Schedule 5(e)

European Train Control System (ETCS)

California High-Speed Rail Authority

Standard Specifications

TSCC Specification

SPEC-0009 – European Train Control System (ETCS)

Rev. 1.0

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0.0	September 2025	First edition
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1 INTRODUCTION

1.1 Scope of the Technical Specification

1.1.1 The scope of this Technical Specification is to define the CHSR Authority's Requirements for the European Railway Train Management System / European Railway Train Control System (ERTMS/ETCS).

1.1.2 This Technical Specification is based on the Authority's Design Criteria Manual (DCM) Chapter 12: Communication Systems and Train Control.

1.1.3 The functional architecture of ETCS alongside other Train Control Systems is presented in Appendix A.

1.1.4 The requirements are formulated in accordance with using the following words and their meanings:

- **"Shall":** Indicates mandatory requirement that must be strictly implemented. Any impossibility to fulfil this requirement must be agreed through a derogation case (see change management procedure).
- **"Should":** Indicates preferred course of action, recommendations. No agreement of derogation is necessary, there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course - for example the same goal is reached by other solutions, which are permissible within the binding standards or documents.
- **"Must":** Indicates an obligation or a mandatory requirement.
- **"May":** Indicates a permissible course of action within the limits of the standards, but which is not mandatory to be fulfilled.

2 REFERENCE STANDARDS AND DOCUMENTS

2.1 General

2.1.1 The TSCC Contractor shall apply the in-force standards, guidelines and specifications provided in this chapter for all stages of the design, test, manufacture, supply, delivery, assembly, installation, testing, commissioning, and training.

2.1.2 All generic standards to be used are provided in: Technical Contract Requirements – Scope of Work.

2.2 Engineering Rules Guidelines

2.2.1 Engineering Rules shall be considered as a guideline that has been used for reference design purpose and can be adjusted by the TSCC Contractor if necessary.

2.2.2 The latest version of the following Engineering Rules shall be applied:

ID	Code	Title
[R1]	19_STS	Signalling Engineering Rules
[R2]	DCM_01	Design Criteria Manual Chapter 1: Overview
[R3]	DCM_12	Design Criteria Manual Chapter 12: Communication Systems and Train Control
[R4]	AREMA_17	AREMA Standards Chapter 17 – High-Speed Rail Systems

TABLE 12 - ENGINEERING RULES

2.3 Technical Specifications for Interoperability

2.3.1 The following TSI and the related Application Guide applies to the Control-Command and Signalling (TCS) subsystems of the rail system in the European Union, including the HSR.

2.3.2 The Guide for the application of the TCS TSI is of voluntary application, as it does not mandate any requirement or specification in addition to those set out in the TCS TSI which instead are an essential part of the definition of the basic parameters and therefore mandatory.

ID	TSI	Title
[R5]	[TCS TSI 2023]	COMMISSION IMPLEMENTING REGULATION (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union and repealing Regulation (EU) 2016/919
[R6]	[TCS TSI AG]	Guide for the application of the TCS TSI. In accordance with Article 19(3) of Regulation (EU) 2016/796 of the European Parliament and of the Council of 11 May 2016

TABLE 13 - LIST OF TSI AND REGULATIONS

2.4 EULYNX

2.4.1 The EULYNX Baseline Set 4 Release 4 shall apply to the Interlocking system of HSR, including its standard common interface with ETCS.

	Standard	Title
[R7]	[EULYNX Baseline Set 4 Release 4]	All documents listed in "EULYNX Documentation plan Eu.Doc.11 v4.1.pdf"

TABLE 14 - EULYNX SET OF SPECIFICATIONS

2.5 European and Other International Standards

2.5.1 The relevant standards to be used for ERTMS/ETCS are listed in the Scope of works document.

2.5.2 The latest in-force standards shall be applied, and if the standard is directly quoted in Annex A of the TCS TSI (list of mandatory standards) the version referenced in the TSI shall always prevail.

2.6 EUG/ERTMS Engineering Guidelines

2.6.1 The following ERTMTS Users Group (EUG) guidelines can be applied to the ERTMS/ETCS of HSR where applicable.

2.6.2 As the current ERTMS guidelines refer to ETCS Baseline 2 and Baseline 3, the TSCC Contractor shall be able to reflect the engineering approach recommended by EUG in the new TCS TSI introducing ETCS Baseline 4.

	Guideline	Title
[R8]	EUG/ERTMS Engineering Guideline #23	Balise Engineering L2 and L3
[R9]	EUG/ERTMS Engineering Guideline #28	Gradients Segmentation
[R10]	EUG/ERTMS Engineering Guideline #66	Transition from SV 1.Y to SV 2.Y L1/2/3 with NTC Fallback
[R11]	EUG/ERTMS Engineering Guideline #67	Level Transition from LNTC to L1 SV2.Y
[R12]	EUG/ERTMS Engineering Guideline #68	Start of Mission B3
[R13]	EUG/ERTMS Engineering Guideline #69	Automatic Track Ahead Free (ATAF) B3
[R14]	EUG/ERTMS Engineering Guideline #70	Transition from L1 to STM
[R15]	EUG/ERTMS Engineering Guideline #71	Transition from L2 to LSTM
[R16]	EUG/ERTMS Engineering Guideline #72	Level Transition from level STM to L1
[R17]	EUG/ERTMS Engineering Guideline #74	RBC-RBC Handover
[R18]	EUG/ERTMS Engineering Guideline #75	Management of Shunting Activities
[R19]	EUG/ERTMS Engineering Guideline #76	Border Crossings
[R20]	EUG/ERTMS Engineering Guideline #77	Level Transition from LNTC to L2
[R21]	EUG/ERTMS Engineering Guideline #78	Level Transition from L2 to LNTC
[R22]	EUG/ERTMS Engineering Guideline #79	Baseline 2 Trackside for Baseline 3 Trains
[R23]	EUG/ERTMS Engineering Guideline #80	Hybrid Train Detection Engineering

	Guideline	Title
[R24]	EUG/ERTMS Engineering Guideline #81	Extension Key Request Function
[R25]	EUG/ERTMS Engineering Guideline #82	B2 to B3 RBC handover – under development
[R26]	EUG/ERTMS Engineering Guideline #83	Lost Connections – under development
[R27]	EUG/ERTMS Engineering Guideline #84	Overall ETCS (Compendium) – under development
[R28]	EUG/ERTMS Guideline 23E064-1A	KMS Guideline

TABLE 15 - LIST OF EUG GUIDELINES

2.7 TSCC Documents

2.7.1 The following documents shall be referred to:

ID	Document	Title
[R29]	Technical Contract Requirements	Scope of Work
[R30]		Wireless Communication System Specification
[R31]		Cybersecurity Technical Specification
[R32]		Hazard Detection and Early Warning System Specification
[R33]		Medium Voltage/Low Voltage Power Supply Technical Specification
[R34]		Network Timing System Technical Specification
[R35]		Digital Communication Network Technical Specification

TABLE 5 – TSCC DOCUMENTS

3 TERMS, DEFINITIONS, AND ABBREVIATIONS

3.1.1 All the terms, definitions, and abbreviations are provided in the Glossary of Terms, Abbreviations and Definitions.

4 SYSTEM DESCRIPTION

4.1 Purpose of ERTMS/ETCS

4.1.1 The purpose of the ERTMS/ETCS is to ensure safe and technically interoperable train operation across the HSR Railway.

4.2 ERTMS/ETCS Definition

4.2.1 In this Technical Specification, the ERTMS/ETCS (hereinafter ETCS) shall be understood as part of the ERTMS system consisting of the standardised ETCS components and the Wireless Communication Systems component as specified in [R30].

4.2.2 Focusing on the regulatory framework of TCS TSI, the ETCS is expected to operate within the technical context set out below.

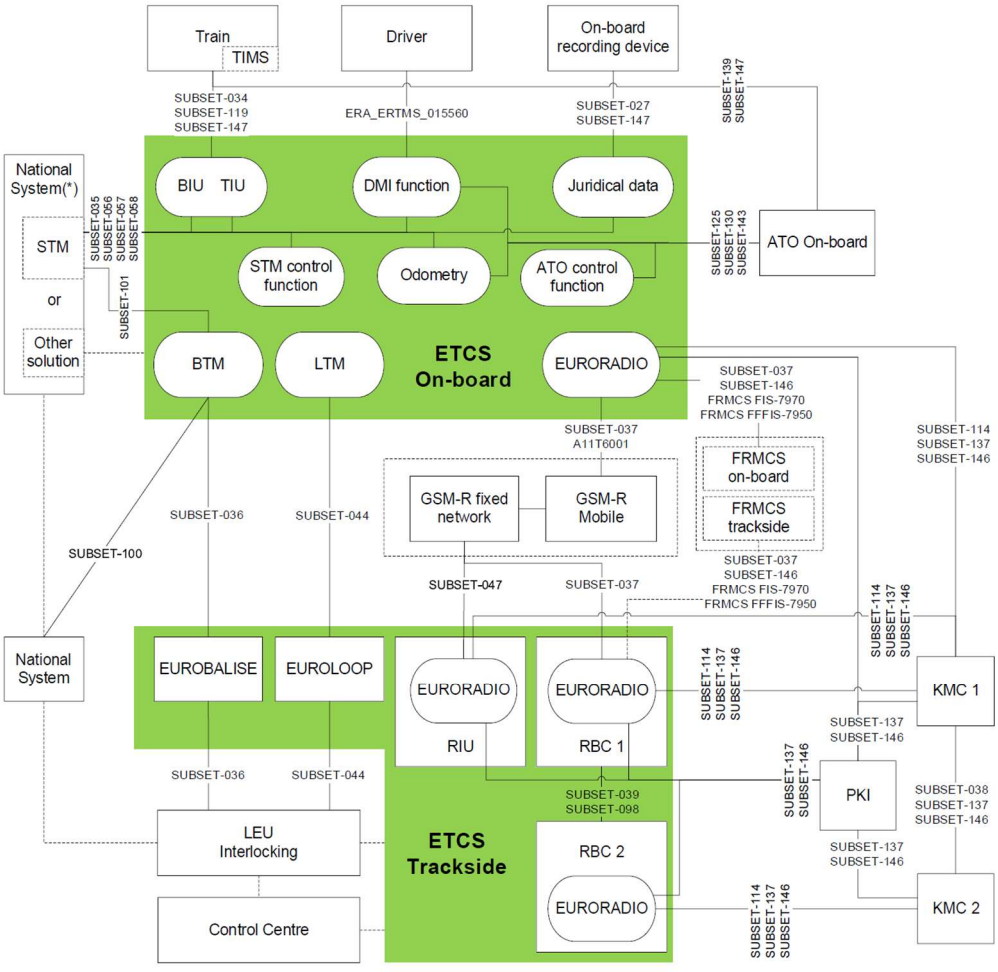

FIGURE 1 - ETCS TECHNICAL CONTEXT

4.2.3 The ETCS is composed of ETCS Trackside (ETCS-TS) and ETCS On-Board (ETCS-OB) which communicate via balises or radio messages.

