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**SCHEDULE 1 PART A:
AUTHORITY TIER III
TRAINSETS
PERFORMANCE
SPECIFICATION**

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1 INTRODUCTION

This document identifies California High-Speed Rail Authority (Authority) requirements for new Tier III Trainsets.

The Contractor shall provide a Tier III compliant, single-level, electric multiple unit (EMU) Trainset platform of a Service-Proven design, or any variant of a Service-Proven Trainset platform including the next generation evolution of that Trainset design. The Contractor shall refer to a Reference System and provide details that support its claim of a Service-Proven Trainset.

The Contractor shall participate in the successful commissioning of the Trainsets, including obtaining relevant approvals from the FRA.

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4 REGULATIONS AND STANDARDS, AND UNITS OF MEASURE

4.1 REGULATIONS AND STANDARDS

4.1.1 Regulations

Refer to Articles 3.4 and 3.5 of the General Provisions.

4.1.2 Standards

Refer to Articles 3.7 and 3.8 of the General Provisions.

4.2 UNITS OF MEASURE

4.2.1 Requirements and Information

System, Subsystem and component designs and associated fasteners shall be metric standard.

Fractional measurements shall not be used on drawings but shall be expressed as decimal values.

The Trainset design drawings shall be metric standard, with the U.S. inch standard noted in brackets or directly below the metric standard.

If there is an inconsistency between the metric measurement and the U.S. measurement in this Specification, the metric measurement shall prevail.

5 PERFORMANCE CAPABILITIES

5.1 JOURNEY TIME

5.1.1 Requirements and Information

Trainset performance shall achieve a CHSR journey time between San Jose and Union Station in Los Angeles in no more than 2 hours 10 minutes without intermediate station stops. The Contractor shall use the information provided in the “Authority’s San Jose–LA Union Station Alignment” attachments, as referenced in Section 13.2, to verify compliance with this requirement. The Contractor shall reference the same information for verification of propulsion and braking performance.

5.2 OPERATIONAL PERFORMANCE

5.2.1 Requirements and Information

The Trainset shall be provided with a driver’s cab at each end, accommodate bidirectional operation, and achieve the performances set forth in this Specification, including a Train operating in a consist of two coupled Trainsets (i.e., double traction configuration).

Capability shall be provided for Trainset Systems to be reset from the Controlling Cab.

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5.4 PASSENGER FLOWS

5.4.1 Requirements and Information

During Preliminary Design Review, the Contractor shall provide an Analysis illustrating the passenger flows at station platforms for able-bodied passengers and passengers with disabilities, in the ratio as determined by the number of seating locations per Trainset. The Analysis shall assume that 50% of the passengers are carrying luggage, with the maximum luggage size equal to 1143 linear mm (45 linear inches) representative of the total of the height, width, and depth of the bag. The Trainset, including size and location of exterior doorways, vestibules, internal features, and seating areas, shall meet or exceed ADA requirements, and shall accommodate passenger flows that achieve the required boarding, disembarkation, and evacuation times as referenced in section 8.13.1.

6 RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND SAFETY (RAMS)

6.1 RELIABILITY, AVAILABILITY, AND MAINTAINABILITY OBJECTIVES

CHSR Trainsets shall provide reliable, dependable passenger service. The Contractor shall achieve and document Trainset reliability, availability and maintainability (RAM) characteristics and performance through the design, manufacture, testing, commissioning, and specified maintenance over the life of the Trainset. The Contractor shall assure Trainset RAM by implementing a RAM program that conforms with EN 50126-1 and CLC/TR 50126-3.

Trainset design and manufacture shall control maintenance times and costs over the Trainset design life, incorporating modular, maintainable equipment, and diagnostics, condition monitoring, and data systems.

The Trainset shall provide functionality and redundancy to recover from or mitigate typical failures and malfunctions, and to reduce impact of a malfunction in a Trainset in passenger service. Sufficient redundancy and/or spare capacity shall be provided to permit a fully loaded Train to complete a service run to the end of the line, possibly at reduced speed depending on the nature of the failure.

