Schedule 5(g)

Hazard Detection and Early Warning System (HDEWS)

California High-Speed Rail Authority

Standard Specifications

TSCC Specifications

SPEC-0011 – Hazard Detection and Early Warning System (HDEWS)

Rev. 0.0

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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 Authority's requirements for the Hazard Detection and Early Warning System, hereinafter: HDEWS.

1.1.2 The functional architecture of the HDEWS is presented in Appendix A.

1.1.3 The requirements are formulated 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 technical specification for all stages of the design, test, manufacture, supply, delivery, assembly, installation, testing, commissioning, training, operations and maintenance.

2.1.2 All generic standards to be used are provided in: Schedule 16.

2.2 TSI

2.2.1 The applicable TSIs are listed below:

ID	TSI	Title
[R1]	SRT TSI	Commission Regulation (EU) No 1303/2014 of 18 November 2014 - concerning the technical specification for interoperability relating to 'safety in railway tunnels' of the rail system of the European Union including commission regulation (EU) 2016/912 of 9 June 2016 L 153 28 10.6.2016 and commission implementing regulation (EU) 2019/776 of 16 May 2019
[R2]	OPE TSI	The Commission has published the latest version of the TSI OPE under the Implementing Regulation 2023/1693 (TSI OPE 2023). This amends the Implementing Regulation 2019/773 (TSI OPE 2019). TSI OPE 2019 is in force since 16 June 2021 except for: 4.2.2.1.3.2 on Train visibility – rear end – freight trains (Tail Plates), Appendix A on ERTMS operational principles and rules (Appendix A) and Appendix C on communication (Appendix C). TSI OPE 2023 is published as an amendment to 2019 version and it enters into force 20 days after its publication (28 September 2023). Railway undertakings and infrastructure managers shall adapt their SMSs to the changes introduced by the TSI OPE 2023 within 9 months after TSI's publication (28 June 2024)
[R3]	TSI INF	Commission Regulation (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union, amended on 16/05/2019, including commission implementing regulation (EU) 2019/776 of 16 May 2019 and commission implementing regulation (EU) 2023/1694 of 10 August 2023
[R4]	ENE TSI	Commission Regulation (EU) No 1301/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'energy' subsystem of the rail system in the Union Text with EEA relevance including commission implementing regulation (EU) 2018/868 of 13 June 2018 and commission implementing regulation (EU) 2019/776 of 16 May 2019 and commission implementing regulation (EU) 2023/1694 of 10 August 2023

TABLE 1 LIST OF TSI AND REGULATIONS

2.3 Standards

2.3.1 The relevant European standards to be used for HDEWS are listed below.

2.3.2 The TSCC Contractor shall fully consider and apply the following standards in the provision of the Services, the in-force standards shall be applied.

ID	Standard	Title
[R5]	EN ISO 11205	Acoustics Noise emitted by machinery and equipment Engineering method for the determination of emission sound pressure levels in situ at the workstation and at other specified positions using sound intensity
[R6]	EN 13460	Maintenance – Documentation for maintenance
[R7]	EN 13775-1	Railway applications – Measuring of new and modified freight wagons – Part 1: Measuring principles
[R8]	EN 17230	Information technology – RFID in rail
[R9]	EN 15273-1	Railway applications – Gauges – Part 1: General – Common rules for Rolling Stock and Infrastructure
[R10]	EN 15273-2	Railway applications – Gauges – Part 2: Rolling stock gauge
[R11]	EN 15273-3	Railway applications – Gauges – Part 3: Structure gauges
[R12]	EN 14067-6	Railway applications — Aerodynamics — Part 6: Requirements and test procedures for cross wind assessment
[R13]	EN 15437-1	Railway applications - Axle box condition monitoring - Interface and design requirements Part 1: track side equipment and rolling stock axle box
[R14]	EN 15437-2	Railway applications - Axle box condition monitoring - Interface and design requirements Part 2: performance and design requirements of on-board systems for temperature monitoring
[R15]	EN 16729-3	Railway applications – Infrastructure – Non-destructive testing on rails in track – Part 3: requirements for identifying internal and surface rail defects
[R16]	EN 50119	: Railway application – Fixed installations – Overhead contact lines for electric traction, Principle drawing 21404/304730 – Obstacle and electrical insulation template

TABLE 2 LIST OF APPLICABLE STANDARDS

2.4 UIC Recommendations

2.4.1 The relevant UIC recommendations to be followed are listed below listed below.

UIC	Title
UIC 505-1	Railway transport stock - Rolling stock construction gauge
UIC 515	Cars – Running gear
UIC 608	Pantograph/Overhead line Interaction
UIC 660	Measures to ensure the technical compatibility of high-speed trains
UIC 779	Safety in railway tunnels

TABLE 3 - LIST OF UIC RECOMMENDATIONS

3 TERMS, DEFINITIONS, AND ABBREVIATIONS

3.1 General

3.1.1 All the terms, definitions, and abbreviations are provided in Schedule 5(t) SPEC-0024 – Glossary of Terms, Abbreviations, and Definitions.

4 SYSTEM DESCRIPTION

4.1 Purpose of the HDEWS

4.1.1 The HDEWS is a collection of integrated technologies and sensors designed to oversee and manage various auxiliary components of the trainsets and wayside infrastructure. This system will monitor and control the trainset health, broken rail or falling vehicles detection, among others.

