CENTRAL RAILWAY PROJECT

Appendix M – Sign alling System and Centralized Traffic Control System

November 2017

INDEX

Abbreviations

ATP	Automatic Train Control System
CBI	Computer Based Interlocking
CdF	Certificate of Completion (Certificado de Finalización)
CFP	Certificate of Interim Completion (Certificado de Finalización Provisoria)
CPFP	Interim Certificate for Partial Completion (Certificado Provisorio de Finalización Parcial)
CTC	Centralized Traffic Control System
EMC	Electromagnetic Compatibility
ERF	Operation Requirement Specification (Especificación de Requerimientos de Funcionamiento)
ERS	System and Subsystem Requirement Specification (Especificación de Requerimientos de Sistemas y Subsistemas)
ERSS	System Safety Requirement Specification (Especificación de Requerimientos de Sistemas de Seguridad)
ETCS	European Train Control System
FPP	Partial Provisional Completion (Finalización Parcial Provisoria)
HABD	Hot Axle Box Detector
HMI	Human Machine Interface
ISA	Independent Safety Advisor
NoBo	Notified Body
OTN	Optical Transport Network
PND	Defects Notification Period (Período de Notificación de Defectos)
RAMS	Reliability, Availability, Maintainability and Safety
S&D	Service and Diagnostic
SdP	Proposal Request (Solicitud de Propuesta)
SIL	Safety Integrity Level

1 GENERAL REQUIREMENTS

1.1 Standards and Specifications

1.1.1 General Standards

The Central Railway Project shall be implemented in accordance with the latest edition in force at the date of the application of the following general standards (and amendments):

	International Union of Railways
CEN	Centre European de Normalisation
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
CENELEC	Comité Européen de Normalisation Electrotechnique
DIN	Deutsche Industrie Normen

Table 1: General Standards

In the event that the above mentioned standards are less restrictive than the Technical Specifications included in Appendix B, the Technical Specifications shall prevail. For the purpose of solving specific situations, the Infrastructure Manager can apply other internationally acknowledged standards

1.1.2 Technical Standards

The relevant technical standards that apply in this project are listed in Appendix B - Technical Specifications. Standards of a System Supplier shall be accepted only if such standards are equal to or higher than those set out in Appendix B - Technical Specifications.

1.2 Signalling System Upgrade

The signalling and telecommunication systems shall comply with speed limits and requirements for each section of the Railway, and shall be upgraded for future track infrastructure modifications, allowing for the highest line speeds required.

1.3 Reliability, Availability, Maintainability and Safety (RAMS)

The System Supplier shall carry out the Railway Project in accordance with the Reliability, Availability, Maintainability, Safety (RAMS) specifications as defined in EN 50126. The Railway Contractor shall be responsible for the execution of all RAMS tasks.

In its Tender, the Railway Contractor shall present the values of all RAMS parameters of every system and subsystem to be used as specified in EN 50126. Such RAMS parameters shall comply with the goals for train services set out in Appendix B - Technical Specifications, of the Railway Project. The Infrastructure Manager shall appoint an External Auditor to review and verify the RAMS parameters and their compliance with these Railway Specifications. If the External Auditor does not validate the values of the RAMS parameters, these values shall be revised to the satisfaction of the Infrastructure Manager.

The entire Signalling System and all signalling subsystems shall be based on fail-safe principles. The Signalling System shall not fail in hazardous situations, and irregular inputs or situations shall not affect the fail-safe operation of the Signalling System. The Safety Integrity Levels (SIL) of the system (according to EN 50129) are set out in Appendix B - Technical Specifications.

1.4 Safety Validation and Verification

All subsystems shall be designed, developed, tested and approved/commissioned according to CENELEC/ISO/IEC railway standards. The System Supplier shall provide satisfaction, validation, and verification references of previous successful customer projects, as assessed by accredited organizations.

The supplier of the system for the Railway Contractor shall list the project references where this same subsystems were implemented, and provide specific information for each one respect to the country or countries of implementation, time in service, system availability, drawings, standards applied and hazard rates.

The approval process for the Signalling System shall be a mutually recognized standardized procedure, which shall be based on either CENELEC or a globally (ISO/IEC) accepted approval process.

As a minimum, the following shall be provided for approval before start of service by the System Supplier to the Railway Contractor:

- An assessed and approved safety case from a System Supplier, which shall be inspected by an IEC/ISO 17020:2012 accredited Independent Safety Advisor organization; and
- A close-out report, detailing hazards and ensuring that all functional and safety requirements of the Railway Project were met.

1.5 Environmental Conditions

The System Supplier shall be requested to select adequate device protection levels for all the system components according to EN 60529, meeting the environmental conditions of Uruguay —e.g. heavy rain and thunderstorms.

All materials and equipment shall be suitable for operation under the following environmental conditions:

- Climate: humid subtropical
- Temperature:
    - Indoor: 0°C to +55°C
    - Outdoor: -10°C to +70°C
- Relative humidity: 95 %.

If required, the Railway Contractor shall place a temperature control system in the building where the system equipment is located.

1.6 Electromagnetic Compatibility (EMC)

All systems installed shall be adequately protected against any known and potential electromagnetic interference. Accurate measures shall protect persons as well as all equipment and facilities requiring protection.

Critical indoor equipment (e.g. racks for CBI, etc.) could be installed with or without grounding connection, according to manufacturer's recommendations. This indoor signalling equipment shall be installed in a separate room, with or without grounding connection and elevated floors (false floor). All of the non-grounded equipment shall be monitored by an insulation level monitor.

All non-critical indoor equipment (e.g. power supply, telecommunications, etc.) shall be grounded.