4.2.4 This Technical Specification deals with the ETCS trackside part of TCS Subsystem, consisting of:

- Radio Block Centre (RBC), to enable ERTMS Level 2 train operations.
- Eurobalises, mainly for location referencing.
- Offline Key Management System (KMS), to secure Euroradio messages via the cryptographic keys. (Note: inputs and outputs provisions shall be made to enable future interface with Online KMS, which would eventually replace the Offline KMS)
- Harmonized trackside marker boards, mainly to support driver operations when running close to the end of authorities or during on-sight train operations.
- Non-harmonized trackside boards, mainly consisting of fixed signs supporting shunting operations, geographical reference, and other operational purposes.
- Data recording, diagnostic and maintenance support.
- Technical and functional interfaces internal to ETCS.
- Technical and functional interfaces between ETCS and the other Systems of TSCC Subsystem.
- Technical and functional interfaces between ETCS and the other Subsystems: Trainsets which are designed in accordance with the relevant TSIs.

4.2.5 All items listed above shall be within the scope of supply and delivery of the TSCC Contractor.

4.2.6 Balise groups shall consist of one or two balises.

4.2.7 KMS shall be an Offline KMS developed in accordance with Subset 114 of [TCS TSI 2023]. This Offline KMS shall be capable of being replaced with Online KMS when the number of keys required to be managed increases to a level where this Online feature becomes necessary.

4.2.8 Harmonized marker boards are designed according to the relevant TSI; non-harmonized signs shall be proposed by Contractor and agreed by CHSR Authority during the generic design phase. The TSCC Contractor shall provide information on materials, dimensions, optical properties, and operational purpose.

4.2.9 Additional non-harmonized signs may be necessary to identify other specific locations on the track:

- Wireless Communication Systems area;
- RBC borders;
- Start/end of interlocked areas;
- Start/end of reversing areas, if any;
- Safe areas, if any;
- Station platforms: start/end of platform, normal stopping points;
- At road overpasses when protected by vehicle fall detectors, etc...

4.3 ERTMS/ETCS Operational Context

4.3.1 In the operational context of TCS Subsystem, ETCS is one System of the whole HSR Train Control System which also includes the Wireless Communication System (Future Railway Mobile Communication System), CBI (Computer Based Interlocking) or IXL, TMS (Traffic Management System), and other TSCC supporting systems (Network Timing System, Hazard Detection and Early Warning System, Low Voltage Power System, Enterprise Asset Management System, etc.).

4.3.2 The architecture enveloping the TCS TSI and EULYNX domains described in Figure 1 and EULYNX System Definition Appendix A1 – EULYNX System Architecture Version 4.2 shall be taken as a reference for the implementation of ERTMS on the HSR Railway.

4.3.3 Looking at the organizational context of HSR railway operations, the main stakeholders involved in the use of ETCS, and in general of the whole TSCC system, are Train Operators and Maintainers of CAHSR, who are responsible for establishing the procedures for operating and maintaining the System.

4.4 Design Life

4.4.1 The design life of the ETCS shall be 30 years.

4.4.2 TSCC Contractor shall ensure that the manufacturers will be able to produce ETCS system components (with equal or compatible technical specifications) for the entire lifetime required.

5 SYSTEM REQUIREMENTS

5.1 General Requirements

5.1.1 The ETCS shall fulfil the TCS TSI requirements, ensuring the technical interoperability of the HSR Railway and the compliance with the essential requirements set out in Interoperability Directive (EU) 2016/797 regarding: safety, reliability and availability, health, environmental protection, and technical compatibility.

5.1.2 The ETCS shall be based ETCS Baseline 4 Release 1 and System Version 2.1 according to TCS TSI 2023 and the necessary error correction available at the time of designing the system.

5.1.3 The ETCS train operations shall be based on ETCS Level 2, using RBC for radio messages, Wireless Communication Systems as radio bearer, fixed Eurobalises for location referencing, Marker Boards and fixed block sectioning based on axle counters for track vacancy detection.

5.1.4 The ETCS shall support train operations on HSR Railway under normal, degraded and emergency conditions:

- Train and shunting movements on the HSR main line and related Facilities under the supervision of RBC (no line side signals);
- Transitions between HSR main line and Facilities outside the supervision of RBC (line side signals may be required);
- Transitions between HSR main line and other railway network (in the future)

5.1.5 The ETCS shall ensure that the expected safety and operational performances of HSR main line are achieved, both in open line and in local facilities under the supervision of RBC.

5.1.6 The ETCS shall ensure easy scalability to support the commissioning of TSCC system according to HSR implementation schedule.

5.1.7 The ETCS shall be based on Commercial Off The Shelf (COTS), open and modular system architecture, reducing the use of proprietary interfaces.

5.1.8 The SIL 4 certification process of ETCS shall comply with the relevant CENELEC safety standards: EN50126, EN50716, EN50129 and EN50159 (refer to 2.4).

5.1.9 The Interoperability Constituents of TSCC Subsystem shall be provided with an ‘EC’ declaration of conformity to the relevant basic parameters set out in the TCS TSI.

5.1.10 [Note to: 5.1.9: the compliance with the basic parameters ensures the fulfilment of the essential requirements set out in the Directive. For TSCC HSR project this requirement shall refer to the following trackside components: RBC, Eurobalise, Axle Counter, Marker Board]

5.1.11 Only Systems with service proven records of at least 2 years for application on railway infrastructure should be proposed by the TSCC Contractor, unless properly justified by the required ETCS application and agreed by the CHSR Authority.

5.1.12 The ETCS design shall tend to minimize the Environmental Impact of the TSCC subsystem and of the entire railway operation during O&M phase.

5.1.13 The correct functioning and performances of ETCS hardware, electronic and software components shall not be affected by the action of environmental conditions of the geographical area.

5.1.14 The ETCS shall comply with the HSR cybersecurity policies and main standards for cybersecurity in safety-related applications.

5.1.15 The ETCS design shall be aligned with the overall RAM and Safety target required for HSR.

5.1.16 Following requirement 5.1.15, the hazard mitigation shall be part of the ERTMS/ETCS design phase of TSCC Contractor covering all specific scenarios of HSR project and the generic scenarios set out in UNISIG standard SS-113 (ETCS Hazard Log).

5.2 Environmental Requirements

5.2.1 Refer to the Contract for general environmental requirements.

5.2.2 The ETCS equipment shall be compliant with EN50125-3 and the generic International Standards (refer to 2.4).

5.2.3 Outdoor ETCS components shall be aligned with the relevant parameters related to the following environmental conditions:

- Atmospheric pressure / Altitude;
- Temperature;
- Humidity;
- Wind;
- Surrounding air;
- Rain ;
- Solar Radiation;
- Lightning;
- Pollution;
- Vibration and shocks

5.2.4 The ETCS equipment located in external ambient and in cubicle/shelter/building shall be compliant to the Climatic Class T2 defined in EN 50125-3 according to environmental classification provided by 60721-2-1, concerning Temperature and Humidity (refer to 2.4 and 2.2).

5.2.5 The Eurobalises shall comply with the specific environmental conditions defined in UNISIG standard SS-036 (FFFIS for Eurobalise) related to:

- Operational Temperature;
- Storage;
- Sealing, dust, and moisture;
- Mechanical stress;
- Meteorological conditions;
- Lightning;
- Chemical conditions;
- Biological conditions;
- Debris.

5.2.6 The Eurobalises shall be compliant with Debris Class A balises and related environmental parameters.

5.2.7 Marker Boards and Eurobalises shall be designed to be durable in railway environments, adequately protected from weathering and vandalism to preserve their physical, optical, and mechanical properties.

5.2.8 ERTMS/ETCS equipment shall be compliant to CENELEC standard 50121 Railway applications - Electromagnetic compatibility.

5.2.9 The TSCC Contractor shall include in the project the identification, analysis, and mitigation of environmental hazard risks.

5.3 Operational Requirements

5.3.1 The ETCS design shall ensure that the expected headway, capacity, and traffic volume on HSR main line are achieved.

5.3.2 The ETCS shall support train operations according to the HSR Operational Concept.

5.3.3 The ETCS shall ensure train operations at the design speed and maximum operational speed of 220mph.

5.3.4 The ETCS shall allow bidirectional train operations on all station tracks and in open line.

5.3.5 The ETCS trackside shall grant Movement Authorities (MAs) via radio according to the routes set by CBI and the status of the relevant trackside elements.

5.3.6 Harmonized ETCS marker boards, namely Stop Marker and Location Marker, shall be located at the end of the movement authorities where the driver requires supplementary information to identify the exact stopping location in addition to the display on the DMI.

5.3.7 Stop Markers and Location Markers may also be sub-located within an MA section to identify a specific location that shall be observed by the driver during degraded train operations. In this case they do not necessarily have to contribute to the spacing between trains.

5.3.8 Stop Markers shall be used where it is necessary to protect one or a group of safety-critical locations. The train must not overpass the Stop Marker at the end of authority or while running without MA, unless the driver has received a specific authorization by the signaler.

5.3.9 Location Markers should be preferred in case there is no safety-critical location to be protected. The train may overpass the Location Marker at the end of authority or while running without MA, under the responsibility of the driver. In general, it is up to Infrastructure Manager to decide whether a Location Marker can be used instead of a Stop Marker where no safety critical location needs to be protected.

5.3.10 [Note to 5.3.6, 5.3.8 and 5.3.9: an example of deployment of Stop markers and Location markers based on requirements is shown in the figure below.

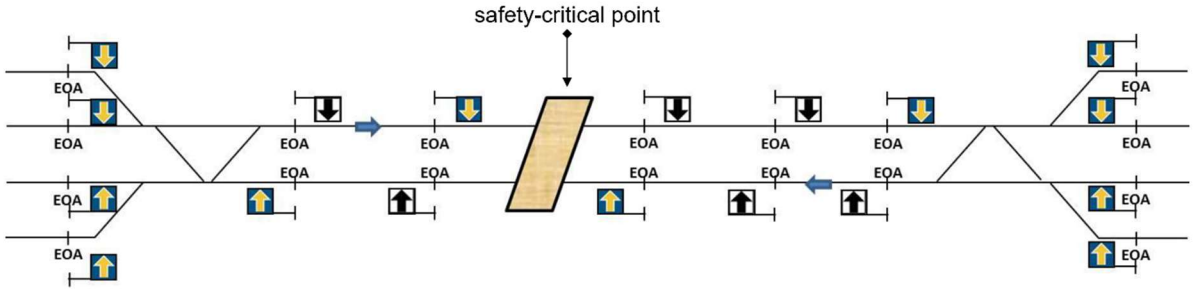

FIGURE 2 - STOP MARKERS AND LOCATION MARKERS EXAMPLE

5.3.11 In the operational context of HSR, the term “safety-critical location” shall be understood as any element on the track located between the TVP limits of an MA section (switch, fouling point of conflicting routes, entry of station, junction, vehicle intrusion at road overpass, other critical locations of rail infrastructure) that requires major protection via an ETCS Stop Marker, as the driver cannot pass it without specific authorization when the MA is not available

5.3.12 Since the operational purpose of Stop Markers and Location Markers may often coincide, the priority defined in the TCS TSI (reference document 21E089) shall apply to determine which type of marker must prevail.