4.1.2 The primary objectives of HDEWSs are:

- Reducing maintenance costs.
- Collecting data for railroad service provision.
- Preventing damage to the environment.
- Preventing accidents: Vehicles and infrastructure damage can result in expensive repairs and erode public confidence in the transportation system.
- Preventing human injuries or fatalities: The transportation system must ensure safety.
- Minimizing downtime resulting from infrastructure damage and extending the lifespan of assets.

4.1.3 The HDEWS shall be based on the methods of automatic identification of the irregularities based on data from several Modular Sensors and initiation of the procedures to reduce the impact on service in general and rather on safety (e.g.: by sending alarms to the OCC). Probabilistic decision-making methods and theories shall be used to analyze the collected data and compare them with the reference systems information to make recommendations about any further actions.

4.2 HDEWS definition

4.2.1 The HDEWS is composed of the:

- A set of servers and data collectors for the control and supervision of the HDEWS subsystems
- Hot-Axle Box Detection System (HABDS)
- Derailment Detection System (DDS)
- Broken Rail Detection System (BRDS)
- Rail Temperature Monitoring System (RTMS)
- Road Vehicle Detection System (RVDS)
- Flooding Detection System
- Earthquake Detection System
- Meteorological Condition Detection System (MCDS)

4.3 HDEWS operational context

4.3.1 The mission of the HDEWS is to prevent accidents, to maintain expected availability of service, to reduce downtime of the railway line and to improve the asset life cycle by implementing systems (as stated in the general requirement) dedicated to the monitoring of the trainset, infrastructure, and other conditions.

4.3.2 The personnel involved in the operation of the HDEWS are maintenance and operation managers.

4.3.3 The HDEWS shall be operated according to Authority procedures. These procedures should be aligned with the system's operational requirements. Provisions for continuous information sharing and lessons learned shall be integrated into the operational framework.

4.4 Design Life

4.4.1 The design life for the HDEWS shall be 30 years in compliance with the General requirements Installation and Integration.

4.4.2 The TSCC Contractor shall ensure that the manufacturers will be able to produce HDEWS components, with equal or better technical specifications, throughout the required operational lifetime, recognizing the potential for successive generations and evolving sensor technology.

5 SYSTEM REQUIREMENTS

5.1 General Requirements

5.1.1 Trainset Health Monitoring Equipment

5.1.1.1 Equipment targeting the detection of the correct health of the train are wayside detectors that monitor passing trains for defects. Monitored defects may require immediate action and require corrective maintenance. The wayside detectors will provide information directly to the Operational Control Center, to the train or to dedicated remote systems and to the train control system that permits a safe stop of the faulty train. The HDEWS shall include the following modular sensors dedicated to the monitoring of the trainset:

- Hot-Axle Box Detection System (HABDS),
- Derailment Detection System (DDS),

5.1.2 Infrastructure Monitoring Systems

5.1.2.1 The HDEWS shall include the following modular sensors dedicated to the monitoring of Infrastructure:

- Broken Rail Detection System (BRDS),
- Rail Temperature Monitoring System (RTMS),
- Road Vehicle Detection System (RVDS), which derivative can be used as a landslide/falling rock detection system,

5.1.3 Environmental Monitoring Equipment

5.1.3.1 The HDEWS shall include the modular sensors dedicated to the:

- Meteorological Condition Detection System (MCDS) wind,
- Meteorological Condition Detection System (MCDS) rain,
- Flooding Detection System (MCDS),
- Earthquake Detection System (MCDS),

5.1.4 Data Collectors

5.1.4.1 The locations and compositions of the Modular Sensor provided in different locations shall be selected based on its purpose during the detailed design phase and in conjunction with the Employer

5.1.4.2 The TSCC Contractor shall provide a specific strategy of data collector locations.

5.1.4.3 The program for the implementation of all HDEWSs, what detectors and at what location, shall be justified. The TSCC Contractor shall provide an additional analysis of the detection sensors needed and their geographical distribution.

5.1.4.4 The exact positions of Data Collectors and Modular Sensors shall be defined based on the technologies chosen to meet the requirements according to the Reference Standards and Documents.

5.1.4.5 When defining the exact location for the Data Collector, the TSCC Contractor shall consider the concentration of the equipment in the predefined land plot reservation areas at block section locations, cross-over and station turnout areas – system equipment locations (SEL).

5.1.4.6 All Modular Sensors included in the HDEWS of a location shall be provided as a trackside modular system.

5.1.4.7 All Modular Sensors included in the HDEWS of a location shall be integrated within the Data Collector.

5.1.4.8 Each independent detection sensor shall be connected to the Data Collector.

5.1.4.9 All monitored, measured, or controlled parameters must communicate using a standardized and open protocol, defined in an EN or ISO standard, an IETF RFC, or an equivalent unencumbered specification, available for industry review before submission.

5.1.4.10 Data collectors shall be based on standard architecture to ensure independence from any specific manufacturer, programming language, or operating system.

5.1.4.11 No constraints shall be imposed on data ownership or the usage of the protocols.

5.1.4.12 The protocol used between the Data Collector and peripherical sensors shall be fully aligned with the Cybersecurity Technical Specification.

5.1.4.13 The protocols used shall be fully documented, including documented data schema. The implementation shall be documented in both human and machine-readable formats.