In the grounding system design, all systems to be installed as well as all affected existing systems shall be taken into consideration. The System Supplier shall be responsible for an adequate grounding system for all equipment required to be grounded.

All systems installed shall be protected against lightning. The lightning protection system shall be a common system comprising all new signalling and telecommunications installations as well as all affected existing systems; likewise, it shall have one common grounding point.

All systems installed and designed shall comply with the requirements stated in the Reglamento de Baja Tensión of UTE (Administración Nacional de Usinas y Transmisiones Eléctricas).

1.7 Power Supply

The electricity demands of the Railway Project include power needed for point machines, signalling systems and sidings' lighting. Given the possibility of power outages, the Signaling System and the Centralized Traffic Control systems shall be equipped with an alternative power source such as batteries, an Uninterruptible Power Supply (UPS) system or diesel generators according to Appendix B - Technical Specifications.

For maintenance purposes, all the controlled switching points shall have artificial lighting in accordance with Appendix B - Technical Specifications.

2 SCOPE OF SIGNALLING WORK

2.1 General

The Railway Contractor shall design, supply, procure, install, test and hand over the required Signalling System. The scope of signalling work shall include all works needed to create a functional, safe and high availability level Railway.

After the Certificate of Completion (CdF) is issued, the Railway Contractor shall provide maintenance services in accordance with Appendix C (Maintenance Standards).

The Central Railway Project includes the provision of:

- a new interlocking system for control of the stations and automated block sections along the track span covered by the Project (Montevideo-Paso de los Toros);
- an Automatic Train Control System (ATP) (ETCS Level 1 at least) along the track span covered by the Project
- a new and upgraded Automatic Level Crossing protection system;
- a Hot Axle Box Detection (HABD) system;
- equipment for upgrade or replacement and extension of the existing telecommunications system required for operation of the Railway including;
    - a monitoring system for remote installations (CBI, Level crossings, etc.); and
    - a new data transmission system;
- the necessary redundant power supply stations needed to have reliable power for the new Signalling System and subsystems, and
    - connection of the mains supply from the UTE power grid;
    - remotely controlled UPSs (Power SCADA); and
    - stand-by diesel generators for backup power supply (only applicable in rural areas);
- cables for signalling, telecommunication and power supply installations, including cable ducts, pipes and crossings;
- related civil works, including but not limited to;
    - room overhaul, including temperature control systems or design of CTC and local control rooms;
    - installation of new containers;
    - erecting a fence wall or other protection system;
    - grounding of technical installations;
    - modification of level crossings;
    - installation of cable ducts, pipes and manholes;
    - laying of foundations for signal devices and booths, and of other technical installations;

- all relevant documentation (including design documents, operation, maintenance manuals, and SIL certificates of comprehensive safety levels);
- permits and authorizations issued by UTE and other regulatory authorities;
- tools and spare parts needed for all installations;
- a maintenance contract for full maintenance services and power supply, including the provision of spare parts.

The System Supplier shall provide all systems in accordance with Appendix B (Technical Specifications) and the Scope of the Railway Project specifications, and all related documents. When required, and in accordance with local regulations, the project or technical documents shall be provided to the relevant local authority for review.

The Railway Contractor shall issue a compliance statement confirming that the proposed system meets all the signalling requirements as defined in the tender documents.

The Railway Contractor is advised to visit the site of the Railway Project to undertake a detailed survey and collect any information that may be missing in the tender documentation. The Infrastructure Manager shall offer assistance to facilitate the visit to the site. Missing information in Railway Contractors' proposal does not exempt Contractor from its obligation concerning the detailed requirements.

(Optional) The Railway Contractor may have the option to propose an Automatic Train Control System (ATP) ETCS Level 2 without trackside signals, for the signaling system within the metropolitan area (Montevideo – Progreso), providing a detailed design and amendments to costs required by said proposal.

2.2 Central Railway Project Implementation and Timetable

The Railway Contractor shall submit a Project Implementation Plan including a project organization chart and a timetable for the signalling works.

The project organization chart shall indicate all roles and responsibilities required for the execution of the Railway Project. This shall include the entity who will undertake each respective role (e.g. nominated experts, subcontractors, etc.) and the intended locations where work shall be carried out (e.g. on site, in Uruguay, contractors' manufacture site, etc.).

Together with the Project Implementation Plan, Railway Contractor shall submit a timetable indicating how the signalling aspects of the Railway Project will be met, reflecting all time periods, critical dates and milestones including:

- the start-up phase of the Railway Project;
- the design phase;
- engineering and manufacturing;
- Factory Acceptance Tests (FAT);
- site preparation and related civil works;
- supply and installation of signalling, telecommunications and power supply equipment;
- system validation (time for approval of the new Signalling System in Uruguay);
- testing, commissioning and system acceptance (including installation tests, operation tests, integration tests, safety verification, safety qualification, and the migration process between new and existing systems) and Railway Project Completion;
- maintenance;
- trainning programs.

The detailed project timetable shall indicate, per subsection, the applicable time period and critical dates, and the total time period for the Railway Project. The timetable shall be updated regularly and submitted jointly with the monthly progress report, or at any other time if requested by the Infrastructure Manager during the implementation of the Railway Project. It will begin on the date the Railway Contract is signed up to the date on which the CdF is issued.

2.3 Design

The Railway Contractor shall provide a full design of all the signalling aspects of the Railway Project (i.e. the "Design"). Such design shall be prepared based on the pre-engineering documentation: Scope of the Railway Project and its Appendices A to O.

The Design shall include: (i) a detailed Design, and (ii) 'As built' documentation.

2.3.1 **Detailed Design**

The System Supplier shall carry out the detailed design of the system and all related subsystems.

The detailed design shall be based on the Functional Requirements Specification (ERF), the System and Subsystem Requirement Specification (ERS), and the Safety System Requirement Specification (ERSS).