6.2 TRAINSET RAM PERFORMANCE REQUIREMENTS

CHSR Trainsets shall achieve the following specific RAM performance targets:

- a) Mean Time between Service Interruptions (MTBSI): 2,288 hrs.
- b) Mean Time between Component Failures (MTBCF): 278 hrs.
- c) Mean Time to Restore Service (MTTRS): 0.87 hrs.
- d) Mean Time to Repair (MTTR): 1.70 hrs.
- e) Trainset Availability: 99.96%.
- f) Fleet Roll-Out Availability: 90.3%.

The Contractor shall use the following definitions to calculate RAM performance targets.

MTBSI is the mean time in Trainset revenue service hours between failures causing a service interruption. Trainset revenue service hours are the hours a Trainset is carrying passengers (i.e., running between terminals and boarding and deboarding passengers at station stops). A service interruption is a Trainset in service being:

- a) More than 3 minutes late arriving at or departing from any station.
- b) Cancelled at its originating point or en route.
- c) Reduced in size or revenue capacity due to failure requiring a failed Trainset to be removed from operation.

MTBSI is the combined allowance for Mean Time between Failures (MTBF) for Significant (MTBF_I) and Major (MTBF_S) failures in CLC/TR 50126-3, and is equal to the inverse of the sum of all Trainset service interrupting failure rates.

MTTRS is the mean time in man-hours to restore regularly scheduled service after a service interrupting failure, including time to identify and bypass the failure, or to bring a gap Train into service. For the Trainset, MTTRS is the sum of all failure mode Maintenance Ratios divided by the sum of all service interrupting failure rates. Each failure mode Maintenance Ratio is equal to the failure rate for that mode times the MTTRS for that mode. The Maintenance Ratio for an item is the number of man-hours of restoration time per hour of item operation.

MTBCF is the mean time in Trainset revenue service hours between failures that require Corrective Maintenance (CM), but do not cause a service interruption. MTBCF is equivalent to MTBF for Minor failures (MTBF_M) in CLC/TR-50126-3

MTTR is the mean time in man-hours to repair a minor, or component, failure once a Trainset is out of service, including removing and replacing, or repairing, the faulty item, and performing functional checkout. Trainset MTBCF and MTTR are calculated the same

way as MTBSI and MTTRS, but using component failure rates and component repair times.

Trainset Availability is the percentage of time a Trainset is either in service or ready for service.

Fleet Roll-Out Availability is the percentage of Trainsets that are available for revenue service at the beginning of each service day.

If, in passenger service, the Trainsets fail to meet the specified RAM targets, the Contractor shall:

- a) Investigate to determine the cause of the reliability problem.
- b) Evaluate whether the problem is sustained or transitory.
- c) If the problem is sustained and is caused by equipment design dependability, or quality defect, modify equipment so that the modified Trainset will achieve the RAM targets.
- d) If a modification is required during the Reliability Demonstration, extend the Reliability Demonstration period to demonstrate that the modification is effective.

6.3 TRAINSET SYSTEMS RAM ALLOCATION

The Contractor shall achieve and demonstrate RAM performance metric values for all Trainset systems for Authority SONO.

The Contractor shall calculate MTTRS using the failure response logistic times in the "Trainset RAM Analysis Factors" table.

The Trainset in passenger service shall comply with the MTBSI, MTTRS, MTBCF, and MTRR in the Contractor's proposed "Trainset RAM Metric Values" table.

6.4 CONTRACTOR RAM PROGRAM

The Contractor shall establish and execute a Contractor RAM Program that:

- a) Assures that Trainsets comply with the CHSR Trainset RAM requirements.
- b) Guides and coordinates RAM design, analyses, tests, documentation, and certification activities for the Contractor and for suppliers of all Trainset Systems which affect passenger service dependability.
- c) Ensures RAM integration between the Contractor RAM Program and the CHSR project management, RAM program, systems, and sections through all project phases.
- d) Complies with applicable regulatory requirements, including RAM requirements in EN 50126-1 and CLC/TR 50126-3.
- e) Creates and submits deliverables which are provided for Authority's SONO.