5.3.13 Non-harmonized trackside boards shall be used to provide supplementary information, or to clearly identify those specific operational points where harmonized ETCS marker boards would not be able to fit the intended operational purpose.

5.3.14 The MA segmentation constitutes the basis for the spacing between trains, therefore it shall respect the HSR approach on block sectioning which shall be optimized by TSCC Contractor with the aim of achieving the performance of HSR operations.

5.3.15 All features of HSR railway line related to Tracks and Civils Subsystem (line speeds, slopes, curves, switches, bridges, tunnels, platforms, big metal masses, etc.), Traction Power Subsystem (traction system

voltage, etc.) and Trainset Subsystem (train categories, axle load, brake position, etc.) shall be reflected in ETCS data.

5.3.16 The ETCS may provide a safe response to the alarms triggered via direct interface, CBI or TMS by the detectors of the Hazard Detection and Early Warning System (HDEWS) that are specified in Schedule 5(g) – HDEWS Specification.

5.3.17 The engineering of movement authorities and of balises shall allow passenger trains to approach fluently and accurately to the operational stopping points.

5.3.18 The trains approaching the end of authority shall be prevented from overrunning the Supervised Location (hazard ETCS H-0001 of ETCS Hazard Log – subset 113).

5.3.19 The fixed release speed should be the main option to provide driving consistency.

5.3.20 TSCC Contractor shall evaluate which release speed among fixed is the most suitable option for HSR operations, considering that the nominal length of the overlap in station area is 70 m and that this value can change in some places. Note that 15km/h is expected to meet both safety and operational needs but that shall be validated during design.

5.3.21 In the case of conditional overlap (e.g., when overlap is too short) indicated to the RBC by the CBI, the RBC may authorize entry into the section in restrictive conditions (e.g., OS mode or Lower Release Speed).

5.3.22 When a switch is included in the overlap, the interlocking system may release the overlap immediately if the train is safely proven at stop before the marker. The overlap release can be requested by the RBC or can be determined by the interlocking system, using a timer, considering the lowest train speed and the stopping conditions.

5.3.23 ETCS trains shall be able to start or end a mission in any location of HSR mainline, including the facilities partially supervised by RBC.

5.3.24 The RBC shall allow trains to run on the mainline using the following ETCS modes: Full Supervision (FS), On-Sight (OS), Staff Responsible (SR), Reversing (RV).

5.3.25 Train movements under normal trackside conditions shall be performed in FS mode.

5.3.26 ETCS shall support joining and splitting of trains at station tracks.

5.3.27 Train movements under degraded trackside conditions shall be performed in OS or SR mode.

5.3.28 The RBC shall authorize OS mode to allow a train to move under the partial responsibility of the train driver, for example in a track which may be occupied by another train or other obstacles.

5.3.29 The RBC shall authorize SR mode to allow a train to move under the full responsibility of the train driver.

5.3.30 The balise engineering shall prevent trains in SR mode from passing critical locations.

5.3.31 The RBC should authorize RV mode to allow the trains to reverse to a safe location or to fit the train at station platforms in case of “long overshooting” of the stop location. Shunting (SH) and Isolation (IS) are other possible ETCS modes for reversing the movement direction.

5.3.32 Long tunnels and bridges are considered typical locations where it should be possible to reverse the train movement direction in case of emergency. RV mode shall require a careful recognition of the potential reversing areas during design phase of TSCC Contractor.

5.3.33 ETCS shall support shunting operations on all tracks equipped with ETCS.

5.3.34 The RBC shall authorize the SH mode for shunting operations in those facilities under the RBC supervision with scheduling of frequent shunting.

5.3.35 The RBC shall authorize the SH modes for shunting operations in those local facilities under the RBC supervision where shunting is occasional (e.g., passenger stations):

- Shunting operations in SH mode shall be carried out within a safe envelope (shunting area) to increase the safety level of the overall train operations.

- The balise engineering shall prevent trains in SH mode from overrunning the shunting area limits.
- Shunting in the large rail yards outside the HSR mainline and the RBC supervision, shall be allowed by shunting signals and ETCS-OB shall be set to Level 0 SH mode.
- Shunting in non-signalled areas (e.g., infrastructure maintenance facilities) shall be carried out under the supervision and full responsibility of the local staff.
- ETCS shall allow smooth and harmonized train transitions with any interfaced railway network
- Handover and level transitions shall not affect the train operations in terms of speed, safety, and regularity.

5.3.36 ETCS National Values are a set of parameters usually defined by the Infrastructure Managers to ensure coherency between the onboard system behaviour and the rules and regulations in different countries. Since national values are only provided as example for the current project, the TSCC Contractor shall submit to the CHSR Authority a proposal compliant with the performance and safety requirements of HSR.

5.3.37 The following National Values shall be taken as examples:

Variable	Value	Note
V_NVSHUNT	30 km/h	-
V_NVSTFF	30 km/h	-
V_NVONSIGHT	30 km/h	-
V_NVLIMSUPERV	0 km/h	Limited Supervision mode is not authorized.
V_NVUNFIT	30 km/h	-
V_NVREL	15 km/h	-
D_NVROLL	5 m	-
Q_NVSBTSMPERM	1 (Yes)	-
Q_NVEMRRLS	0 (Apply emergency brake until standstill)	-
Q_NVGUIPERM	1 (Yes)	-
Q_NVSBFBPERM	0 (No)	Using the service brake feedback could cause unexpected brake interventions.
Q_NVINHSMICPERM	0 (No)	consider the speed measurement inaccuracy in the calculation of the braking curves.
V_NVALLOWOVTRP	0 km/h	Override to be selected only when the train is at standstill.
V_NVSUPOVTRP	30 km/h	Override speed limit shall be equal to the default Staff Responsible speed limit.
D_NVOVTRP	100 m	100 m is considered a suitable distance limit for the validity of train trip override

Variable	Value	Note
T_NVOVTRP	60 s	60s is considered a suitable time window for train trip override
D_NVPOTRP	0 m	It is not permitted to undertake reverse movements in Post Trip mode.
M_NVCONTACT	00 (Train Trip)	Value to be confirmed by risk Assessment
T_NVCONTACT	20s	Value to be confirmed by risk Assessment
M_NVDERUN	0 (No)	
D_NVSTFF	32767 (∞)	To facilitate operation in SR in case of degradation
Q_NVDRIVERADHES	1 (Allowed).	
A_NVMAXREADADH1	1.0 m/s2	Default value
A_NVMAXREADADH2	0.7 m/s2	Default value
A_NVMAXREADADH3	0.7 m/s2	Default value
Q_NVLOCACC	12 m	Default value.
M_NVAVADH	0	Default value.
M_NVEBCL	9 (99.9999999%)	Highest confidence level for emergency brakes.
Q_NVKINT	1 (Integrated correction factors follow)	Only Gamma trains are allowed to operate. A preventive correction factor is applied to restrict any Lambda train from operating normally on the line.
Q_NVKVINTSET	01 (Conventional passenger trains)	Set of values below applicable to passenger trains
A_NVP12	0.5 m/s^2	1st Pivot value for 'Lower deceleration limit to determine the set of Kv'. (Kv = Correction factor)
A_NVP23	0.55 m/s^2	2nd Pivot value for 'Upper deceleration limit to determine the set of Kv'. As close as possible to the 1st pivot is used to ensure that the correction factor applies to all deceleration range
V_NVKVINT	0 km/h	Fixed value which starts the Kv speed dependant profile
M_NVKVINT	0	Integrated correction factor Kv applicable forany speed above V_NVKVINT (0 km/h) if the maximum train deceleration is below
A_NVP12	(0.5 m/s^2).	Most permissive value '0' selected to ensure Lambda trains cannot operate with ETCS normally on the line.

Variable	Value	Note
M_NVKVINT	0	Integrated correction factor Kv applicable for any speed above V_NVKVINT (0 km/h) if the maximum train deceleration above A_NVP23 (0.55 m/s^2). Most permissive value '0' selected to ensure Lambda trains cannot operate with ETCS normally on the line.
N_ITER	0	No further speed step iterations for the Kv correction factor provided.
Q_NVKVINTSET	00 (Freight trains)	Set of values below applicable to freight trains
V_NVKVINT	0 km/h	Fixed value which starts the Kv speed dependent profile
M_NVKVINT	0	Integrated correction factor Kv applicable for any speed above V_NVKVINT (0 km/h). Most permissive value '0' selected to ensure Lambda trains (which are not authorized to operate with ETCS on the line the Irish Network) will be enforced to calculate extremely conservative braking curves, leading to operation below release speed.
N_ITER	0	No further speed step iterations for the Kvcorrection factor provided.
L_NVKRINT	0 m	Fixed value which starts the Kr train length
M_NVRINT	0	Integrated correction factor Kr applicable for any train length above L_NVKRINT (0 m). Most permissive value '0' selected to ensure Lambda trains (which are not authorized to operate with ETCS on the line) will be enforced to calculate extremely conservative braking curves, leading to operation below release speed.
N_ITER	0	No further train length step iterations for the Kr correction factor provided.
M_NVKTINT	1	The Kt correction factor brake build-up time for Lambda trains is unchanged, as the chosen Kv and Kr correction factors can enforce the operation of Lambda trains under very conservative braking curve

TABLE 5 – NATIONAL VALUES EXAMPLES

5.4 Functional Requirements

5.4.1 Functional requirements refer to the functions specified in UNISIG standard SS-026, or any other expected functionality for maintenance supporting and data recording to carry out ETCS train operations on HSR railway line according to the high-level operational requirements defined in 5.3.

5.4.2 ETCS train operations shall be related to functions and processes managed by ETCS-TS and ETCS-OB for the safe supervision of train and shunting movements on HSR railway line, including but not limited to:

- Euroradio and Eurobalise messages.
- Movement authorities.
- Fixed and temporary speed restrictions, gradient, track conditions, and other profile data.
- ETCS modes for train and shunting operations, mode transitions.
- Supervision of the radio contact.
- Start of mission / End of mission.
- Level transitions.
- Handover RBC/RBC.
- Emergency messages.
- Text messages.
- National Values.
- Shunting areas management.
- Protection of working areas and other safety-related locations.
- HSR Territory Entering/leaving.

