 2 URS.
- 6.1.10 The Bidder shall record any Installation and verification of Installation and attach it to the "ETCS Level 2 trackside static SAT" report (also called "Installation Report") to be produced after the Installation.
- 6.1.11 The Bidder shall where possible install the RBC, RBC terminals and LEUs in the Signalling Equipment rooms.
- 6.1.12 The Bidder shall Design, Supply and construct any additional Equipment rooms required to install the RBC and RBC terminals, should it not be possible to install in the signal Equipment rooms.
- 6.1.13 The Bidder shall install the ETCS Level 2 Maintenance server in the PRASA Centralized Traffic Center ("CTCC") Signal Equipment Room.
- 6.1.14 The location for the PRASA KMC shall be discussed with and agreed by PRASA.
- 6.1.15 Equipment shall be positioned and installed to ensure enough space for the Maintenance staff:

- a) To do all the Maintenance activities in excellent work conditions.
 - b) To move easily in the Equipment room without risking incidents because of accidental contact with the Equipment.
- 6.1.16 Equipment shall only require front and back access (no side access).
- 6.1.17 Equipment requiring back access shall not be positioned against a wall or obstruction.
- 6.1.18 The Bidder shall install the cables required for the ETCS Level 2 Equipment in an equivalent manner to conform to the Installation standards for Electrical cabling for the PRASA Signalling Equipment.
- 6.1.19 The Bidder shall use separated cable paths for higher (power Supply) and lower current (data) services.
- 6.1.20 The Bidder shall:
- a) Install all Equipment according to approved Room Plans.
 - b) Provide and lay all cables according to the approved Cable Plans.
 - c) Produce as-built plans that shall be attached to the “ETCS Level 2 trackside static SAT” report (also called “Installation Report”).

7 TESTING AND COMMISSIONING

7.1 General

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

7.2 Factory Acceptance Testing (“FAT”)

- 7.2.1 All relevant ETCS Level 2 Systems, sub-Systems and Equipment shall undergo and pass FAT before shipping to site.
- 7.2.2 The Bidder shall be responsible for all FAT.
- 7.2.3 All FAT shall be conducted at factory(s) at which the Plant and Materials are manufactured and assembled and 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 FAT.
- 7.2.4 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.
- 7.2.5 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.
- 7.2.6 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.
- 7.2.7 The Bidder shall submit all duly signed FAT Test certificates and associated Test sheet to PRASA for information purposes, prior to Commissioning.
- 7.2.8 PRASA accepts no accountability nor liability for any FAT conducted, despite any checks done or inputs given by any of PRASA's agents.

7.3 Site Acceptance Testing (“SAT”)

- 7.3.1 All relevant ETCS Level 2 Systems, sub-Systems and Equipment shall undergo and pass SAT before Commissioning.
- 7.3.2 The Bidder shall be responsible for SAT.
- 7.3.3 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.
- 7.3.4 The person(s) responsible for the SAT shall not have been involved in any Design, FAT or Installation activities relating to the System, sub-System or Equipment to be tested.
- 7.3.5 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.
- 7.3.6 Where practical, all SAT shall be done under OBT conditions, prior to the final Testing and Commissioning Occupation.
- 7.3.7 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.
- 7.3.8 The Bidder shall submit all duly signed SAT Test certificates and associated Test sheet to PRASA for information purposes, prior to Commissioning.
- 7.3.9 The PRASA accepts no accountability nor liability for any SAT conducted, despite any checks done or inputs given by any of PRASA's agents.

7.4 Final Testing and Commissioning

- 7.4.1 Final Testing and Commissioning shall be done by a PRASA approved Test and Commissioning Engineer (“Tester in Charge”) provided by the Bidder.
- 7.4.2 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.
- 7.4.3 The Bidder shall submit a comprehensive Final Testing and Commissioning Method Statement to PRASA for approval before any Commissioning commence.

- 7.4.4 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.
- 7.4.5 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.

8 MAINTENANCE

8.1 Overview

- 8.1.1 The Bidder shall Design the ETCS Level 2 in such a manner to minimize Maintenance requirements and ensure overall maintainability.
- 8.1.2 The Bidder shall develop a Maintenance strategy for the ETCS Level 2 System.
- 8.1.3 Any ETCS Level 2 failure shall be self-announcing and shall lead to a predetermined safe state.
- 8.1.4 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.
- 8.1.5 It shall be possible to mend ETCS Level 2 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 Component failure due to corrosion