5.1.4.14 The protocols used shall include:

- Message namespace,
- Version control,
- Sensor node status,
- Messaging on status changes such as values, events, or threshold breaches.

5.1.4.15 The Data Collector shall be equipped to facilitate communication using a set of specified protocols to ensure seamless integration and interoperability. The protocols are divided into two groups: primary protocols, and secondary protocols, that can be used only within subsystems. Other open protocols can be proposed.

5.1.4.16 The primary protocols, for system interaction, include, but are not limited to:

- OPC UA,
- MQTT / MQTT Sparkplug,
- EULYNX.

5.1.4.17 The secondary protocols, used within subsystems only, include, but are not limited to:

- IEC 60870-5,
- IEC 61850,
- SNMP V3,
- BACnet,
- Profibus,
- Profinet,
- Profisafe.

5.1.4.18 The data collector ensures interoperability by understanding and converting data from different ancillary systems into a common format. This facilitates seamless communication and sharing of information between disparate systems.

5.1.4.19 The data collector is designed to operate within a specific geographical area. It shall be programmed to collect data from ancillary systems located within a defined region, ensuring that the information gathered is relevant to the specific context or location.

5.1.4.20 The design of the data collector shall be scalable to accommodate an increasing number of ancillary systems or expanding geographical coverage. This ensures that the system can adapt to changing requirements and growth.

5.1.4.21 The Data Collector shall be based on PLC, PC or RTU solution.

5.1.4.22 Data shall be transferred into a streaming data pipeline which will correlate and consolidate event information and actions across multiple subsystems to provide a single user interface and to support analytics and other longer-term uses.

5.1.4.23 Data collector nodes, located at the edge of network, should be designed to be manageable from the core infrastructures. These nodes should be treated as edge compute devices, enabling centralized monitoring, configuration, and control.

5.1.4.24 In case sensors generate substantial volumes of data, the HDEWS shall incorporate a local data analysis capability to handle it.

5.1.4.25 The Data Collector shall be modular, scalable, and able to receive information from with each type of Modular Sensors.

5.1.4.26 The Data Collector shall be able to transform formats into a limited number of standardized formats, such as the primary and secondary protocols. This transformation ensures that core systems are relieved from managing raw data across different protocols.

5.1.5 Communications

5.1.5.1 The HDEWS shall be designed to accommodate an extensive range of network connections, without imposing limitations, including the potential utilization of advanced network protocols like the 5G CHSR FRMCS private network.

5.1.5.2 The communication system must adhere to a documented data scheme, rather than relying on standalone applications.

5.1.5.3 The system must allow the automation of node discovery.

5.1.5.4 The data generated by the ancillary systems, shall be treated as confidential and shall be the sole property of CHSR. It is required that this data be securely stored on CHSR servers and made readily accessible to CHSR Incident Managers for analysis.

5.1.6 Technical solutions

5.1.6.1 A Multicriteria Analysis (MCA) must be conducted to assess and select a technical solution that aligns with the specific needs of CHSR. The evaluation criteria for the MCA must be clearly defined and aligned with CHSR requirements before the assessment of technical solutions is initiated. Consideration should be given to factors beyond cost alone, ensuring that the chosen solution is not only cost-effective but also optimally suited to meet the unique requirements of CHSR.

5.1.6.2 Data must adhere to the structure specified in the CHSR requirements and be accessible for integration into the Asset Management System.

5.1.6.3 The TSCC Contractor may propose the Light Detection and Ranging, also called LiDAR for HDEWSs if the proposed solution meets all the requirements described in this TS.

5.1.6.4 The TSCC Contractor’s proposal for HDEWSs should include a detailed explanation of how LiDAR technology will be integrated and utilized, including key functionalities, data processing methods and system interactions.

5.1.6.5 The TSCC Contractor shall ensure that LiDAR solution is fully compliant with all the protocol's requirements and shall adhere to the mentioned modular principles, allowing for seamless integration and future expansion without needing extensive system modifications.

5.1.6.6 The TSCC Contractor should propose solution which allow the concept of the "intelligent gate" (combining all these sensors into a virtual gateway at transition points).

5.2 Environmental Conditions Requirements

5.2.1 The HDEWS equipment shall meet the environmental requirements described in the general requirements.

5.2.2 The trackside HDEWS equipment shall be immune to solar rays.

5.2.3 The HDEWS equipment shall comply with the EMC requirements according to the related standards and considering the typical electrified railway environment.

5.3 Operational Requirements

5.3.1 The TSCC Contractor shall ensure compliance with the CHSR operational rules when defining any additional locations required beyond those to the locations specified in 5.1.

- Establishing alarm, warning and notification levels and thresholds.
- Developing alarm triggering procedures.
- Implementing alarms, protocols, and procedures.
- Defining the structure and classification of reports, considering factors such as track blocks and critical assets.

5.4 Functional Requirements

5.4.1 General Requirements

5.4.1.1 The HDEWS shall include components for monitoring, control, reporting, archiving, and analyzing several functions.

5.4.1.2 The HDEWS shall be capable of exporting data related to the Trainsets to the potential 3rd party Trainsets Asset Management System.

5.4.1.3 The HDEWS shall be capable of checking the required parameters and sending alarms, notifications, warnings to the ICSS systems if some noncompliance is detected.

5.4.1.4 The alarms, warnings, and status from Modular Sensors shall be provided by the HDEWS to the ICSS and shall be represented at the related HMI.