5.4.3 **Euroradio messages**

5.4.3.1 The bidirectional communication between RBC and ETCS-OB shall be based on the Euroradio protocol specified in UNISIG standard SS-037.

5.4.3.2 Euroradio messages shall contain packets and variables in accordance with UNISIG standards SS-026-7 and SS-026-8.

5.4.3.3 The maximum time interval between two consecutive messages sent by RBC to the same train shall not exceed the reference time given by the national value T_NVCONTACT.

5.4.3.4 The risk that a train may enter a not protected route after a loss of radio communication shall be mitigated.

5.4.4 **Eurobalise message**

5.4.4.1 Balise messages shall contain packets and variables in accordance with UNISIG standard, SS-026-7 and SS-026-8.

5.4.4.2 Balise groups shall ensure accurate relocation of the trains running close to operational stopping points (platform, stop marker, location marker, buffer stop, etc.), level transition areas, handover areas, any other relevant location.

5.4.4.3 Balise groups shall update the national values at cross borders, depots, and other relevant local facilities, with the aim preventing trains from moving with wrong values stored on-board.

5.4.4.4 Balise groups shall provide the “big metal masses” information.

5.4.4.5 Balise groups shall prevent trains in SR mode from overrunning critical locations.

5.4.4.6 Balise groups shall prevent trains in SH mode from overrunning the shunting area limits.

5.4.4.7 Balise groups shall support level transitions and handover RBC/RBC via immediate transition orders and announcements where not transmitted via radio.

5.4.4.8 Balise groups shall prevent trains from entering the ETCS Level 2 area with ETCS Level 0 erroneously selected and stored on board.

5.4.4.9 The balise engineering should be based on the approach defined in EUG Engineering Guideline #23 - Balise Engineering L2 and L3 (refer to 2.6), adapted to the requirements of the new ETCS Baseline 4 and related system versions, where necessary.

5.4.5 Movement Authorities for train operations and related modes

5.4.5.1 The ETCS operating modes allowed to be used by the RBC are within the HSL are:

- Full Supervision,
- On-sight
- Shunting
- Reversing

5.4.5.2 The Movement Authority shall contain all information necessary for the trains to run safely, preventing derailments, collisions and other dangerous situations which may cause harm to people (passengers and railway staff), loss of goods and damage to railway assets.

5.4.5.3 Before granting movement authorities, RBC shall evaluate the status of route elements and other wayside conditions transmitted by CBI: switches, TVP sections, asset alarms, working areas under engineering possession, any other element to be supervised on the MA.

5.4.5.4 RBC shall supervise the integrity of the safe connection with CBI and revoke all MAs in the area controlled by CBI when the communication is lost or corrupted.

5.4.5.5 The MA shall provide ETCS-OB with the following information: permission and distance to run, the track description, the linking information, when available, and the mode profile when required.

5.4.5.6 The track description shall define all permanent and temporary speed restrictions, the gradient profile, the track conditions, the areas where reversing is permitted, and the areas with reduced adhesion factor.

5.4.5.7 Where RBC detects that the distance to run includes a temporary speed restrictions area, the TSR's parameters shall be incorporated in the MA message.

5.4.5.8 Where RBC detects that the distance to run includes the handover area between adjacent RBCs, the RBC transition announcement shall be incorporated in the MA message.

5.4.5.9 Where RBC detects that the distance to run includes a level transition area, the level transition announcement shall be incorporated in the MA message.

5.4.5.10 Where RBC detects that the distance to run includes an area where different national values apply, the new values shall be incorporated in the MA message.

5.4.5.11 No movement authority shall be granted if RBC does not know the route or the TVP status.

5.4.5.12 No movement authority shall be granted if the route, or any portion of the route, has already been granted to another train (conflicting MA).

5.4.5.13 No movement authority shall be granted by RBC on the areas under engineering possession.

5.4.5.14 RBC shall supervise the position of the train in the MA and extend or shorten the authorized distance relying on the most updated information provided by CBI.

5.4.5.15 RBC shall ensure continuous supervision of the safety conditions received from CBI, and the loss of such conditions in the existing MA shall result in an immediate restriction on the affected portion of the track. Depending on the hazard and on the train position known by RBC, a new MA shorter than the previous one, or an emergency stop message, or a speed restriction, shall be sent to the train.

5.4.5.16 Note: for each hazard, TSCC Contractor shall evaluate the influence of T_NVCONTACT and the consequences of a possible emergency brake activation by train

5.4.5.17 The cooperative shortening of MA between RBC and ETCS-OB shall be used to increase the overall safety level of the train operation, for example to manage the approach locking function carried out by the interlocking during route cancellation/release (RBC-CBI interworking is required).

5.4.5.18 RBC shall be able to shift the MA location reference in case a slave engine becomes the leading engine after changing the train orientation or the running direction.

5.4.5.19 RBC shall manage the overlap, Danger Point and release speed at the End Of Authority (EOA).

5.4.5.20 The EOA locations shall allow passenger running under normal conditions to reach fluently their operational stopping point according to HSR timetable.

5.4.5.21 The Danger Point shall be located no further than the entry point of an occupied TVP section (axle counter limit), or the fouling point of a switch conflicting with other routes, or any other dangerous location specified beyond the EOA.

5.4.5.22 The Overlap should be used to improve the efficiency of the braking supervision during ETCS train operations.

5.4.5.23 The Overlap location shall be consistent with the portion of the track that CBI may add as a safety margin beyond the end of authority.

5.4.5.24 If CBI use a timer to release the overlap, the corresponding Overlap time-out of ETCS shall reflect the Interlocking behaviour.

5.4.5.25 Both overlap timers (CBI and ETCS) shall not expire before the train has come to a standstill.

5.4.5.26 RBC should inform CBI that the train has come to a standstill and permit the overlap to be released before the interlocking timer has expired (timer normalization).

5.4.5.27 The release speed shall enable ETCS trains performing with insufficient odometer accuracy to approach the EOA location.

5.4.5.28 The release speed shall ensure acceptable driving at the EOA location.

5.4.5.29 The RBC shall grant MA in FS mode for train operations only when all safety conditions within the permitted distance to run are fulfilled: switches shall be locked in the right position, TVP sections shall be vacant, any other expected conditions monitored in real time by CBI which would directly impact the MA shall be safe.

5.4.5.30 The RBC shall be able to grant OS mode to trains entering a TVP section that is not vacant under specific conditions, for example after a trackside failure or a previous axle counting error. The driver is responsible for checking the track vacancy.

5.4.5.31 The OS mode may also be used to allow the train to overrun, under the responsibility of the train driver, a location which may be interfered by peoples, vehicles, or any kind of obstacle, for example a vehicle intrusion reported by the Hazard Detection and Early Warning System at road overpasses, or other similar situations.

5.4.5.32 Since most often OS mode requires compliance with specific protocols to be followed before being granted, the TSCC Contractor shall evaluate when OS mode can be activated automatically by RBC and when it should require authorization by the traffic operator via TMS HMI (TMS Human Machine Interface) using special/double commands capable of overrunning the restriction.

5.4.5.33 Note: use cases for OS mode authorization by the traffic operator may relate to requirement 5.4.5.30

5.4.5.34 For operational needs (platform sharing/joining of trains) RBC shall allow a train to enter a platform partially occupied by another train in FS (or AD mode in case of automatic GoA2 operation), and switch to OS mode before reaching the occupied location.

5.4.5.35 Note: this kind of train operations should require the track to be divided in at least two TVP sections and may require the movement permission to be granted via a special/double command from TMS HMI

5.4.5.36 In OS mode the permitted speed shall be defined by the National Value; different values may be adopted for exceptional cases.

5.4.5.37 The location where the OS mode is requested by RBC shall be, at the latest, the entry point of the occupied track.

5.4.5.38 OS mode shall require the driver acknowledgment, with an acknowledgement area of at least 100 m in rear of the location where the transition to OS is requested by RBC.

5.4.5.39 If after a trackside failure (e.g., a loss of the radio contact) RBC is not able to grant MA in FS or OS, the train can move in SR mode after the Override procedure has been triggered by the train driver. The driver shall coordinate with the traffic controller and observe the specific instructions received (check if the track is clear, if switches are correctly positioned, etc.).

5.4.5.40 Trains are authorized to move in SR mode within fixed limits of speed and distance given by the relevant national values. Trackside balises giving the order "Stop if in SR" shall be deployed at each Stop Marker location to protect turnout areas and other specific locations from SR mode in case of driver misconduct.

5.4.6 Permanent speed restrictions

5.4.6.1 The SSP shall define all fixed speed restrictions imposed by HSR infrastructure (maximum line speed, curves, switches, bridges, tunnels, etc.), and one or more specific SSPs related to the international train categories which apply to HSR project. Train categorization shall be done during the design phase of TSCC Contractor.

5.4.6.2 SSP shall be evaluated as a safe segmentation that incorporates all speed changes as a sequence of static speeds.

5.4.6.3 Each SSP segment shall correspond to one value of the basic speed. Where it is acceptable to join more speed variations in a same SSP segment, the speed rate applied in that segment shall be the lowest of all values.

5.4.6.4 Any speed increase resulting from SSP shall be controlled by ETCS-OB including the train length delay.

5.4.6.5 Any speed changes resulting from ASP shall be controlled by ETCS-OB including the train length delay.

5.4.7 Temporary speed restrictions

5.4.7.1 RBC shall ensure centralized management of Temporary Speed Restrictions (TSRs).

5.4.7.2 TSRs shall be communicated by RBC to ETCS trains via MA.

5.4.7.3 Any speed changes resulting from TSR profile shall be controlled by ETCS-OB including the train length delay.

5.4.7.4 TSRs shall be activated either by the traffic operator via TMS/TSR HMI or automatically by RBC as a safe response to specific dangerous situations.

5.4.7.5 Along working areas, the TMS and/or RBC shall automatically reduce the speed of the trains running on the adjacent tracks. The automatic TSR shall be made SIL4 and shall cover at least the entire projection of the working area on the tracks kept in service for train operations.

5.4.7.6 Along temporary shunting areas, RBC shall automatically reduce the speed of the trains running on the adjacent tracks. The automatic TSR shall achieve SIL4 and cover at minimum the entire projection of the shunting area on the tracks kept in service for train operations.

5.4.7.7 Automatic TSRs shall rely on default TSRs that are automatically transmitted by RBC under predefined conditions. Additionally, the TSR parameters shall be configurable to allow operators to customize automatic TSRs for specific scenarios, especially in case of temporary possession in a working area.

5.4.7.8 Where TSR data are set and stored in a dedicated TSR server, ETCS shall ensure safe synchronization between RBC and TSR server, and any restart of equipment after a shutdown shall not result in a loss of TSR data or in a dangerous mismatch between servers.