The System Supplier shall deliver and justify the ERF, ERS, and ERSS. The deliveries shall be accepted in mutual agreement by the Infrastructure Manager, the Railway Contractor and the System Supplier.

The detailed design shall provide sufficient details of each subsystem including installation diagrams and drawings.

The detailed design documentation shall be subject to review by the Infrastructure Manager and shall include the following:

- a detailed description of signalling, telecommunications, power and related civil works, including technical definitions and operational interfaces between the different existing and new systems;
- for signalling works:
    - the type, quantities and location of existing equipment and of the installations needed for operation;
    - definitions for substitution of old components for new components if needed;
    - a scaled signalling diagram, including gradients and all the existing and newly designed trackside equipment, with mileage;
    - a detailed table of the signals, with information about each one (e.g. signal type, signal location, plates, indicators, etc.);
    - a detailed table of the signals and trackside equipment removed, which will not be reused in the new system;
    - a detailed table of the sidings, with information about each one and about its point machines;
    - an interlocking chart;
    - a scaled outdoor cable plan;
    - layout of the indoor equipment;
    - diagram of the CTC centre;
    - a detailed table of new equipment to be used for the CTC, with a description of each main component;
    - layout of the CTC operating room and of local control operators;
    - installations for trackside ETCS;
    - hardware configuration;
    - software configuration;
    - operational manuals for CTC and local control workstations;
    - drawings showing the connections to all outdoor equipment.
- for telecommunication works, drawings, calculations and manuals regarding:
    - installation of monitoring systems for remote installations;
    - installation of a new data transmission system;
    - drawings showing the connections to all outdoor equipment.
- calculations for the power supply requirements and drawings for redundant power supply stations ensuring reliable power supply of the new Signalling System, including:
    - required power calculations per load, per track section;
    - power supply from the UTE power grid, if applicable;

    - configuration of the diesel generator set including its installations (tank, controller, etc.), if applicable;
    - UPSs details, including batteries;
    - heating, ventilation and air conditioning systems;
    - wirings;
    - grounding and lightning protection;
    - sidings lighting;
    - drawings and descriptions detailing connections to the UTE power grid;
- related civil works drawings and calculations (i.e. static calculations);
    - overhaul of current rooms for CTC if needed;
    - overhaul of workrooms for local operation;
    - new container or booth for signalling and telecom equipment;
- installation drawings;
- detailed Interface documents with detail description of interfaces between the systems;
- testing sheets;
- maintenance manuals for maintenance staff;
- list of tools, special tools and spare parts;
- any other documents necessary for operation and maintenance;
- construction plans for the entire system and its subsystems.

According to RAMS, the System Supplier shall provide:

- lifecycle cost estimation for each subsystem, showing the average service life of each system/subsystem/component;
- detailed engineering information of the SIL-level allocation and its compliance.

2.4 Factory Acceptance Test (FAT)

At the end of the manufacturing process, a Factory Acceptance Test of the material shall be carried out to check the correct completion of the hardware and software, and to guarantee the quality of the end product. The FAT shall demonstrate and verify that the signalling and telecommunication systems (both hardware and software) meet:

- the general and technical specifications of the system;
- the approved detailed design of the system.

The FAT shall be carried out at the premises of the System Supplier manufacturer.

The System Supplier shall prepare a FAT schedule specifying the type of tests to be performed, the sequence and the expected results. The FAT schedule shall be agreed with the Infrastructure Manager before executing the FAT.

The System Supplier shall send a letter of invitation to the Infrastructure Manager and its consultants sufficiently in advance —in any event at least one (1) month in advance, to witness the FAT.

After successful completion of FAT, a certificate signed by the appropriate inspection body/ies shall be issued.

2.5 Supply and Installation

The packaging, shipment and storage of equipment are recommended to be delivered as responsibility of the System Supplier(s).

Upon receiving the shipment, the Infrastructure Manager (or its consultants) shall undertake an inspection of the materials to approve the delivery. If the materials comply with the prestablished requirements, a certificate signed by the appropriate inspection body/ies shall be issued.

Requirements regarding the installation of the individual subsystems are specified in Appendix B (Technical Specifications) and System Suppliers' installation manuals.

2.6 System Acceptance Test (SAT)

The System Acceptance Test will be carried out by the consultants of the Infrastructure Manager together with the Railway Contractor as part of the system commissioning phase, for each section of the track.

The SAT shall demonstrate and verify that the signalling, telecommunications and power supply systems (both hardware and software) comply with:

- the general and technical specifications of the system;
- the approved detailed design of the system.

The Railway Contractor shall be well prepared for the commissioning of the Railway Project and shall carry out all necessary tests after the installation, as part of the pre-commissioning phase, to demonstrate the system's functionality and safety . All installations shall be fully tested and thoroughly documented; besides, they shall be justified by the Railway Contractor by means of the respective pre-commissioning tests and testing protocols. The tests to be carried out as part of the pre-commissioning and commissioning shall include the tests described below.

After successful completion of the tests, a certificate signed by the appropriate inspection body/ies shall be issued.

2.6.1 **Installation Tests/On-Site Checks**

During the installation of the equipment and interconnecting cables and after this is completed, an installation test/on-site check shall be conducted (at each section of the Railway) to demonstrate and verify that the installation is being/has been carried out according to the installation documentation and to ensure that cables are fault free.

The schedule for the Installation Tests shall be provided by the Railway Contractor before executing the tests and shall be agreed with the Infrastructure Manager.

The Railway Contractor shall invite the Infrastructure Manager and its consultants to witness the tests. This invitation shall be sent at least one (1) month in advance of the tests.