5.4.1.5 Data provided to the ICSS systems shall supply continuous and effective monitoring and control of the concerned assets.

5.4.1.6 All alarm indications shall be flashing when requiring immediate attention and steady if less urgent attention is necessary.

5.4.1.7 Alarms shall be provided for any conditions affecting normal operation.

5.4.1.8 Specific procedures shall be put in place for rail temperature, pantograph, load condition, gauge, road vehicle, broken rail, and wheel flat, and alarms thresholds shall be remotely configurable.

5.4.1.9 The HDEWS shall provide data and alarms directly to the AMS and AMS modules (predictive, supply chain, etc.):

- Significant measure deviations of an asset during a single journey (device failure suspicious).
- Indicators such as number of operations, time of use, number of failures, etc.

5.4.1.10 The HDEWS shall provide alarms on the abnormal conditions detected by the HABDS, BRDS, RTMS and MCDS to the OCC (Traffic Management System, Interlocking and ETCS).

5.4.1.11 The HDEWS shall provide alarms on the abnormal conditions detected from the DDS, RVDS, MCDS (flood) to the train control system.

5.4.1.12 The HDEWS shall collect and store the data shared by national weather conditions institutions to define at a minimum parameters such as temperature, humidity, wind, precipitations and forecast of wind, temperature, and precipitations.

5.4.1.13 The HDEWS shall be able to provide Asset Information data for maintenance purposes when requested to the EAMS

5.4.1.14 Vehicle tracking may also be used as a source for correlating information for other sensors.

5.4.1.15 The overall monitoring system shall include a functionality for correlating information from the sensors, enhancing the overall railroad operations and facilitating efficient data correlation.

5.4.2 Hot-Axle Box Detection System (HABDS)

5.4.2.1 The HABDS shall check the wheel temperatures and shall determine which axle is outside of the normal parameters.

5.4.2.2 The HABDS sensors shall be installed at a regular interval on both side of the main track to stop a faulty train at a pre-determined location on the main track (to be defined by the safety study)

5.4.2.3 The HABDS shall also integrate the function of detecting brake binding.

5.4.2.4 The HABDS shall be implemented along the line to monitor the train component overheating.

5.4.2.5 The HABDS shall be implemented to prevent a train on fire entering a tunnel.

5.4.2.6 The HABDS shall be designed according to EN 15437.

5.4.2.7 The HABDS shall be designed to monitor various types of axles and possess radiation immunity.

5.4.2.8 The HABDS shall be designed to monitor various types of axles and possess radiation immunity.

5.4.2.9 It will have the capability to acquire, at minimum, the following trainset parameters:

- Temperature of axle boxes,
- Temperature of wheels treads/rim/brake disc,
- Speed of a wheelset.

5.4.2.10 The HABDS shall be able to monitor all types of axles.

5.4.3 Derailment Detector System

5.4.3.1 The DDS sensors shall be installed at a regular interval on both side of the main track to stop a faulty train before it reaches a sensitive area on the main track (such as a viaduct, switch area… to be defined by the safety study)

5.4.3.2 DDS detectors shall be interfaced with the train control System and complex operation (rerouting of following and passing train) shall be applied in case of faulty train detected within a configurable reaction time

5.4.3.3 The DDS System shall send alarms to the OCC if one axle derailment is detected.

5.4.3.4 Detection of default by the Derailment Detection System shall result in automatic emergency stopping of the faulty trains

5.4.3.5 The TSCC Contractor shall develop an adequate general interface document

5.4.3.6 The DDS detection system should directly interact with the train control system to stop the faulty train

5.4.3.7 The DDS shall be able to monitor trainsets running at 220 mph.

5.4.3.8 The number of false alerts shall be minimized to 1 / 1000 maximum

5.4.3.9 DDS system shall be at least SIL 2

5.4.4 Broken Rail Detection System (BRDS)

5.4.4.1 The BRDS shall be able to identify if an abnormal rail parameter is detected.

5.4.4.2 The BRD System shall provide an alarm to the OCC in case BRDS identifies abnormal conditions

5.4.4.3 Different alarms shall be trigger at the OCC level for the various parameters of the rail detected

5.4.4.4 Detection of default by the BRD system shall result in automatic emergency stopping of all approaching trains in the concerned area

5.4.4.5 The TSCC Contractor may propose the fiber optic sensing solution for HDEWSs if the proposed solution meets all the requirements described in this technical specification.

5.4.4.6 The TSCC Contractor may propose an acoustic solution for broken rail detection if the proposed solution meets all the requirements described in this technical specification.

5.4.4.7 Both systems can be used in combination (optic fiber for open line and acoustic for switch machines area, to be defined by the safety study)

5.4.4.8 The area monitored by the BRDS shall be determined in accordance with the TSCC Contractor's design or the country's regulations

5.4.4.9 BRDS detectors shall be interfaced with the train control System and complex operation (rerouting of following and passing train) shall be applied in case of rail default detected within a configurable reaction time

5.4.4.10 For the generation, update or removal of BRDS-related operation stopped, an alert shall be triggered at the operator level

5.4.4.11 The number of false alerts shall be minimized to 1 / 1000 maximum

5.4.4.12 BRD system shall be at least SIL 2.

5.4.5 Rail Temperature Monitoring System (RTMS)

5.4.5.1 The temperature sensors' range shall be -60°C to +120°C (precision 3%)

5.4.5.2 The RTM sensor shall be installed in the immediate vicinity of the train track, eventually inside the rail core itself, with direct exposure to the sun if not embedded in the rail.