Contractor RAM Program work shall include:

- a) Contractor RAM Program Plan (CRMP) covering Contractor, Subcontractors, and equipment suppliers.
- b) RAM design.
- c) RAM analyses.
- d) RAM demonstration plans and procedures.

- e) Integration of RAM with system safety, operations and maintenance (O&M), and verification and validation (V&V).
- f) Application of Reliability Centered Maintenance (RCM) design.
- g) Corrective action as required to assure RAM performance.
- h) Compliance with RAM requirements with Trainsets in passenger service.

The Contractor RAM Program shall include the Table 6-1 tasks and deliverables.

| Table 6-1 Contractor RAM Program Tasks and Deliverables | | | |
|--|---|----------------|--|
| No. | Tasks and Deliverables | Section | Due Date |
| 1 | Contractor RAM Program Plan (CRMP) | 6.5.1 | First Release: NTP + 30 days |
| 2 | RAM Allocation Report (RAR) | 6.5.2 | First Release: NTP + 60 days |
| 3 | Preliminary Reliability Analysis (PRA) | 6.4.3 | First Release: NTP + 90 days |
| 4 | Historical Product Maintainability Report (HPMR) | 6.4.4 | First Release: NTP + 90 days |
| 5 | Reliability Prediction Report (RPR) | 6.4.5 | First Release: NTP + 180 days |
| 6 | Reliability Failure Modes and Effects Analysis (R-FMEA) | 6.4.6 | First Release: NTP + 180 days |
| 7 | Reliability Fault Tree Analyses (R-FTA) | 6.4.7 | First Release: NTP + 180 days |
| 8 | RCM Report | 6.4.8 | First Release: NTP + 240 days Final: Final Design Review |
| 9 | Corrective Maintenance Analysis (CMA) | 6.4.9 | First Release: NTP + 240 days Final: 2 weeks prior to Final Design Review |
| 10 | Preventative Maintenance Analysis (PMA) | 6.4.10 | First Release: NTP + 240 days Final: 2 weeks prior to Final Design Review |
| 11 | Special Tools List (STL) | 6.4.11 | Draft: 2 weeks prior to Final Design Review Final: Final Design Review |
| 12 | Software Quality Assurance Documentation | 6.4.13 | Draft: NTP + 240 days Final: Final Design Review |
| 13 | Reliability Demonstration Test Plan (RDTP) | 6.4.14 | First Release: 2 weeks prior to Final Design Review |
| 14 | Reliability Demonstration Test Report | 6.4.14 | Monthly during the Reliability Demonstration |
| 15 | Maintainability Demonstration Test Plan (MDTP) | 6.4.15 | Plan and procedures: 2 weeks prior to Final Design Review |

| Table 6-1 Contractor RAM Program Tasks and Deliverables | | | |
|--|---|----------------|--|
| No. | Tasks and Deliverables | Section | Due Date |
| 16 | Maintainability Demonstration Report (MDR) | 6.4.15 | One month after completion of each Maintainability Demonstration |
| 17 | Failure Reporting and Corrective Action System (FRACAS) | 6.4.16 | First Release: 2 weeks prior to Final Design Review |

6.4.1 Contractor RAM Program Plan (CRMP)

The Contractor shall develop a CRMP and submit for Authority's SONO. The CRMP shall:

- a) Comply with CHSR RAM requirements, and conform to EN 50126-1 and CLC/TR 50126-3.
- b) Define RAM Program scope, tasks, techniques, deliverables, and milestones.
- c) Provide a Contractor RAM Program schedule, which identifies specific tasks, with start and completion dates, and explains how these tasks are coordinated and integrated with major program milestones for design, manufacturing, and testing.
- d) Provide the organization of Contractor and supplier personnel responsible for performing the RAM Program. Personnel shall be trained and qualified by the Contractor and/or the supplier.
- e) List each RAM Program deliverable, and for each deliverable, describe the approach to develop the deliverable, the participants, and the contents of the deliverable.
- f) Present the Contractor's methodology to assure compliance with RAM requirements.
- g) Summarize demonstration test plans for verification of compliance with RAM requirements.
- h) Describe monitoring and control of subcontractors and suppliers.
- i) Define interfaces to and coordination with other system assurance activities such as system safety, design, procurement, and quality assurance.
- j) Identify RAM data sources to be used in Contractor RAM analyses.
- k) Establish a RAM V&V process.

6.4.2 RAM Allocation Report (RAR)

The Contractor shall provide and submit, for Authority's SONO, a RAR. The RAR shall demonstrate that the Trainsets will achieve RAM targets, consistent with the Trainset RAM performance targets identified in Section 6.2.

The RAR shall provide RAM allocations for each Trainset Subsystem. Subsystem RAM allocations shall:

- a) Conform with Trainset RAM performance requirements.
- b) Include MTBSI, MTTRS, MTBCF, and MTTR.
- c) Assign RAM performance requirements for Trainset Subsystem suppliers.

The RAR shall describe the basis for the RAM allocations. RAM allocations may be based on:

- a) Historical information.
- b) Experience with similar equipment.
- c) Industry standard techniques.

6.4.3 Preliminary Reliability Analysis (PRA)

The Contractor shall provide a PRA for Authority's SONO. The purpose of the PRA is to ensure that the potential service interrupting failure and modes, causes, and mitigations are well understood by all parties as the design, integration, fabrication, testing, and acceptance activities move forward.

The PRA will provide an initial broad and high-level assessment of service interrupting failures and modes for each Trainset system. The PRA shall include estimated service interruption frequencies and consequences of service interrupting failures. The PRA shall list Trainset design provisions and O&M procedures which will eliminate or control service interrupting failures to levels acceptable to the Authority. The PRA shall be consistent with Table 6-2 and shall include service interrupting failures and errors for each service interrupting mode in Table 6-2. Service interrupting failures and errors may be at the system, subsystem, assembly, or lowest line replaceable unit (LLRU) level. The Contractor shall provide a PRA Report which summarizes the PRA results, highlights service reliability issues, and describes next steps.

| Table 6-2 Preliminary Reliability Analysis | | | |
|---|---|-------------------|---------------------------|
| Service Interruption Mode | Failure Rate / Frequency per Trainset Operating Hour | Mitigation | |
| | | Design | O&M Procedures |
| Equipment Failures | | | |
| Software Errors | | | |
| Design Errors | | | |
| Operation Errors | | | |
| Maintenance Errors | | | |

6.4.4 Historical Product Maintainability Report (HPMR)

The Contractor shall provide a HPMR for Authority's SONO. The HPMR shall present maintainability information based on previous applications of the Trainset Subsystems. The HPMR shall provide historical preventative and corrective maintenance information in formats consistent with Tables 6-3 and 6-4.

The HPMR shall:

- a) Designate each Subsystem.
- b) Indicate the Subsystem supplier.
- c) Identify previous equipment applications.
- d) Demonstrate that the Subsystem meets the RAM allocations.
- e) Describe the configuration of the subsystem, identifying any differences between the CHSR design and previous applications.

- f) Indicate the source, date, and reference contact for the historical product information.
- g) Provide user certifications from the cited equipment applications.

The report shall describe any maintainability, accessibility, or interchangeability improvements or degradations related to design changes for CHSR.

| Table 6-3 Historical Preventative Maintenance Task List | | | | |
|--|--------------------------------|---|------------------------------|----------------------|
| System / Subsystem / LLRU | Preventative Task Title | Task Time Per Location (Man-Hrs) | Task Interval (month) | Special Tools |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| Table 6-4 Historical Corrective Maintenance Summary | | | | | |
|--|--------------------------|----------------------------|--------------------------|-----------------------|----------------------|
| System / Subsystem / LLRU | Failure Frequency | Failure Description | Corrective Action | Time To Repair | Special Tools |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

6.4.5 Reliability Prediction Report (RPR)

The Contractor shall provide a RPR for Authority's SONO. The Contractor shall submit periodic reliability prediction updates until the task is concluded. The Contractor shall conduct the reliability prediction in accordance with IEC 60863 and IEC 61078.