2.6.2 **Operation Tests**

Operation Tests shall be performed (at each section of the track) to demonstrate that the signalling software and hardware, telecommunications and power supply systems comply with both functional and operational requirements. A subset of the FATs and the simultaneous tests performed in-house shall be repeated at each section of the track.

The Operation Tests schedule shall be provided by the Railway Contractor before executing the tests and shall be agreed with the Infrastructure Manager.

The Railway Contractor shall invite the Infrastructure Manager and its consultants to witness the tests. This invitation shall be sent at least one (1) month in advance of the tests.

2.6.3 **System Integration Test (SIT)**

The System Integration Test (SIT) shall be carried out (at each section of the track) in order to verify that all systems' functionality is compatible and that signalling, telecommunications and power supply systems are smoothly integrated; and that the new system, including subsystems, is integrated into the already existing systems (e.g. telecommunications, power supply, etc.).

The Integration Test schedule shall be provided by the Railway Contractor before executing the tests and shall be agreed with the Infrastructure Manager.

The Railway Contractor shall invite the Infrastructure Manager and its consultants to witness the tests. This invitation shall be sent at least one (1) month in advance of the tests.

2.7 Partial Provisional Completion (FPP)

The Partial Provisional Completion Certificate (CFPP) shall be issued after completion of all the tests set out in paragraphs 2.6.1 to 2.6.3 above, and the commissioning. The Partial Provisional Completion process will be carried out according to the Contract provisions.

In the event the Infrastructure Manager and/or its consultants find defects or remarks during the installation, testing or commissioning process, a list of defects to be remedied by the Railway Contractor will be attached to the CFPP.

Any inspection made by a third party organization (ISA/NoBo) shall be duly reported and noted in the CFPP.

2.8 Defects Notification Period (PND) & Provisional Completion (FP)

Within the timeframe of the Defects Notification Period (PND), the Railway Contractor shall repair every defect included in the list of defects.

The DNP shall begin after the FPP and the commissioning of the first section of the Railway, and shall end three (3) months after issuing the Provisional Completion Certificate (CFP) and commissioning the Railway Project.

The Railway Contractor shall be responsible for repairing all defects during the PND. The supply of spare parts and installation works required to repair the defects shall be carried out on account of the Railway Contractor.

When all systems are ready —i.e. when all sections of the Railway are completed and all defects are rectified, and the safety assessment report is issued by the Independent Safety Advisor—, the Infrastructure Manager shall issue the CFO based on ISA/NoBo recommendations.

Should the Railway Contractor fail to repair all defects within the PND, the PND date shall be extended.

2.9 Submission and Review of Documents and Drawings

The Railway Contractor shall submit the documentation (including calculations and drawings) comprising the technical documents specified in chapter 0, documents required to satisfy all approvals, construction documents, and operation and maintenance manuals, to the Infrastructure Manager and third party consultants (ISA/NoBo). The documentation shall be delivered for review according to the timetable for the signalling works, in digital format and in paper copies when requested.

In the event the Infrastructure Manager, ISA, or NoBo require any corrections to the documentation, these shall be carried out by the Railway Contractor within the next 30 calendar days.

The construction drawings and documents as well as the final and approved versions of both operational and maintenance manuals shall be submitted in both Spanish and English language versions.

All information and documentation shall be delivered in open source format; otherwise applications for their use must be provided.

2.9.1 **Notified Body (NoBo) Assessment**

A Notified Body shall be an organization appointed to assess conformity with FRS and SRS for certain products or systems before they are put into use. A NoBo carries out tasks which are related to conformity assessment procedures, when a third party is required.

Each NoBo provides assessment services to verify conformity of systems or products, and is free to offer its conformity assessment services to any operator. Each NoBo shall operate in a non-discriminatory, transparent, neutral, independent, and impartial manner, and shall employ the necessary personnel, with sufficient knowledge and experience, to carry out the conformity assessment in accordance with the relevant laws.

The Infrastructure Manager and the Railway Contractor shall jointly choose a NoBo that has been accredited according to the IEC/ISO 17020:2012 standard to carry out the conformity assessment procedure.

2.9.2 **Independent Safety Assessment**

The Independent Safety Assessment consists of the evaluation of the risk management process described in the EN 50126 standard. The Independent Safety Advisor (ISA) must issue a Safety Assessment Report. The report references and the ISA conclusions shall be reported in the Safety Case itself.

The consultant's output about each life cycle phase shall be provided as a documented feedback or a report that shall be distributed to the relevant parties described herein. Additionally, the consultant may generate and deliver examination reports during certain phases covering activities, document structures and analysis.

The Infrastructure Manager and the Railway Contractor shall jointly choose an ISA that has been accredited according to the IEC/ISO 17020:2012 standard to carry out the safety assessment procedure.

Every safety related document shall be assessed by the ISA, to ensure that:

- A risk management process has been followed by the System Supplier;
- All relevant information about the safety system has been assessed in the Safety Assessment Report by the ISA.

The ISA shall make a decision as to the system safety based on documented justifications and safety qualification tests. The ISA shall report all findings to the Railway Contractor and the Infrastructure Manager.

2.10 Trial Runs

Trial runs shall begin after completing the SAT on the full length of the track, and after the Infrastructure Manager has issued the CFP. The trial runs can be considered as safety qualification tests according to EN 50126.

The trial run schedule shall be provided by the Railway Contractor before executing the tests and shall be agreed with the Infrastructure Manager.

The trial runs shall be performed with a locomotive running on all routes, on all the interlockings of the track, and shall be agreed with the Infrastructure Manager.

2.11 Certificate of Completion (CdF)

The Infrastructure Manager shall issue the CdF after the successful trial runs have been completed and all defects recorded during the commissioning have been remedied; this shall mark the beginning of the Defect Liability Period.