5.4.5.3 The sensor shall report rail temperature at a configurable frequency that should be chosen in accordance with speed of the variation of the natural phenomena.

5.4.5.4 The threshold of the rail temperature triggering a speed restriction will be selected specifically for track exposed to the sun to avoid completely the risk of derailment of the train.

5.4.5.5 Several thresholds associated with several speed restrictions shall be determined in accordance with the TSCC Contractor's designs, or the country's regulations to mitigate the risk without being too restrictive for the Authority's operating plan.

5.4.5.6 Trackside rail temperature detectors shall be interfaced with the train control System and temporary speed restrictions shall be applied in case of high rail temperature within a configurable reaction time.

5.4.5.7 For the generation, update or removal of rail temperature-related speed restriction, an alert shall be triggered at the operator level.

5.4.5.8 Trends analysis shall be possible.

5.4.6 Road Vehicle Detection System (RVDS) and derivative landslide/falling rock detection system

5.4.6.1 The RVDS shall provide warning at all overpasses against vehicle impact.

5.4.6.2 The RVDS shall be able to detect any vehicle intrusion from overpasses, onto the CHSR tracks.

5.4.6.3 When used as a landslide/falling rock detection system, The RVDS shall be able to detect any rock intrusion or landslide from overpasses, onto the CHSR tracks.

5.4.6.4 Detection of intrusions shall result in automatic emergency stopping of approaching trains.

5.4.6.5 The RVDS shall be able to transfer alarms and information to the Data Collector.

5.4.6.6 The TSCC Contractor shall define, according to the CHSR operational needs, an alarm triggering, validation and response procedure.

5.4.6.7 The TSCC Contractor shall cooperate with the Authority for the definition of alarms, protocols, and procedures.

5.4.6.8 To prevent false positives, the TSCC Contractor shall establish a redundant detection system.

5.4.6.9 Remote cancellation of alarms shall be possible from the OCC Including the possible involvement of onboard staff should risk analysis identify this need.

5.4.6.10 The RVDS shall be interfaced with the train control System. Detection of intrusions shall result in emergency stopping of approaching trains.

5.4.6.11 For the generation, update or removal of BRDS-related operation stopped, an alert shall be triggered at the operator level.

5.4.6.12 The RVDS detection system should directly interact with the train control system to stop the approaching train

5.4.6.13 The number of false alerts shall be minimized to 1 / 1000 maximum

5.4.6.14 RVDS system should be SIL 4 and shall at least achieve SIL 2.

5.4.7 Meteorological Condition Detection System (MCDS): Wind

5.4.7.1 The TSCC Contractor shall provide Wind Detectors, as part of the MCDS.

5.4.7.2 A study shall be made to identify the need for dedicated wind detection on exposed structures (bridges, viaducts, embankments, etc.) where high crosswinds would result in a threat to the safe operation of trains.

5.4.7.3 The Trackside Wind detectors shall not be installed in the immediate vicinity of the track to avoid train shuffles, and shall not be installed near the ground level to avoid ground effect.

5.4.7.4 The sensor shall report wind speed at a configurable frequency that should be chosen in accordance with speed of the variation of the natural phenomena.

5.4.7.5 The threshold of the wind speed triggering a speed restriction will be selected specifically for every exposed structure to avoid completely the risk of derailment of the train.

5.4.7.6 Thresholds associated with speed restrictions shall be determined in accordance with TSCC Contractor's studies and/or the Federal and State regulations to mitigate the risk without being too restrictive for the Authority's operating plan.

5.4.7.7 Based on the study and the proposed solution for wind detection, the TSCC Contractor shall develop an adequate general interface document.

5.4.7.8 The Trackside Wind detectors shall be able to handle the measurement of the speed on range from zero to hundred miles an hour (5% precision), and direction from zero to 360° (precision 5°).

5.4.7.9 The Trackside Wind detectors shall have an integrity SIL2.

5.4.7.10 Trackside Wind detectors shall be interfaced with the train control System and temporary speed restrictions shall be applied in case of high wind within a configurable reaction time.

5.4.7.11 For the generation, update or removal of Wind-related speed restriction, an alert shall be triggered at the operator level.

5.4.7.12 The number of false alerts shall be minimized to 1 / 1000 maximum.

5.4.8 **Meteorological Condition Detection System (MCDS): Rain**

5.4.8.1 The TSCC Contractor shall provide Rain Detectors, as part of the MCDS.

5.4.8.2 A study shall be undertaken to identify the need for dedicated rain detection on exposed structures (bridges, viaducts, embankments, etc.) where heavy rain would result in a threat to the safe operation of trains.

5.4.8.3 The sensor shall report rainfall at a configurable frequency that should be chosen in accordance with speed of the variation of the natural phenomena.

5.4.8.4 The threshold of the rain quantity triggering a speed restriction will be selected specifically for every exposed structure to avoid completely the risk of derailment of the train.

5.4.8.5 Several thresholds associated with several speed restrictions shall be determined in accordance with study and/or the Federal and State regulations to mitigate the risk without being too restrictive for the Authority's operating plan.

5.4.8.6 Based on the study and the proposed solution for rain detection, the TSCC Contractor shall develop an adequate general interface document.