5.4.7.9 The traffic operator shall be allowed to activate TSRs with default data (predefined TSRs), as well as to modify the existing ones, or plan new TSRs entering identity, start point, end point and speed rate via HMI, with a granularity of 10 meters and 5 km/h.

5.4.7.10 The traffic operator shall be proposed whether to activate the TSR immediately or schedule it for a given time.

5.4.7.11 The TSR time scheduling shall be done entering via HMI any time slot within the 24 hours of the day.

5.4.7.12 It shall also be possible to set the validity period of that time slot: daily, weekly, monthly, or any other date interval.

5.4.7.13 For operational needs, it shall be possible for the operator to revoke a TSR that has been set automatically by RBC.

5.4.7.14 For TSRs generated by the Hazard Detection and Early Warning System, RBC shall be able to revoke the TSR as soon as the alarm is reset.

5.4.7.15 [Note: regarding the speed rates of automatic TSRs in the above-mentioned scenarios, a safety study shall be necessary at system level, through benchmarking and alignment with Shadow Operator and IMs]

5.4.8 **Other static speed restrictions**

5.4.8.1 The RBC may transmit the Permitted Braking Distance (PBD) information to allow ETCS-OB to calculate a speed restriction based on the PBD and the applicable National Values to ensure that the train can stop within the maximum permitted stopping distance.

5.4.9 **Gradient profile**

5.4.9.1 Each segment shall correspond to one gradient value. Where it is acceptable to join more slope changes in a same segment, the gradient rate applied in that segment shall be the safest of all values.

5.4.9.2 As ETCS manages gradient values with a minimum resolution of 1‰, decimal numbers in uphill shall be rounded by defect, decimals in downhill shall be rounded by excess.

5.4.9.3 Gradient data collection and gradient segmentation should be carried out according to the EUG Engineering Guideline #28 - Gradients Segmentation (refer to 2.6).

5.4.10 **Linking information**

5.4.10.1 The linking information shall link all relevant balise groups that will be passed by the train.

5.4.10.2 The linking information shall ensure that ETCS-OB applies a safe reaction (train trip or service braking) if a linked balise group containing vital information in FS or OS is not found or the transmitted data are inconsistent.

5.4.10.3 TSCC Contractor shall provide adequate balise engineering and ensure that the linking information is available on board in due course.

5.4.10.4 Track conditions

5.4.10.5 The Track Conditions information shall be incorporated in the MA message as soon as RBC detects that the train movement authority involves a HSR location where one or more track conditions apply.

5.4.10.6 RBC shall be able to manage at least the following types of track conditions as per SS-026:

- Non stopping area;
- Air tightness;
- Switch off regenerative brakes;
- Big metal masses;
- Radio hole;
- Station platform.

5.4.10.7 For track conditions Air tightness, and Switch off regenerative brake, the latest transmission of the announcement in rear of the start location shall fulfil the time requirements defined in UNISIG standard SS-040.

5.4.10.8 The track condition "non-stopping area" should be set, railway bridges, tunnels, viaducts, or other locations according to the specific operational needs of HSR.

5.4.10.9 The TSCC Contractor shall include in the project the identification of metal object locations (turnouts, guard rails, big metal masses, etc.) with the aim of establishing the balise locations according to requirements defined in UNISIG standard SS-036.

5.4.10.10 If required, the track condition “big metal masses” shall be transmitted via balises at freight yards, depots, and other locations of HSR, to allow ETCS-OB to ignore the “integrity check” alarms of the onboard balise-reading system which may be triggered by big metal objects exceeding the limits given in UNISIG standard SS-036.

5.4.11 **Start of Mission**

5.4.11.1 RBC shall support the Start of Mission (SoM) of ETCS trains according to the procedure defined in UNISIG standard SS-026-5.

5.4.11.2 Departure/arrival tracks of passenger and freight stations of HSR main line, as well as the exchange tracks of Facilities partially supervised by RBC, shall be considered as planned locations where it is possible to start a mission in ETCS Level 2.

5.4.11.3 It shall also be possible to start a new mission in any track section of HSR, including the open line areas, in case ETCS-OB is restarted after a system failure.

5.4.11.4 The SoM shall be designed to achieve FS mode as soon as possible, while ensuring transparent and predictable behaviour and procedures as well.

5.4.11.5 The ETCS trackside configuration should follow the basic principles defined in EUG Engineering Guideline #68 - Start of mission in Level 2/3, B3 (refer to 2.6), adapted to the requirements of the new ETCS Baseline 4 and related system versions, where necessary.

5.4.11.6 TSCC Contractor shall ensure adequate balise engineering and interworking between RBC, CBI and TMS, to reduce the occurrence of start of missions with invalid or ambiguous position.

5.4.11.7 Note: according to Regulation (EU) 2023/1695 (refer to 2.3) the ETCS on-board equipment shall be fitted with a Cold Movement Detection (CMD) to determine if a vehicle has been moved during the power off phase

5.4.11.8 If available, information from interlocking, TVP system and TMS shall enable RBC to (re)validate a position reported as invalid by onboard.

5.4.11.9 When the train position is valid and deemed unambiguous by RBC and the route conditions for MA are fulfilled, RBC shall allow the train to start the mission in FS or OS mode.

5.4.11.10 To guarantee an unambiguous train position when the SoM is performed close to switches, additional wayside engineering methods should be necessary.

5.4.11.11 If the SoM is performed by a slave engine which becomes a leading engine after a change of train orientation, RBC shall be able to shift the MA location reference.

5.4.11.12 Where RBC can determine that the train is the first to enter the route section, RBC shall authorize the train to start immediately in FS mode.

5.4.11.13 The correct engineering of routes and TVP sections, as well as the use of train data or other information coming from CBI and TMS, should allow RBC to determine that the presence of another train is sufficiently improbable.

5.4.11.14 Where RBC is not able to ascertain that there is no other train between the train front and the route entry point, this first portion of MA shall be granted in OS mode.

5.4.11.15 No MA shall be granted if the route is not set or route conditions for MA are not fulfilled or the train position is unknown or invalid and cannot be validated by RBC.

5.4.11.16 Where available, information from RBC, TMS and CBI should be used by RBC as condition to trigger the SR authorization, mitigating any misunderstandings in verbal communication between driver and dispatcher.

5.4.11.17 On HSR tracks where SoM in SR is likely to occur due to the train awakening without a valid position, a relocation balise group shall be placed sufficiently in rear of the route entry point to enable the train to obtain a valid position and receive the MA from RBC before passing the ETCS marker board.

5.4.11.18 In the previous scenarios ATAF (Automatic TAF) may be required to switch from OS/SR to FS mode.

5.4.11.19 In case ATAF is proposed to mitigate the risk of a driver incorrectly acknowledging a Track Ahead Free request, it is recommended to follow the basic principles defined in EUG Engineering Guideline #69 - Automatic Track Ahead Free (ATAF) B3 (refer to 2.6), adapted to the requirements of the new ETCS Baseline 4 and related system versions, where necessary.

5.4.11.20 Safe procedures and adequate trackside configuration shall mitigate the risk of moving in SR mode through a different track/path/direction than the expected one, as well as prevent ETCS trains from passing critical locations in SR mode or entering routes with ETCS Level 0 erroneously selected and stored on board.

5.4.11.21 In general, any hazardous scenarios related to the SoM shall be clearly identified by risk analysis.

5.4.12 **ETCS level transitions**

5.4.12.1 The ETCS shall allow dynamic level transitions L2<-->L0 at the specified project locations, such as the project borders.

5.4.12.2 The engineering of balises in the level transition area shall allow ETCS trains to perform the level transition at the precise location defined in the LT announcement.

5.4.12.3 The LT announcements shall be designed to allow the ETCS trains to pass the transition point at the maximum speed permitted by the infrastructure for the nominal situation.

5.4.12.4 The maximum speed applied in the transition point shall also consider the possible speed limitations imposed by the adjacent network system and by the temporary restrictions overlapping the LT area.

5.4.12.5 The transition point shall be fitted with both a light signal and an LT ETCS board which shall inform the train driver about the transition between the national signalling system and the RBC area.

5.4.12.6 The delay time to establish the safe communication between RBC and the trains entering ETCS L2 shall not reduce the performance set out in requirement 5.4.12.3.

5.4.12.7 Note: according to UNISIG standard SS-037-2 (Euroradio FIS), normally the safe connection establishment delay is less than 40s. This time span is commonly used in ETCS applications over GSM-R to set the position of “session BGs” in rear of the transition announcement; it must be confirmed that 40s is a delay able to fit the Wireless Communication Systems applications]

5.4.12.8 The transition to ETCS L2 should only be announced to the trains routed to the ETCS border. If this announcement cannot be avoided, for example because there is a diverging route after the announcement location, then it must be cancelled before performing the transition.

5.4.12.9 Note: using LEUs and switchable balises (not recommended solution), or announcing the level transition via RBC, could avoid unnecessary radio connections and several dedicated balise groups for cancellation and disconnection

5.4.12.10 The engineering of level transition area shall at least ensure that no trains are routed to ETCS L2 border unless connected to RBC, to prevent trains not equipped with ETCS and/or the Wireless Communication System from entering HSR.

5.4.12.11 The trackside configuration supporting level transitions L0<->L2 should follow the basic principles defined in EUG Engineering Guideline #77 – Level Transition from LNTC to L2 (refer to 2.6), adapted to the requirements of the new ETCS Baseline 4 and related system versions, where necessary.

5.4.13 **Handover RBC/RBC**

5.4.13.1 The transition between RBCs shall fulfil the handover requirements set out in the relevant UNISIG standards SS-026, SS-034 and SS-098.

5.4.13.2 The ETCS shall manage the handover RBC/RBC at each specified project location of HSR.

5.4.13.3 The handover areas shall be designed to allow ETCS trains to pass the border at the maximum speed permitted by the infrastructure for the nominal situation, taking into account the connection establishment delay with the Accepting RBC (refer to 5.4.12.6) and the registration delay on GSM-R network when required (refer to UNISIG standard SS-093).

5.4.13.4 The Handing Over RBC shall be able to grant authorizations beyond the transition point after receiving from the Accepting RBC the following route related information, when available:

- Movement authorities ;
- Linking ;
- International static speed profiles ;
- Axle Load Speed profiles ;
- Gradients ;
- Temporary speed restrictions ;
- Mode profiles ;
- Temporary speed restriction revocations ;
- Track Conditions ;
- Level Transition orders ;
- Route Suitability Data ;
- National Values ;
- Adhesion Factor.

5.4.13.5 The trackside engineering of handover areas should follow the basic principles defined in EUG Engineering Guideline #74 - RBC-RBC Handover (refer to 2.6), adapted to the features of the new ETCS Baseline 4 and related system versions, where necessary.

5.4.14 **Emergency messages**

5.4.14.1 Emergency stop messages shall be used to provide hazard mitigations and increase the overall safety level of train operations in case of emergency situations.