Before issuing the CdF, any deviation or hazard reported in the CFPP by ISA or NoBo shall be solved or resolved by the Railway Contractor.

2.12 Training

2.12.1 **General**

The Railway Contractor shall carry out training for the personnel of the Infrastructure Manager with respect to system operation and maintenance of the works.

The Railway Contractor shall provide all necessary tools, equipment and documentation required to carry out the training.

Training courses shall be carried out for experienced personnel of the Infrastructure Manager as well as for new staff/young professionals, as follows:

- System Management (for engineers and technicians);
- System Operation (for dispatchers, signalmen, and others);
- System Maintenance (for engineers and technicians).

Training courses shall be repeated at least every two (2) years for both current and new personnel. Therefore, the Railway Contractor shall include in its training program a quality management system to ensure that the system knowledge displayed by the Infrastructure Manager staff maintains the level required for the safe and reliable operation of the Railway.

The training courses and instructions to be offered shall have enough scale, content and scope so as to enable the trainees to operate and maintain the new signalling and telecommunications system as well as to adapt the system to future extensions and changes.

The Railway Contractor shall develop a program for such proposed training. This program shall include the course title, the maximum and minimum numbers of trainees on each course, scope, duration, proposed location, syllabus, minimum qualification level for students, and their targeted abilities following successful completion of the training course. The number of participants/trainees attending shall be agreed between the Infrastructure Manager and the Railway Contractor.

In addition to the initial training program to be offered, the Railway Contractor shall offer repetitions of any training course, as per demand of the Infrastructure Manager.

All trainees shall be tested and certified by the Contractor to ensure their high education level. The Railway Contractor’s testing and certification procedure shall be prepared in close cooperation with, and finally approved by, the Infrastructure Manager.

The detailed training program shall be submitted to the Infrastructure Manager in its design phase for review.

The initial training program for the management, operation and maintenance of the new system must be attended and successfully completed by all employees in the areas of system operation, maintenance and management, before the start of the Signalling System commissioning phase.

2.12.2 **Training Tools and Equipment**

The training facilities shall include operator training workplaces with simulators, which shall provide full functionality for training regarding the operation of the new system, and allow for real time simulations as well as their recording and playing. The placement of the training centre shall be decided during the construction phase of the Railway Project.

The training workstations —including all tools, equipment and documentation— shall be available at the training centre before the start of the Signalling System commissioning phase.

The training workstations shall be equipped with appropriate software tools for simulation of all future tasks, including error cases. These workstations shall be updated and upgraded by the Railway Contractor as needed during the contract period.

2.12.3 **Management Training**

Management level courses are also needed .These are for managers to be capable of (i) creating and maintaining new and efficiently organized signalling, telecommunications and power supply systems; and (ii) defining the required organizational changes, and the necessary changes to rules and procedures in advance. Management training shall include handling of the system services, which include:

- Timetable planning;
- automatic and manual route configuration;
- Event record system;
- relevant archive;
- HABD monitoring.

Management training courses shall be provided to management officers of the Infrastructure Manager (President; Vice President; Heads of the signalling, operations, maintenance departments, and others), and to the Railway Contractor's maintenance officers. The management training courses must be completed before beginning the Signalling System installation phase in order to allow trained managers to internally set up the required rules, procedures and structures on time.

The management training courses shall be available for approximately 10 persons; some parts of the courses can be performed off-shore, in the home country of the System Supplier. The training courses and any related training documents shall be provided in Spanish language and made available before the start of the Signalling System installation phase.

2.12.4 **System Operation Training**

System operation training shall qualify all dispatchers and operators so that they can handle the new signalling, telecommunications and power supply systems under both regular and failure conditions. This training shall include, but not be limited, to;

- Introduction of the new system, including:
    - outdoor installations;
    - indoor installations;
    - system architecture;
    - operator interface for the workstations;
    - local particularities (special locations for signals, usable track length, etc);
- comparison to the existing system;
- general arrangement and handling of the interlocking system;
- commands and indications for the new system;
- operation of the interlocking system in normal conditions, including:
    - manual operation;
    - automatic operation (automatic route configuration);
    - setting of train routes (and shunting);
    - individual setting/cancellation of route elements;
- regular operational procedures;
- operation of the interlocking system in failure conditions, including:
    - manual operation;
    - automatic operation; and
    - auxiliary operation;
- training for the handling of specific failure cases, including but not limited to signal failure, switching point devices, track vacancy detection and block failure;
- training for the handling of failures and system breakdown related to specific signalling, telecommunications or power supply;
- blocking of track at the station and blocking of tracks;
- auxiliary operational procedures;

- CTC/local control;
- various failure scenarios;
- simulator training for regular and auxiliary operation;
- training for operation during installation, test and commissioning of the new system (handling of track takeover in auxiliary conditions);
- preparation for inspection;
- preparation for examination;
- test and certification
- updating and advance training courses.

2.12.5 **Training for the Maintenance Team**

Training for maintenance team (engineers and technicians) shall be offered for each individual signalling, telecommunications and power supply subsystem provided for herein, before starting the installation of the Signalling System. Some personnel shall receive more intensive training in order to become future trainers. Maintenance training courses and the related documents shall be completed before the start of the installation phase of the Signalling System.

The maintenance training courses and related training documents and elements shall be provided in Spanish.

2.13 Maintenance

The scope and applicable standards for the maintenance of the Signalling System are described in detail in Appendix C (Maintenance Standards). Maintenance shall include all work that is needed to create a functional and safe Railway.