5.4.8.7 The rain detectors shall be able to handle the measurement of the rain quantity per hour on a range from zero to twenty inches (precision 5%) and rain quantity per day (24 hour) on a range from zero to sixty inches (precision 5%).

5.4.8.8 Trackside rain detectors shall be interfaced with the Operating Control Center and temporary speed restrictions shall be applied in case of heavy rain within a configurable reaction time.

5.4.8.9 For the generation, update or removal of rain-related speed restriction, an alert shall be triggered at the operator levels

5.4.8.10 The number of false alerts shall be minimized to 1 / 100 maximums

5.4.9 **Meteorological Condition Detection System (MCDS) Flood**

5.4.9.1 The TSCC Contractor shall provide Water flood Detectors, as part of the MCDS.

5.4.9.2 A study shall be made to identify the need for dedicated water flood detection on exposed structures (tunnel, platform, embankments, etc.) where water flood would result in a threat to the safe operation of trains.

5.4.9.3 The water flood detectors shall be installed in the immediate vicinity of the train track to prevent flood reaching the platform underlay or reaching the base of the rails or to cause any other damage.

5.4.9.4 The threshold of the water flood triggering a speed restriction will be selected specifically for every exposed structure to avoid completely the risk of derailment of the train.

5.4.9.5 Two thresholds associated with two speed restrictions shall be determined in accordance with study and/or the Federal and State regulations to mitigate the risk without being too restrictive for the Authority's operating plan.

5.4.9.6 Based on the study and the proposed solution for water flood, the TSCC Contractor shall develop an adequate general interface document.

5.4.9.7 The MCDS Flood detection system should directly interact with the train control system to stop approaching trains.

5.4.9.8 The water flood detectors shall have an integrity SIL2 whether they have or do not have moving parts.

5.4.9.9 Water flood detectors shall be interfaced with the train control system and temporary speed restrictions shall be applied in case of high wind within a configurable reaction time.

5.4.9.10 For the generation, update or removal of flood-related speed restriction, an alert shall be triggered at the operator level.

5.4.9.11 The number of false alerts shall be minimized to 1 / 1000 maximum.

5.4.9.12 The flood detection system should directly interact with the train control system to stop the train.

5.4.10 **Meteorological Condition Detection System (MCDS): earthquake**

5.4.10.1 The TSCC Contractor shall provide earthquake Detectors, as part of the MCDS.

5.4.10.2 A study shall be undertaken by the TSCC Contractor to identify the areas where earthquake detection is requested.

5.4.10.3 The Earthquake detectors shall not be installed in the immediate vicinity of the track to avoid train movement disturbing the measurements, and shall not be installed near any other source of vibration such as road, factory etc.

5.4.10.4 The detection of an earthquake shall trigger a speed restriction to avoid completely the risk of derailment of the train.

5.4.10.5 Based on the study and the proposed solution for earthquake detection, the TSCC Contractor shall develop an adequate general interface document.

5.4.10.6 The earthquake detectors shall be able to handle the measurement of the ground movement on range from zero to hundred gal (5% precision).

5.4.10.7 The earthquake detectors shall have an integrity of SIL2.

5.4.10.8 Earthquake detectors shall be interfaced with the Operating Control Center and temporary speed restrictions shall be applied in case of detection of an earthquake.

5.4.10.9 For the generation, update or removal of earthquake-related speed restriction or operation stopped, an alert shall be triggered at the operator level.

5.4.10.10 The number of false alerts shall be minimized to 1 / 1000 maximum.

5.5 Performance Requirements

5.5.1 Safety Requirements

5.5.1.1 The TSCC Contractor shall conduct safety studies in order:

- To monitor train health, meteorological events, and infrastructure conditions, the Authority must conduct a safety study to determine the types of sensors to be installed,
- To monitor train health, meteorological events, and infrastructure conditions, the Authority must conduct a safety study to determine the place of each type of sensors to be installed,
- The Authority needs to perform a safety analysis to establish the threshold that initiates actions on train circulation for each type of event, including monitoring train health, meteorological conditions, and infrastructure status,
- The Authority is required to carry out a safety assessment to identify the appropriate actions, such as imposing speed limits or halting the train, for each type of event, while monitoring train health, weather conditions, and infrastructure status.

5.5.1.2 Part C – Supplementary Technical Requirements – Technical Specifications (including this document). Terms, abbreviations, and definitions are specified in the Parts A, B, and C of the Contract. The HDEWS shall comply with the safety requirements defined in the safety studies organized by the Authority.

5.5.1.3 The Trainset Health Monitoring Equipment shall be designed, installed, and tested to ensure their correct functioning.

5.5.1.4 The infrastructure monitoring systems shall be designed, installed, and tested to ensure they function correctly.

5.5.1.5 The meteorological systems shall be designed, installed, and tested to ensure they function correctly.

5.5.2 RAM Requirements

5.5.2.1 The HDEWS shall comply with the RAM requirements defined in the Schedule 1.

5.5.2.2 The HDEWS shall ensure uninterrupted operation.

5.5.2.3 The HDEWS shall be designed and implemented to ensure geographical and hardware redundancy.

5.5.2.4 The HDEWS shall have field-proven reliability and intrinsic fault tolerance aligning with CHSR RAM objectives.

5.5.2.5 The whole HDEWS shall be designed to have optimum maintainability (quick replacement of faulty parts, equipment swap-out only) in each operating section of the main line.