5.4.14.2 Conditional Emergency Stop (CES) and Unconditional Emergency Stop (UES) messages shall fulfil the requirements set out in UNISIG standard SS-026.

5.4.14.3 It shall be possible to send CES/UES messages spontaneously by RBC to provide a quick response to an emergency, or manually by the traffic operator via the TMS HMI.

5.4.14.4 CES messages shall be used to allow ETCS-OB to accept the stop message when the train has not yet passed, with its minimum safe front end, the stop location.

5.4.14.5 Note: if the stop location is not beyond the current EOA/LOA, the CES message is handled by ETCS-OB similarly to a shortening of MA, as the new stop location shall be supervised as EOA/SvL

5.4.14.6 The emergency stop locations shall be clearly identified during the design phase of TSCC Contractor as part of the risk mitigation analysis, and these may include:

5.4.14.7 Any safety-related location (switch, hot box detection, falling road vehicle detection, etc.) where the train should be stopped when the relevant safety conditions in the current MA are no longer supervised (see also requirement 5.4.5.14).

5.4.14.8 Limit of TVP sections to ensure the track occupancy supervision based on the position of the train in the MA.

5.4.14.9 The engineering of CES messages (message identity, stop location, etc.) when used shall be consistent with the balise engineering, to take into consideration the odometer errors which may lead ETCS-OB to accept the CES improperly.

5.4.14.10 CES/UES messages, once accepted by the train, shall be revoked via TMS HMI before resuming train operations.

5.4.15 **Text messages**

5.4.15.1 It shall be possible to transmit information from RBC to ETCS-OB to be displayed on the onboard DMI (Driver Machine Interface) in the form of text messages.

5.4.15.2 According to UNISIG standard SS-026, each transmitted text information shall individually contain:

- The class of message: auxiliary or important information.
- The conditions for Start/End of Indication: location, mode, level, time.
- If driver acknowledgement is requested or not.
- For Plain Text Messages, a customized text string element to be displayed in the required language.
- For Fixed Text Messages, a number selecting the fixed message stored on-board.

5.4.15.3 Note: fixed text messages are stored on-board in all languages that can be selected by the driver, for example 1-“Acknowledgement”

5.4.15.4 Plain and fixed text messages shall be coherent with the relevant operational scenarios of HSR, to inform the driver on the conditions which may require the activation of a specific ETCS mode, or an emergency stop, or a temporary speed restriction, or to provide other specific and general information.

5.4.15.5 Plain text messages should include, but not be limited to, the following text strings:

- “Route not protected”.
- “Road vehicle intrusion location not protected”.
- “Strong wind detected”.
- “Earthquake detected”
- “Flooding detected”
- “Station platform partially occupied”.
- “Working area on the adjacent track”.
- “Acknowledgement”.

5.4.16 **Shunting operations and related mode**

5.4.16.1 Shunting operations in HSR local facilities shall be performed in Shunting (SH) mode according to the operational requirements 5.3.34 and 5.3.35.

5.4.16.2 SH authorization by RBC shall require the shunting movement to be performed in a safe envelope set by CBI as a shunting area.

5.4.16.3 SH authorization by RBC shall be granted for movement from shunting signals when movement is protected by interlocking.

5.4.16.4 If it is not possible for RBC to grant SH mode because RBC cannot validate the train position in the shunting area, it shall be possible for the traffic operator to grant authorization via TMS HMI.

5.4.16.5 The “start of shunting” and “end of shunting” locations shall be marked with specific trackside boards.

5.4.16.6 End of shunting balises shall be placed at the “end of shunting” locations to prevent shunting trains in SH mode from passing such locations. A level transition order, from L0 to L2, may also be required together with the "danger for shunting" information to trip the trains in case of wrong level selection by the driver.

5.4.16.7 SH mode shall also be possible to allow maintenance vehicles (yellow fleet) equipped with ETCS onboard to move in a temporary working area.

5.4.16.8 [Note: according to UNISIG standard SS-026-4, SH mode does not manage level transitions, however immediate orders shall be accepted and stored for later evaluation]

5.4.17 **Diagnostic, maintenance and recording functions**

5.4.17.1 ETCS trackside shall be equipped with diagnostic and maintenance supporting functions capable of monitoring the health of the system and its interfaces.

5.4.17.2 The Diagnostic and Maintenance module of ETCS shall collect data, incidents, malfunctions, failures, and alarms relating to the system components.

5.4.17.3 Diagnostic information, failures, alarms, and other data shall be recorded for maintenance purpose (corrective and preventive maintenance) and incident investigations.

5.4.17.4 The Maintainer shall interact with the System and its components, both hardware and software, through dedicated D&M consoles.

5.4.17.5 The supporting functions shall allow operators to perform preventive and corrective maintenance, consisting of:

- Showing the status of trackside components and interfaces;
- Real-time monitoring and interrogation functions;
- Acknowledgement of alarms ;
- Recording and archiving of data on non-volatile media for statistics, playback, and post-analysis.

5.4.17.6 The recorded data for maintenance purposes shall be available for a minimum period of 12 months.

5.4.17.7 The ETCS system shall support data recording for regulatory purpose (incident investigation).

5.4.17.8 The recorded data shall be available in a separate standalone JRU (Juridical Recording Unit) for a minimum of 90 days, or a longer period if required by national laws/regulations.

5.4.17.9 All recorded information shall be accessible in a readable format and shall be provided with a user manual for the correct understanding of the retrieved information.

5.4.17.10 The ETCS supporting functions shall fulfil the general cyber security requirements defined in 5.7.

5.5 Performance Requirements

5.5.1 The ETCS design, and more generally the TCS design, should optimize capacity of the line and reduce the journey time.

5.5.2 ETCS equipment shall ensure that the line can be operated without service interruption on 24 hours and 7 days a week all year round (with required traffic stops for maintenance work).

5.5.3 ETCS equipment shall fulfil safety requirements defined in UNISIG standard SS-091 (Safety Requirements for Technical Interoperability of ETCS in Levels 1 & 2).

5.5.4 ETCS trackside shall fulfil the requirements defined in UNISIG standard SS-088 part 3 THR Apportionment (ETCS Application Levels 1 & 2 - Safety Analysis).

5.5.5 The TSCC Contractor shall implement adequate mitigations for the ETCS hazards identified in UNISIG standard SS-113 ETCS Hazard Log.

5.5.6 ETCS shall comply with the safety requirements defined in the TCS Safety Analysis Report which is a mandatory document.

5.5.7 ETCS shall comply with the RAM requirements defined in the TCS RAM Analysis Report.

5.5.8 The ETCS project shall consider the technical performance requirements of ERTMS equipment which are relevant for interoperability defined in UNISIG standard SS-041 in terms of:

- Response times ;
- Accuracy ;
- Clock.

5.5.9 Time-related performance: RBC generates and grants movement authorities to trains based on route information sent by CBI; the maximum time for data processing and data transmission through the communication chain CBI > RBC > Wireless Communication System > OBU (EVC/DMI) shall not exceed 5s (five seconds), from the moment the information is transmitted from CBI to RBC until ETCS On-Board Unit (OBU) processes the radio message and displays the MA on the DMI.

5.5.10 Diagnostic, maintenance and recording performance shall fulfil requirements set out in 5.4.17.

5.6 Requirements for Eurobalises

5.6.1 The Eurobalise Transmission System shall comply with RAMS requirements defined in UNISIG standard SS-036.

5.6.2 Eurobalises shall fulfil installation criteria defined in 11.2.

5.6.3 Accessibility: installation locations of balise groups on open line sections (between stations) shall respect the possibility of direct access from already designed maintenance roads.

5.6.4 Relocation balise groups shall be provided close to the signals at station tracks and in open line, to minimize the odometer error of the trains approaching the end of the movement authority.

5.6.5 Number and location of BGs should be optimized considering balise size, telegram lengths and user bit availability, to define when a same BG can fulfil multiple purposes.

5.6.6 **Requirements for Radio Block Centre**

5.6.6.1 RBC shall be upgradable for future track layout modifications and/or extensions.

5.6.6.2 RBC shall be designed to allow modifications without significant disruption on the traffic operations.

5.6.6.3 One RBC shall be able to manage at least 100 connected trains simultaneously and process up to 1.200 trackside element information (TVP, switch, etc.).

5.6.6.4 One RBC shall be able to interface with more than one CBI.

5.6.6.5 In case of start-up of RBC, or restart following a shutdown of the operating system, the initialization of RBC shall take no longer than 3 minutes and shall not require any intervention by the operator.

5.6.6.6 At each start-up RBC must restore operations in the safest conditions, ensure synchronization with the interfaced systems, such as CBI, TMS, including TSRs, and present the restored data on the HMI.

5.6.6.7 Any previous communications or radio connections that were active before the restart of RBC must be deleted.

5.6.7 **Key Management System (KMS)**

5.6.7.1 The cryptographic key management shall be based on an Offline KMS and shall involve in the key-distribution all RBCs and OBUs of HSR railway line.

5.6.7.2 The KMC shall be required to support offline key management configurations.

5.6.7.3 Off-line KMC shall comply with the relevant UNISIG standards SS-038, for the interface with other off-line KMC, and SS-114, for the interface with ETCS entities.

5.6.7.4 KMC setups and inter-KMC arrangements should comply with the solutions recommended by KMC Expert Group in EUG 23E064-1A KMS Guideline (refer to 2.6).

5.6.7.5 The TCS design should also fulfil the Cyber Security guidelines created by OCORA and RCA, and EULYNX regarding the security risk assessment for System Design process based on IEC 62443 and CLC/TS 50701 (refer to Section 2.4 of this specification for the EULYNX standard).

5.7 Cybersecurity Requirements

5.7.1 ETCS System shall comply with the general HSR cybersecurity policies specified in the related Technical Specification for Cybersecurity.

5.7.2 The ETCS shall be protected against cyber threats which can compromise its availability and integrity requirements.

5.7.3 Adequate defences shall be also provided for the communication interfaces as any safety-related equipment connected through open communication networks can be subjected to many different IT security threats (EN50159 – refer to 2.4).

5.7.4 Any threats which are not to be assumed shall be agreed with the safety authority and/or railway authority and shall be put into the safety-related application conditions.

5.7.5 The following communications subsystems and functions of ETCS System shall require to be protected/secured against cybersecurity threats:

- Balise - On-Board Unit (OBU);
- Programming of balises ;
- RBC - OBU via the Wireless Communication System (Euroradio protocol) ;
- RBC/TMS Operator interface;
- RBC - RBC (UNISIG standard SS-098);
- RBC - CBI (EULYNX cybersecurity requirements);
- RBC - TMS (for critical functions);
- RBC - Master Clock System (for internal RBC clock synchronisation);
- KMC Operator interfaces (set-up keys and access authorization);
- KMC Key transmission to OBU and RBC.