2.14 Operational Approval

The Infrastructure Manager will certify operational approval and issue the Operational Approval Certificate (CAO) for the facilities (including the Signalling System) after completion of each of the following:

- works on site;
- construction documentation;
- training of the Infrastructure Manager’s management and operation staff, and of the Railway Contractor’s maintenance staff;
- implementation of an on-site maintenance system —qualified staff included— to provide operation, support and maintenance services, and equipment, tools, documentation, and spare parts;
- successful pre-commissioning testing, documented by the respective Functional Test Certificates, Integration Test Certificates and CFPP;
- provisional approval after completion of all points and sections of the track, and completion of the safety assessments documented in the respective CFP;
- successful trial runs performed on the track;
- DNP and presentation of a final Defects Notification Period Report;
- project structural and functional completion certified with the CdF issued by the Infrastructure Manager;
- any complaints from the Infrastructure manager corrected;
- every remaining commissioning punchlist item successfully completed.

3 OPERATION SPECIFICATIONS

3.1 Infrastructure

For the purpose of increasing safety and performance of the railway operation on the Railway line between Montevideo and Paso de los Toros, a new Computer Based Interlocking (CBI) system will be installed. This new Signalling System will need new telecommunication and power supply installations.

3.2 Rules of Operation

Operation rules shall reflect the actual technologies to be found on the Railway, accompanied by specific demands for employees with respect to observance of safety rules in their daily work, either for shunting and/or line operation.

As the Railway shall be equipped with a new Signalling System, the Operation Rule Book shall be updated accordingly.

3.2.1 **Dispatching and Control**

The Dispatch and Control unit oversees railway operation. As traffic increases, it is critical to have a monitoring system in place to ensure proper and safe operational management.

The new Centralized Traffic Control (CTC) center shall include remote control and monitoring of the traffic, train operation, interlocking and other systems in operation on the Railway.

3.3 Operational Requirements

3.3.1 **Signalling System including Automatic Train Control (ATP) system**

The entire Signalling System and all signalling subsystems shall be based on fail-safe principles. There will be no failures in the system, and irregular inputs shall not affect the fail-safe operation of the system.

Generally speaking, the new Signalling System shall be fit for extensions or modifications for future infrastructure changes, including:

- installation of additional stations and sidings;
- future redesign and extension of stations and sidings;
- installation of new double-track sections;
- increase of the maximum speed allowed;
- extension of the ATP system operation to the entire railway network;
- adaptation to existing connecting lines, with or without signalling systems.

3.3.2 **Centralized Traffic Control - Montevideo**

The operation and control of the entire Railway, including connections to main lines, shall be fully integrated into the new CTC.

The proposed system shall be flexible enough to allow future improvements or expansions of the CTC.

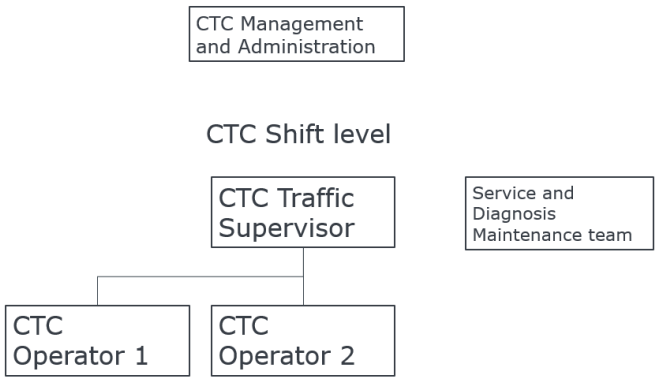

Diagram 1: Proposed CTC Organization

The proposed CTC control areas for each operator are as follows:

- CTC Operator 1 for Montevideo – 25 Agosto section, train and shunting operations;
- CTC Operator 2 for 25 Agosto – Paso de los Toros, train operations.

Allocation of control areas can be changed according to operational and regulatory needs, and shall be determined together with the Traffic Control Authority.

3.3.3 **CTC Operator**

CTC operators are responsible for safe and punctual train movements, and for setting train routes required in due time, by using the remote control functionalities in the installed workstations.

3.3.4 **CTC Traffic Supervisor**

The traffic on the entire network is monitored by a separate traffic supervisor. The traffic supervisor shall have all the relevant data for traffic dispatch available at his workplace by means of the installation of various information and communication systems including, but not limited to:

- timetable planning and monitoring system;
- fixed telephone line and train radio;
- level crossing monitoring system;
- Hot Axle Box Detector (HABD) monitoring system.

The CTC traffic supervisor acts as the shift leader for all operators at the Centralized Traffic Control.

3.3.5 **Local CBI control**

In the event of any failure in the CTC, auxiliary operator workplaces are installed on site. The Local Operators can take over traffic control from the CTC for the setting of train routes.

Efficient procedures shall be defined in the Operational Rule Handbook to handle traffic after a system failure.

The locations of the Local CBI control work places shall be specified in the detailed design.

3.3.6 **System Maintenance Service and Diagnostics**

A Service and Diagnostic workplace shall be located at the Centralized Traffic Control, for servicing and diagnosing the Railway system.

Workstations are installed for service and diagnostic activities covering several systems.

The Service and Diagnostic workstations shall handle the following, which includes but is not limited to:

- timetable planning;
- data backup;
- event record system;
- automatic route setting/automatic train numbering;
- service and diagnostic for the interlocking system;
- Hot Axle Box Detector (HABD).

Service and Diagnostic workstations shall be installed at all the signal cabins with interlocking stations in the Railway line, for maintenance purposes.

3.3.7 **Workstations for CBI Management**

CBI terminals shall be available for the organizational management purposes of operators. These terminals show the current state of the system and traffic, but do not provide commands for system control.

3.3.8 **Block System**

Any block system applied shall prevent any train from moving into track sections already occupied by a railway vehicle. The usage of a track in one direction will be blocked by the interlocking system for oncoming trains until the technical installations have confirmed that the line is clear to proceed.