5.5.2.6 The HDEWS shall be designed and implemented to ensure sufficient accessibility and maneuverability space for installation, testing, operation, inspection, maintenance, and repair.

5.5.2.7 Standard labelling and marking shall be applied for all HDEWS equipment according to GS1 Application Standard for the rail sector in a manner to be agreed with CHSR, which will be uniform across all systems.

5.5.2.8 The TSCC Contractor shall supply an obsolescence management plan to be communicated to the AMS system.

5.6 Security and Cybersecurity Requirements

5.6.1 The HDEWS design shall be in full compliance with cybersecurity controls specified in the CHSR Cybersecurity Technical Specification.

5.6.2 The HDEWS shall have a System Owner who is accountable for cybersecurity risk ownership and mitigation.

5.6.3 The HDEWS System Owner shall be responsible for ensuring that resources with appropriate expertise attend cybersecurity threat modelling and risk assessment activities to facilitate risk identification and mitigation strategies.

5.6.4 IP-based/digital based communications between HDEWS components, such as PLCs, RTUs, and sensors shall use cryptographic means of protection and authentication as outlined in the CHSR Cybersecurity Technical Specification to verify the integrity and authenticity of messages.

5.6.5 Information deemed confidential shall be stored in compliance with the information security requirements outlined in the CHSR Cybersecurity Technical Specification.

5.6.6 Interfaces identified between HDEWS and other internal or external systems must be co-engineered with the Cybersecurity Lead to ensure they comply with the cybersecurity objectives.

6 INTERFACES REQUIREMENTS

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 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 the FPS design considering the identified external interfaces and internal interfaces to ensure the required functionalities and performance described in this specification for FPS.

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

6.1.4 The TSCC Contractor shall ensure the integration with all identified third party, external and internal interfaces.

6.2 Third Party Interfaces

6.2.1 The HDEWS system shall collect data from third-party systems such as:

- Weather services
- USGS (United States Geological Survey) ShakeAlert System

6.3 External Interfaces – facilities contractor

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

6.3.2 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

6.3.3 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

6.3.4 With regard the level 0 interface, the TSCC Contractor shall follow the process defined in the Authority Interface Management Plan and shall support the Authority in developing the requirements and a scope

split with related stakeholders. The TSCC Contractor shall execute the level 0 interfaces based on defined requirements and scope split.

6.4 Internal Interfaces for the HDEWS

6.4.1 Interface with Low Voltage Power System (LVPS)

6.4.1.1 The HDEWS shall have a redundant interface with the LVPS for the power supply of the related HDEWS equipment.

6.4.2 Interface with Digital Communications Network (DCN)

6.4.2.1 The HDEWS shall have a redundant interface with the DCN to ensure the related data transmission from the Data Collector to the OCC / BOCC. Data concerning alarms and status shall be prioritized over raw data transmitted to OCC HDEWS server.

6.4.3 Interface with Network Time System (NTS)

6.4.3.1 The HDEWS shall have redundant interface with the NTS for accurate current time synchronization.

6.4.4 Interface with Integrated Control and Supervision System

6.4.4.1 The HDEWS shall have a redundant interface with the ICSS system:

6.4.4.2 A graphical interface of the HDEWS shall be provided within the ICSS system.

6.4.4.3 The dedicated ICSS graphical interface shall enable monitoring and status provision of the HDEWS equipment.

6.4.4.4 The HDEWS shall at least provide the data to allow the ICSS to calculate and show the following information of each connected sensor:

- Status,
- Failure codes.

6.4.5 Interface with Enterprise Asset Management System (EAMS)

6.4.5.1 The HDEWS System shall provide static Asset Information and dynamic Asset Information to the EAMS for maintenance activities and asset lifecycle management activities.

6.4.6 Interface with Interlocking

6.4.6.1 The HDEWS shall have a redundant interface with the IXL to have a safety response from the train control system in case of hot axle detection, high wind detection, and Road Vehicle intrusion detection. This interface needs to be specified and shall be with the Safety Integrity level SIL 2 (safety relay or safety communication network, to be defined).

6.4.7 Interface with Traffic Management System (TMS)

6.4.7.1 The HDEWS shall have a redundant interface with the TMS to send alarms from at least:

- HABDS,
- DDS,
- BRDS,
- RTMS,
- RVDS,
- MCDS.

6.4.7.2 The HDEWS shall have an interface with the TMS to identify the train ID that is concerned by an alarm. For this specific purpose the TSCC Contractor may propose a different solution.

6.4.7.3 The HDEWS shall have a functional interface with the Point Heating System to receive data related to temperature, snow level, wind level, humidity.

6.4.7.4 The HDEWS shall interface with cybersecurity systems according to the Cybersecurity Technical Specifications.

6.4.8 **Interface with ETCS**

6.4.8.1 RBC shall interface the alarms raised by the HDEWS 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…)

7 MATERIALS, PRODUCT AND COMPONENTS REQUIREMENTS

7.1 General Requirements

7.1.1 All materials supplied shall conform to the requirements and test methods of the relevant standards and regulations as described in Reference Standards and Documents.

7.1.2 All materials supplied shall be of sufficient grade and quality to meet the designed life requirements.

7.1.3 The HDEWS equipment shall be complete with all parts and accessories or material which are useful for efficient operation of the HDEWS components. Such accessories and materials shall be deemed to be within the scope of this specification whether specifically mentioned or not.