5.7.6 Cyber threat defences in the ETCS design shall include measure for the balises to verify the authenticity of data.

5.7.7 Cyber threat defences in the ETCS design shall include measure to minimise the effect of reduced availability on the communication between OBU and RBC.

5.7.8 Cyber threat defences in the ETCS design shall include measure for integrity and authenticity of the communication, especially from/to RBC.

5.7.9 Cyber threat defences in the ETCS design shall include measure event logging and analysis.

5.7.10 Cyber threat defences in the ETCS design shall include access control measures, such as “Administrative accounts” and “Authentication and identification” security measures.

5.7.11 Cyber threat defences in the ETCS design shall include an update/patching policy for key components (Wireless Communication System, RBC, etc.).

5.7.12 Cyber threat defences in the ETCS design shall implement network controls measures (network segregation, no direct internet connection, no remote access by administrators, ensuring unnecessary services, interfaces, protocols, and port numbers are not activated, etc.).

5.7.13 Cyber threat defences in the ETCS design shall include up-to-date key and certification management and distribution.

5.7.14 Cyber threat defences in the ETCS design shall include scalable KMS.

6 INTERFACES

6.1 General Requirements

6.1.1 Interfaces are classified as below:

- Third Party interfaces: interfaces between TSCC systems and systems provided by Third Party (excluding CHSR TSCC Contractors);
- External interfaces: interface between TSCC systems and systems provided by CHSR contractors (Civils Packages, Stations contractor, Facilities contractor, Solar PV and BESS contractors);
- Internal interfaces between systems within the TSCC scope.

6.1.2 The TSCC Contractor shall develop design considering the identified Third Parties, External and Internal interfaces to ensure the required functionalities and performance described in this specification.

6.1.3 The TSCC Contractor shall, if necessary, propose any additional interfaces required to ensure the functionalities and performance described in this specification.

6.2 Third Parties Interfaces

6.3 External interfaces - Trainsets Contractor

6.3.1 The ETCS, and more generally the whole TCS Subsystem, shall interface with the Trainset Subsystem of HSR Railway in accordance with Commission Regulation (EU) 321/2013 concerning the technical specification for interoperability relating to the subsystem Trainset - freight wagons of the rail system in the European Union (LOC&PAS TSI - WAG TSI).

6.3.2 The interface with Trainset Subsystem shall mainly refer to the following general aspects in relation to the passenger and freight train operation on HSR Railway:

- Compatibility with trackside train detection systems including EMC: Trainset characteristics (CBI scope);
- Train braking performance and characteristics;
- Position of on-board antennas;
- Isolation of ETCS-OB functionality;
- Visibility of trackside marker boards;
- Interface with onboard Data Recording for regulatory purposes;
- Interface with Train Interface Unit: forwarding information/orders and receiving status information from Trainset;
- Construction of TCS onboard equipment: material requirements;
- Emergency and service braking commands.

6.3.3 [Note: most aspects refer to the interface between ETCS onboard and Trainset Subsystem which does not fall within the scope of work of TSCC Contractor, and they are reported within this technical specification only for completeness of the technical topics]

6.3.4 The visibility of trackside marker boards shall refer to the compatibility between dimensions, optical properties, and position of the marker board on the infrastructure, and the driver's external field of view.

6.3.5 The optical properties (colours and retroflection coefficients) of any trackside board shall fulfil EN12899-1 (refer to 2.4) and shall be adapted to the optical features of train head lamps manufactured in accordance with EN15153-1. The driver shall be able to easily read the information in any condition and at any time.

6.3.6 The relevant information/orders that ETCS-OB receives from ETCS-TS shall be forwarded to the train interface unit. This train interface shall comply with the ETCS onboard requirements defined in UNISIG standard SS-034 (Train Interface FIS) and UNISIG standard SS-119 (Train Interface FFFIS).

6.4 External Interfaces – facilities contractor

6.4.1 The TSCC Contractor shall install ETCS equipment in the OCC and facilities being provided by the facilities contractor.

6.4.2 The TSCC Contractor shall provide to the facilities contractor:

- Equipment dimensions
- Equipment clearances requirements
- Equipment mounting and fixings requirements
- Cable routes/containment requirements
- Equipment loadings
- Installation and maintenance requirements
- Equipment heating loads
- Equipment cooling loads
- Equipment hydraulic requirements

6.4.3 To be provided by facilities contractor to accommodate the TCSS equipment installation and operational/maintenance requirements:

- Room dimensions and layouts
- Room facilities (Plumbing, HVAC, Lighting, Fire Protection Systems, Doors, electricity)
- Room raised floor system
- Delivery access routes.
- Maintenance access routes

6.5 Internal Interfaces

6.5.1 **Track interfaces**

6.5.1.1 The ETCS shall interface with the Track Subsystem of HSR Railway in accordance with Commission Regulation (EU) 1299/2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union (INF TSI).

6.5.1.2 The interface between ETCS and INFRA Subsystem shall mainly refer to the following components of ETCS in relation to the structure gauge parameters of HSR Railway:

- Eurobalise communication system: space for installation;
- Trackside Control-Command and Signalling objects: trackside marker boards;
- Eurobalises and trackside marker boards shall be located on HSR according to the installation requirements defined in 11.2.

6.5.1.3 The interface shall also relate to the track gradient, track objects and speed profiles determined by track (and Operation) and the corresponding track model implemented in the RBC. TSCC Contractor shall implement a SIL 4 process for the treatment of data.

6.5.2 **Computer Based Interlocking (CBI)**

6.5.2.1 RBC and CBI shall operate in the same TCS domain as depicted in the HSR operational context (refer to 4.3).

6.5.2.2 RBC shall have a redundant interface with CBI via the transmission network (DCN).

6.5.2.3 RBC-CBI-(TMS) interworking shall ensure that the expected functions set out in 5.4 are achieved.

6.5.2.4 The interface between RBC and CBI shall be based on the Standard Common Interface SCI-RBC of EULYNX Baseline Set 4 Release 4, which provides a common set of Messages and Commands (Orders)

6.5.2.5 RBC shall be able to receive from CBI the following set of Messages based on the EULYNX standard interface:

- Signal status;
- Switch status;
- TVP section status (axle counter system);
- I/O generic element status: alarms, any other possible alarm received from the detection devices;
- Emergency Stop Area (ESA) status;
- Local Shunting Area (LSA) status;
- Working Area (WA) status;
- Route status.

6.5.2.6 [Note: in an ERTMS/ETCS L2 domain it may be the status of the “virtual signal” associated to an ETCS marker board]

6.5.2.7 RBC shall be able to send to CBI the following set of Messages based on the EULYNX standard interface:

- Train data;
- Flank Protection status;
- Signal cancelling reply;
- Signal occupation;
- Route cancelling reply;
- Route occupation.

6.5.2.8 RBC shall be able to receive from CBI the following Commands based on the EULYNX standard interface:

- Signal cancelling;
- Route cancelling.

6.5.2.9 RBC shall be able to send to CBI the following Commands based on the EULYNX standard interface:

- I/O generic element control;
- Signal control;
- Signal overlap control;
- Route control.

6.5.2.10 Any additional message or command that for operational needs must integrate the previous list shall be exchanged via the EULYNX interface, if feasible, otherwise through a different safe communication interface.

6.5.2.11 The full set of messages/commands exchanged between RBC and CBI shall be defined during the design phase of TSCC Contractor.

6.5.3 **Traffic Management System (TMS)**

6.5.3.1 RBC and TMS shall operate in the same TCS domain as depicted in the HSR operational context (refer to 4.3).

6.5.3.2 RBC shall have a redundant interface with TMS via the Digital Communication Network (DCN).

6.5.3.3 RBC-TMS-(CBI) interworking shall ensure that the expected functions set out in 5.4 are achieved.

6.5.3.4 The SCI-CC interface specification of EULYNX is currently used to interface TMS with CBI; it may also be used to interface RBC to TMS for some specific functions.

6.5.3.5 The user interface (TMS HMI) shall show to the Traffic Operator the status of the line, and of the trains, under its jurisdiction.

6.5.3.6 RBC shall be interfaced with the TMS to exchange a general set of information/orders (messages/commands) related to:

- Movement Authorities;
- ETCS modes;
- Traction Power conditions;
- Trackside Conditions: non-stopping area, etc;
- Emergency stop areas, shunting areas, and working areas, via CBI;
- Train information: train running number, train position, train speed, status of radio connection;
- ETCS equipment: integrity status, alarms, and events;
- Temporary speed restrictions;
- Emergency messages;
- Text messages;
- Any other information or order to fulfil HSR operational/safety needs.

6.5.3.7 The full set of messages/commands exchanged between RBC and TMS shall be defined during the design phase of TSCC Contractor.

6.5.3.8 The user interface shall be provided with - but not limited to - the following general commands:

- Temporary speed restriction: activation/deactivation.
- Non-stopping area: activation/deactivation.
- Shunting area/train authorized in shunting mode association.
- Emergency stop message: activation/revocation.

6.5.3.9 The traffic operator shall manage TSRs using the following specific commands:

- Plan a TSR.
- Activate a TSR.
- Deactivate a TSR.
- Remove a TSR.

6.5.3.10 To make the TSR implementation a safe process, the TSR module shall include authority rights as regard to planning, activation, deactivation, and removal. The TSCC Contractor should adopt protocols and techniques coming from the best practice for possession management in safety-related railway systems (for example, planning a TSR in 2 steps executed by different operators, 1 for preparation and 1 for validation; double commands to avoid unexpected deactivation or removal).

6.5.3.11 The traffic operator shall be informed about the presence of issues in the actions performed through dedicated alarms (e.g., TSR planning rejection, TSR activation rejection, TSR removal rejection, CES rejection, etc.).

6.5.4 Wireless Communication System

6.5.4.1 Wireless Communication System used as radio bearer service for ETCS shall be as specified in Schedule 5(r) - WCS Specification].

6.5.4.2 RBC shall have a redundant interface with the Wireless Communication System via the Digital Communication Network (DCN).

6.5.5 Hazard Detection and Early Warning System

6.5.5.1 Hazard Detection and Early Warning detectors shall be deployed on HSR Railway to ensure:

- Monitoring of trackside assets;
- Monitoring of meteorological events.

6.5.5.2 RBC shall interface the alarms raised by the Hazard Detection and Early Warning detectors via direct interface, or TMS or CBI, depending on the outcome of the Hazard Analysis that shall be performed to define the level of mitigation required (e.g. immediate emergency stop order, confirmation or not by the controller before the mitigation is put in place, Maker board set to danger, application of TSR…)

6.5.5.3 The ETCS design shall include any other mitigation that may be further required by the hazard analysis.

6.5.6 **Enterprise Asset Management System (AMS)**

6.5.6.1 The maintenance of ETCS trackside shall be integrated with the maintenance of the other Systems of TCS Subsystem.