Should a malfunction of a block system occur, there shall be a reset function accessible to both the CTC operator and the local operator (in case of local control operation) once they have ensured that there are no railway vehicles on the line. This procedure is stated in the Operational Rule Handbook. Any reset entries will be recorded in the event recording system.

According to the operational rules, after a reset, the next train entering the track section shall be authorized only by means of a written order, and under staff-responsible mode.

According to the operational rules, after a reset, the next train entering the track section shall be authorized only by means of a written order, and under staff-responsible mode.

Any alarm shall be displayed on all relevant terminals, and the operator response to the relevant alarm shall be recorded in the system.

A block system shall always be setup between two adjacent interlocking stations.

The block functionality shall be integrated in the new CBI system.

3.3.9 **Division of Block Sections**

Track sections between two adjacent stations longer than 20 km apart shall be equipped with an extra block section.

3.3.10 **Automatic Train Protection**

The Railway shall be equipped with an ETCS Level 1 (or higher) automatic train control system.

The train driver shall follow cab signalling instructions and information to move the train safely As the ATP system permanently supervises the maximum speed allowed, the driver cannot exceed this maximum speed or overlook a danger signal under normal operating conditions.

In the event of a failure in the Signalling System affecting the functionality of the cab signalling system, operation on reduced performance (staff responsible mode) will be made possible. Trains shall stop at each signal and report to the CTC. This procedure shall be described in the Operational Rule Handbook.

3.3.11 **Cab Signalling**

The ETCS on-board equipment together with the Driver Machine Interface (DMI) shall be used for cab signalling. The DMI provides general and safe information to the train driver.

Cab signalling shall provide support to drivers with, at least, the following information:

- stop;
- proceed;
- speed limit;
- target speed;
- target distance.

The cab-signalling system and related procedures are described in full in the Operational Rule Handbook, which also identifies duties for the staff involved.

The ATP system will supervise the maximum speed allowed at any time and place on the new railway. Necessary fixed data information points shall be installed in sufficient number and location providing suitable braking curves and restricted speed limits for the driver, and automatic brake control in due time. Due to temporary speed restrictions, additional information points and marked boards will be placed in the track as needed.

3.3.12 **Braking Curves**

The braking curve parameters shall be defined during the detailed design. These braking curve parameters depend on the rolling stock to be equipped with the on-board ETCS system.

3.3.13 **ETCS National Values (NV)**

The ETCS national values to be used shall be defined during the detailed design.

3.3.14 **Wayside Signals**

New stationary signals using color light signals shall be installed when needed. These light signals can be main, warning or level crossing signals. These signals shall be used as backup in case of cab signalling failure or for locomotives with no on-board equipment.

The warning signal information shall be transmitted to the maximum braking distance for the train fleet, as detailed in Appendix B (Technical Specifications).

All trackside and road light signals shall be implemented with LED technology. The light emitted by the LED light signals shall conform to DIN6163.

All signal aspects are defined in the Operational Rule Handbook.

3.3.15 **Point operation (switches)**

All switching points in the tracks used by the trains shall be operated and equipped with end-position detectors to ensure that the switch blades for track change are fully applied before a train can be allowed to pass the point.

3.3.16 **Control of point position**

The equipment will ensure that a switching point signal in normal position will be displayed only if the blades are fully applied. Points closed halfway or any other fault in the switching point will be immediately displayed at the relevant workstation.

3.3.17 **Individual operation of points**

Any unlocked and not occupied switching point can be individually operated. It will also be possible to reverse the point operation while the blades are changing position.

3.3.18 **Trailability of Points**

All swithcing points with point machines shall be trailable. After trailing a point, an immediate inspection of the mechanical parts of the point is needed, before any railway vehicle can pass the point.

After an inspection by the maintenance or train crew, the trailability indicator can be reset at the workstation; this event will be recorded on the event recording system. If, for any reason, an indicator reset is not possible, a technical possibility to pass a point will be allowed (auxiliary locking device). This will be recorded in the event recording system as per the procedure in the Operational Rule Handbook.

3.3.19 **Electrical point machines**

In the event of a motor failure, the electricity supply can be cut off to avoid hazards and to move the motor and the barbs by hand crank.

The hand crank will be accessible to staff only, on every station.

3.3.20 **Locking/Unlocking of points**

It will be possible to lock a switching point to prevent undesired operation for whatever reason; an appropriate indicator must be displayed. Unlocking will be possible at any time, but such action will be recorded in the event recording system before becoming effective.

It will be possible to collectively lock/unlock all points in a station; an appropriate indicator must be displayed in this case. The unlocking will be recorded in the event recording system before becoming effective.

Any unlocking (i.e. removal of operational restrictions) shall only be possible by executing a "Special Safety Command", in which the system will force the operator to reconfirm the command executed.

3.3.21 **Automatic Train Numbering and Route Configuration**

To ensure smooth operation of the trains, automatic train route setting of the train routes will be essential. For this purpose, the adaptation to a continuous supervision of the trains as per train numbering shall be required.

The operating system will be able to identify up- and down-trains by their number. Trains running northbound from Montevideo will be numbered with odd numbers (e.g. 1, 3, 5,…), while southbound trains running towards Montevideo will be numbered with even numbers (e.g. 2, 4, 6,…). The train number must be the same in the entire Uruguayan rail network. Train numbers shall consist of four (4) digits, e.g. 1914.

A route direction number will be attached to the train number to identify the required route for the Signalling System.

The theoretical graphs of the train schedules and real information about running trains shall be available to the dispatcher.

3.3.22 **Locking/Unlocking of Tracks**

It shall be possible to lock a track section for any route; an appropriate indication must be displayed. It will be possible to unlock a track section at any time.