7.1.4 The supply shall include all supporting structures, load bearing structures, fittings, embedded parts, auxiliary equipment, mechanical linkages, auxiliary circuits wiring necessary for their efficient operation. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

7.1.5 The TSCC Contractor shall provide necessary fittings, supporting and load bearing structures for the installation of the related Modular Sensors.

7.1.6 The design of the supporting and load bearing structures shall comply with the relevant Eurocode (EN 1990, EN 1992, EN 1993 etc.).

7.1.7 The foundations shall be maintenance free all its lifetime.

7.1.8 The foundation design shall be subjected to ground investigation and structure load assessment; all foundation positions shall be confirmed after undertaking site surveys.

7.1.9 The foundations shall be sited to avoid underground utilities such as power cables, piping systems, IT and telecommunication systems and railway-related installations (e.g., sealing in the track embankment) where reasonably practicable or demanded by a railway restriction.

7.1.10 The structures, supports and other components made of steel shall be provided with corrosion protection. Corrosion protection shall be carried out in accordance with standards. The preferred solution for steel parts shall be hot-dip galvanization.

7.2 SW and HW Requirements

7.2.1 The HDEWS design shall be based on COTS, open architecture, and modular system architecture, with standard non-proprietary interfaces.

7.2.2 The TSCC Contractor’s design for all central servers shall be on-premises, either physical, virtualized or cloud-base to ease systems evolution complying the requirement of Security and Cybersecurity Requirements.

7.2.3 All cabling for HDEWS shall be designed, supplied, installed, tested, and commissioned by the TSCC Contractor.

7.2.4 The HDEWS servers/controllers shall have redundant power supply.

7.2.5 All cable requirements must be classified according to the Construction Products Regulation (CPR) codification. Low toxicity, low smoke emission, low flammability, zero halogen fire retardant cable shall be used.

7.3 EMC Requirements

7.3.1 The EMC requirements are described in the Technical Specification – EMC and Grounding/Bonding.

8 TOLERANCES

Not applicable to the HDEWS

9 SCOPE OF SUPPLY AND DELIVERY

9.1 General Requirements

9.1.1 General requirements related to the TSCC Contractor Scope of Work are defined in Schedule 16.

9.2 Specific Requirements

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

- All monitoring sensors with central and local servers.
- Workstations/HMIs.
- Controllers.
- Amplifiers (if needed).
- Cabling and connectors.
- Racks.
- Software architecture including full definition of protocols used.
- Management System.
- SW licenses.
- Supporting and load bearing structures, fittings, etc.
- Spare parts.

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.

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.

13 SUBMITTALS

13.1 General Requirements

13.1.1 The 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 Agreement and associated Schedules.

15 ADDITIONAL INFORMATION REQUESTED

15.1.1 In addition to the mandatory requirements outlined in this specification, the Authority reserves the right to request from the 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 HDEWS reliability, availability, and maintainability characteristics.

16 LOGISTICS

16.1 General Requirements

16.1.1 General logistics requirements are defined in the Agreement.

17 SPEED LIMITATION BASED ON METEOROLOGICAL CHANGE EXAMPLE

17.1 General description

The values provided in section 17.2 come from the Korean National High-Speed Network that makes use (among others) of 46 High Speed Train (18 cars, 300Kph) of French manufacturer Alstom model named KTX. The Korea HSL network initially makes use of French regulation with regards of detectors. Values provided here were used at least from 2004 to 2007 (and more) and come in this document as an example since it is the responsibility of the TSCC Contractor in agreement with the Authority to establish values for the CHSR network

17.2 Values (in metric system) provided as an example

Rail Temp.		Snow		Earthquake		Rain & Flood		Wind *(coefficient applied)*	
Over 45	After work, below 100 km/h, Until stabilization period, below 170 km/h	Rail surface is not seen	Below 30 km/h	Earthquake Yellow alarm (40 gal-65gal)	First Train Below 90 km/h	The rainfall for 24hours is over 140mm. Rainfall per hour is over 30mm.	Below 170 km/h	Wind Speed Below 30 m/sec	Systematic speed reduction based on wind speed
Over 50	Person in charge of installation should continuously monitor temperature detector. If needed, he or she should notify the person concerned.	Over 21 centimeter inside track	Below 130 km/h	Earthquake Red alarm (over 65gal)	Operation shall be Stopped	The rainfall for 24hours is over 150mm. Rainfall per hour is below 35mm.	Below 90 km/h	Wind Speed Over 30m/sec and Below 40m/sec	Below 170km/h
Over 55	Below 230 km/h	Over 14cm and under 21cm Inside track	Below 170 km/h			The rainfall for a day is over 150mm. Rainfall per hour is over 60mm.	Operation shall be stopped (The rainfall per hour in the overhead and bridge sections is over 70 mm).	Wind Speed Over 40m/sec and Below 45m/sec	Below 90km/h
Over 60	Below 70 km/h	Over 7cm and below 14cm	Below 230km/h			Gravel is scattered or the head of rail sank.	Operation shall be stopped.	Over 45m/sec	Operation is held or stopped.
Over 64	Operation shall be stopped.	The sound which snowball or ice splatters	Below 230 km/h			Gravel is not scattered// Water level is below the head of rail and over the rail tile pad.	Below 40 km/h		
		Reoccurrence	Below 170 km/h						