6.5.6.2 The ERTMS/ETCS system shall be interfaced with the Enterprise Asset Management System (EAMS).

6.5.6.3 RBC shall have a redundant interface with EAMS.

6.5.6.4 ETCS shall provide EAMS with the following types of information:

- Incidents and alarms related to the system;
- Subsystem and component failures;
- Data records to prepare the Preventive Maintenance.

6.5.6.5 The full set of information to be transmitted to EAMS, and the format in which this should be presented by ETCS, shall both be defined during the design phase of TSCC Contractor.

6.5.7 **Network Timing System (NTS)**

6.5.7.1 The ETCS trackside shall interface with the NTS for time distribution to RBC and precise synchronisation with the other interfaced systems of TCS subsystem, including ETCS onboard.

6.5.7.2 [Note: out of the TSCC Contractor scope of work, individual GPS-based clock receivers shall be provided on the trains for the time synchronisation]

6.5.7.3 ETCS-NTS shall be a redundant interface.

6.5.7.4 Features and performance required for NTS are set out in the relevant NTS Technical Specification for TSCC.

6.5.7.5 Whatever time protocol is to be supported (PTP, NTP, SNTP, etc.), it must be considered that ETCS requires accurate time synchronisation and rigorous timestamping of Euroradio messages and data records.

6.5.8 **Digital Communication Network (DCN)**

6.5.8.1 RBC system shall use the Digital Communication Network to centrally interface with CBI, TMS, the Wireless Communication System, AMS/SCADA and MCS, as well as with neighbouring RBCs.

6.5.8.2 All previous communications shall be redundant.

6.5.8.3 Features and performance required for the core network are set out in the relevant DCS System Technical Specification for TSCC.

6.5.9 **Low Voltage Power Supply (LVPS)**

6.5.9.1 The ETCS trackside equipment shall have a redundant interface with the LVPS system.

6.5.9.2 The ETCS equipment shall be considered by LVPS as an “emergency load” requiring uninterrupted power.

6.5.9.3 Features and performance required for LVPS system are set out in the relevant MV+LV Power Supply System Technical Specification for TSCC.

7 MATERIALS, PRODUCT AND COMPONENTS REQUIREMENTS

7.1.1 According to the European Construction Products Regulation (CPR) 305/2011/EU, the ETCS trackside components shall be provided with a CE mark accompanied by information on the level or class of performance of the Essential Characteristics. There shall be a clear marking that identifies the Balise Class of the Eurobalise as required by UNISIG SS-026, while the labelling of trackside boards shall comply with the EN12899-1 standard.

7.1.2 The Eurobalise shall also be equipped with a supplementary tag containing the specific ETCS project information, such:

- Type/main function of the balise or balise group;
- “Country or Region Identifier” (NID_C) and “BG Identifier” (NID_BG);
- Progressive number of the balise within the BG;
- Direction of validity of the message it contains.

8 TOLERANCES

8.1.1 The design, dimensions, optical properties, mechanical performances, and maintenance requirements of trackside boards shall fulfil the European Standards EN12899-1 and EN16494 (refer to 2.4).

8.1.2 The tolerance for each dimension referred in EN16494 shall be ±1% with a minimum of ±2mm.

8.1.3 Tolerances for balise installation (height, lateral, angular, etc.) shall fulfil UNISIG standard SS-036.

9 SCOPE OF SUPPLY AND DELIVERY

9.1 General Requirements

9.1.1 General requirements related are described in Technical Contract Requirements.

9.2 Specific Requirements

9.2.1 The ETCS scope of supply and delivery shall include (not limited to):

- Central ETCS servers;
- TMS/RBC Operator Workstations/HMIs;
- Maintenance Workstations;
- Workstation and servers for tests on-site and laboratory compliance tests;
- ETCS On Board Subsystem for laboratory tests;
- Eurobalises, brackets and cover plates adapted to track configuration;
- Trackside boards, including masts and brackets;
- Cabling and connectors;
- Racks;
- Tools and simulators for on-site and laboratory compliance tests, and for CHSR Authority training purposes;
- Software architecture including full definition of protocols used;
- Management System;
- SW licenses.

9.2.2 Specific configuration shall be delivered enabling the testing at operational speed of 350 km/h + 10 %, keeping ETCS supervision active on-board the train (with SIL 4).

10 MANUFACTURING

10.1 General Requirements

10.1.1 General manufacturing requirements are defined in the Scope of Work.

11 INSTALLATION AND INTEGRATION

11.1 General Requirements

11.1.1 General installation and integration requirements are defined in the Scope of Work and Schedule 3.

11.2 Specific Requirements

11.2.1 The installation of TSCC objects shall fulfil the basic TSI parameters in terms of interoperability, visibility, and compatibility with the railway infrastructure.

11.2.2 The installation of TSCC objects shall meet the clearance gauge requirements of HSR Railway.

11.3 Installation requirements for balises

11.3.1 The installation of balises shall ensure that the expected operational, functional and performance requirements defined in this technical specification are achieved.

11.3.2 Balise installation shall fulfil clearance gauge requirements relating to the lower envelope.

11.3.3 The TSCC Contractor shall propose the fixing methods of the balises and provide information relating to the specific support used: whatever solution is proposed, this shall not require drilling of sleepers or rails.

11.3.4 The general installation rules for balises shall comply with UNISIG standard SS-036 for the following main aspects:

- Crosstalk protection.
- Location reference accuracy.
- Time and distance requirements for constraints on distances between Balise Groups.
- Height Tolerances for Balise Mounting.
- Distance from Top of Rail to Balise Reference Mark.
- Lateral and Angular Tolerances for Balise Installation.
- Distance between Balises.
- Number of Balises in a Balise Group.
- Balise Installation in Narrow Curves.
- Metallic Masses and Cables in proximity.
- Environmental Conditions.

11.3.5 The installation of balises shall fulfil UNISIG standard SS-040 (Dimensioning and Engineering rules) for the following main aspects:

- Maximum distance between balises within a group.
- Minimum distance in rear of EOA/LOA of a balise group giving an immediate level transition order or giving a “Stop if in SR”.
- Balise installation relative to track conditions.
- Balise installation relative to mission profile (UNISIG SS-091).
- The minimum distance between two adjacent balises of the same balise groups shall be:
- Main running tracks: 5m from centre to centre to meet maximum speed requirements for dynamic tests (300km/h + 10%) with active ETCS L2 supervision.
- For other tracks: 3m from centre to centre.

11.3.6 Balises shall be installed with an accuracy location of the balise group non greater than ±5m.

11.3.7 According to the safety requirements for technical interoperability set out in UNISIG standard SS-091, the maximum distance between two consecutive balise groups shall never exceed 2500m.

11.3.8 In general, the installation of balises should be avoided in proximity of cables, metal masses, and other interfering conductive materials, unless it is possible to respect the metal free area around the balise required by UNISIG standard SS-036. This restriction may apply to:

- Turnout area.
- Steel sleeper.
- Derailment plinth with metallic reinforcement.
- Metal plane.
- Guard rails.

11.3.9 Specific locations of HSR where the installation of balises should be avoided are:

- Railway bridges where guard rails may be used to provide protection against derailments, as in the case of Neris bridge (approximately 1.500 meters long).

11.3.10 If balises cannot be avoided in proximity of guard rails for any operational, or safety, or interoperability need of ETCS application, such balises shall be positioned on the track under the conditions defined in UNISIG standard SS-036.

11.3.11 [Note: typical solutions which make balises able to operate in presence of guard rails are the longitudinal mounting or a gap/cut in the guard rails]

11.4 Installation requirements for trackside marker boards

11.4.1 The installation of marker boards shall ensure that the expected operational, functional and performance requirements defined in this technical specification are achieved.

11.4.2 The installation of trackside marker boards shall be compatible with both sighting requirements (driver's field of view) and infrastructure requirements (curves, tunnels, bridges, etc.), taking also into account the adverse climatic conditions which may affect the visibility of marker boards (e.g., the high snow level).

11.4.3 Marker board installation shall fulfil gauge requirements relating to lateral and upper envelope.

11.4.4 Since EN16494 provides five sizes for ERTMS trackside boards (500m, 600m, 700m, 800m, 900m), in case a size smaller than 500m must be used, the height/width ratio of the dimensions shall be same of standard size.

11.4.5 ETCS Stop and Location markers shall not be placed in areas where stopping the train may lead to dangerous situations. Bridges, tunnels, ecoducts, and similar areas, should be avoided.

11.4.6 ETCS Stop and Location markers shall be installed on the left side, on the right side or on the top side of the track, in such a way that they clearly indicate the track to which they belong.

11.4.7 ETCS Stop and Location markers in double-track sections should be aligned to the same miles point.

11.4.8 Trackside boards shall be mounted on a dedicated mast or, when possible (mainly in open line), on existing structure (e.g., the catenary pole).

11.4.9 Poles of marker boards shall be made of elements of polyester reinforced with glass fibers, or galvanized steel.

11.4.10 Marker boards and their supporting poles shall be resistant to static and dynamic loads, including snow, rain, wind and overpressures due to aerodynamic effects generated by passing trains. During the design phase TSCC Contractor shall provide type and dimensions of the mast foundation blocks, taking into consideration the geognostic properties of the soil.

11.5 Mounting requirements for indoor equipment

11.5.1 RBC, TSR, and D&M servers shall be mounted in 19” rack cabinets whose dimensions shall comply with EN 60297-3 (refer to 2.4).

12 TESTING & ACCEPTANCE

12.1 General Requirements

12.1.1 General testing and acceptance requirements are defined in the Scope of Work and Schedule 3.

12.2 Specific Requirements

12.2.1 The ERTMS/ETCS tests shall verify the compatibility with other TCS subsystems and related interfaces.

12.2.2 The ERTMS/ETCS tests shall verify:

- The safe integration of all internal components and interfaces that form the architecture of the ETCS subsystem.
- The safe integration of all external interfaces of the ETCS subsystem, within its direct physical, functional, environmental, operational and maintenance context.
- The safe integration between ETCS trackside and ETCS onboard.

13 SUBMITTALS

13.1 General Requirements

13.1.1 submittals required for the Interlocking system are defined in the Scope of Work.

14 QUALITY MANAGEMENT

14.1 General Requirements

14.1.1 General quality management requirements are defined in the Contract and associated Schedules.

15 ADDITIONAL INFORMATION REQUESTED

15.1.1 In addition to the mandatory requirements outlined in this specification, the CHSR Authority reserves the right to request from the TSCC Contractor and related Suppliers, information pertaining to the performance of proposed or supplied elements under similar service conditions, with particular emphasis on railway management aspects which may influence ETCS system reliability, availability and maintainability characteristics.

16 LOGISTICS

16.1.1 General logistics requirements are defined in the Agreement.