Any unlocking (i.e. removal of operational restrictions) shall only be possible by executing a "Special Safety Command", in which the system will force the operator to reconfirm the command executed.

3.3.23 **Level Crossings**

The level crossings' warning time for pedestrians and road traffic, before the rail vehicle arrives at the level crossing, shall be a minimum of 20 seconds without barriers and a minimum of 30 seconds with barriers.

One (1) second shall be added to the warning time for each meter when the distance between the barriers is longer than 10 metres.

The status of the level crossing shall be indicated to the train driver jointly with a level crossing signal.

3.3.24 **Maintenance**

Any maintenance activities shall comply with the instructions and procedures stated in the Operational Rule Handbook. All the activities on the railway need authorization from the CTC operator, or the authority defined by the CTC.

3.3.25 **Train Operation**

For train operation, a train route shall be set and locked including flank protection and overlap, according to the Operational Rule Handbook.

The train route shall remain locked until the train has entered the target area and passed through or stopped at the end of the route, in front of the target signal for the route.

The speed profile of the train movement shall be permanently monitored until the end of the route.

3.3.26 **Shunting Operation**

Shunting activities are allowed inside the stations, shunting yards or at a siding, but are not allowed on an open track span.

Within the interlocking-controlled area in a station, shunting movements shall be applied with permission of the local operation or with shunting routes displaying shunting signals.

All rules and conditions for shunting operations are defined in the Operational Rule Handbook.

3.3.27 **Local Operation Permission**

The area allowed for the local operation permissions shall consist of one or more areas with local operation permission, depending on the size and needs of each individual station.

The CTC operator at the CTC grants the permissions for local operation.

3.3.28 **Key Lock Operation**

Flank protections given to sidings and derailers, not controlled by interlocking, shall be equipped with key locks as indicated in the schematic layouts.

The CTC Operator will grant the permission to operate key locks with the permission of the local operation.

The key lock status shall be indicated to the CTC Operator.

3.3.29 **Line point**

The switching points without electric point machines shall be key-lock operated; these locks shall be supervised in the interlocking system. Line points shall be equipped with switching point blades position indicators supervised in the interlocking system.

3.3.30 **Specially Protected Shunting Areas**

To allow unlimited shunting, designated shunting areas within stations shall be identified and secured by means of interlocked points, derailers and signals.

These track areas are not integrated in the interlocking and are controlled only manually by mechanical devices (turnouts, derailers, etc.).

Connections between interlocking areas and shunting areas shall have flank protection.

This means that the shunting areas will be both secured and technically separated from the main line, to perform as many shunting operations as required without endangering the regular operations in the interlocking area.

3.3.31 **Shunting Limit Boards**

The shunting limit boards inform the train driver where the limits of shunting operations are located. These boards are installed as indicated in the schematic diagrams.

3.3.32 **Traffic Jam Mark**

The signalling system will ensure that a jammed loading gauge blocking the adjacent track will be noticed by the system. This shall initiate the locking of the point to prevent other trains from passing.

3.3.33 **Event Record System**

The interlocking system shall record all actions with a time stamp.

3.3.34 **Radio/Telephone Recordings**

All operating communications (landline or mobile phones) shall be recorded. Records shall be available for at least thirty (30) days; after this period, records shall be kept for at least five (5) years. The searching, filtering and sorting of these recordings shall be easy and convenient. The recording system shall include at least the following functionalities:

- addition/removal of the desired subscriber in the monitored list by means of operation ID, MSISDN, etc., must be done easily and performed though a high-level application;
- the display and call recordings should at least include: caller ID, recipient ID, functional number (if available), duration, reason for call termination, etc., in a standard format and with no need for interpretation;
- no more than one record per call (including group and multiparty calls) is recommended, so as to preserve resources and make searches swift and easy.

Access to the recording system shall be password-protected. The access rights for different staff and function levels shall be configurable and manageable.

The information recorded shall meet the Uruguayan legal framework and shall be open for inspection by the relevant authorities, in accordance with local regulations.

3.3.35 **Operational Rule Handbook**

The Operational Rule Handbook describes the rules, regulations and responsibilities for safe railway operation. The Operational Rule Handbook shall consider the entire Uruguayan Railway Network and shall be approved by the National Direction of Railway Transport.

The Railway Contractor shall prepare and update the Operational Rule Handbook to account for the integration of the new operation system with the existing railway operation. When updating the Operational Rule Handbook, the current Handbook version and local conditions shall be considered.

The content of the Operational Rule Handbook shall include, but not be limited to, the following subjects:

- responsibilities and obligations;
- voice communications;
- train operation, including:
    - train route;
    - individual operation of elements;
    - overlap protection;
    - flank protection;
    - failure situations;
- shunting operations, including:
    - shunting route;
    - local operation permission;
- track maintenance and works;
- communication;
- wayside optical signal aspects, including:
    - main signal aspects, including:
        - stop;
        - proceed with caution, e.g. 40 km/h speed for a point;
        - proceed;
    - warning signal aspects, including:
        - expect stop;
        - expect proceed with caution, e.g. 40 km/h speed for a point;
        - expect proceed;
    - level crossing signal aspects;
        - proceed
    - shunting signal aspects, including:
        - stop;
        - shunting allowed;
        - local permission;
- shape and color of trackside marker boards, including:
    - signal boards for main signals;
    - (temporary) speed restriction -announcement;
    - (temporary) speed restriction - start of speed restriction;
    - (temporary) speed restriction - end of speed restriction;
    - shunting limit boards - to identify stops for shunting movements;
    - traffic jam mark - to secure gauge clearance at the points;
    - approach boards - announcement of impending signal;
    - on-board cab signalling.