The Contractor shall conduct MTBF and availability predictions at the appropriate level of detail to ensure compliance with CHSR RAM requirements. To the extent possible, the Contractor shall base reliability predictions on existing performance records, reliability test data, warranty and operating data, and predictions from previous similar projects. For equipment with incomplete or inconclusive operating, failure, and/or reliability demonstration data, the Contractor shall develop a reliability prediction using other information sources, such as:

- a) MIL-HDBK-217F Notice 2.
- b) Nonelectronic Parts Reliability Data (NPRD).
- c) Manufacture test data.

The Contractor shall review the prediction information, develop details about the equipment application history and service-proven design, evaluate the subsystem reliability predictions versus the subsystem reliability allocations, and prepare the RPR.

For service-proven equipment with suitable existing reliability data, the RPR shall:

- a) Designate the subsystem.
- b) Indicate the subsystem equipment supplier.
- c) Identify previous applications of the same or similar equipment.
- d) Describe the configuration of the subsystem, identifying differences in configuration, component or device quality, function, operating environment, stress, or other factor affecting reliability between CHSR design and previous applications.
- e) Adjust the reliability prediction to accommodate the differences between previous and CHSR application, using MIL-HDBK-217F or similar factors to account for increased or reduced stress, component quality, etc.
- f) Furnish details regarding reliability improvements or degradations related to design changes for CHSR.
- g) Indicate the sources, dates, and reference contact for the historical product information.
- h) Demonstrate that the CHSR equipment meets the allocated failure rates.

For non-service-proven equipment and/or equipment requiring further detailed analysis, the equipment supplier shall use all applicable sources of information and prediction methodology for prediction of CHSR failure rates. These include:

- a) MIL-HDBK-217F Notice 2, Reliability Prediction of Electronic Equipment.
- b) MIL-STD-756B, Reliability Modeling and Prediction.
 - a. Method 2001, Similar Item Method.
 - b. Method 2002, Similar Circuit Method.
 - c. Method 2004, Parts Count Method.
- c) MIL-HDBK-338B failure mode probabilities
- d) Other industrial reliability prediction databases.
- e) Field reliability estimates from comparable systems, products, or parts.

For MIL-HDBK-217F or similar reliability predictions, suppliers shall use factors that are most applicable to the CHSR Trainset system under specified conditions. For example, bogie-mounted equipment may be rated for ground-mobile application, while carbody-mounted electronics may be rated for ground-fixed application. Quality, stress, construction, learning, and other factors shall be applied as appropriate to the specific equipment.

The reliability prediction shall be subject to confirmation during the RDT.

The Contractor shall provide a summary report on the reliability allocations and predictions for review and for monthly progress meetings. The monthly report shall present allocated reliability budgets, predicted reliability for each subsystem, overall reliability predictions for the system, and issues. The Contractor shall provide monthly reports until the RPR task is complete.

6.4.6 Reliability Failure Modes and Effects Analysis (R-FMEA)

The Contractor shall perform a R-FMEA for each Trainset Subsystem in accordance with IEC 60812 for Authority's SONO. The Contractor shall submit periodic R-FMEA updates until the task is concluded.

The R-FMEA shall:

- a) Provide the lowest-level analysis of failures and failure effects on the system and its subsystems and equipment.
- b) Identify weaknesses in system hardware, potential human failures, and software design. It shall hypothesize failure modes and their effects, and shall include failure modes and effects not established in historical records of equipment operation.
- c) Use inductive logic in a "bottom up" system analysis. This approach shall begin at the lowest level of the equipment under analysis and shall trace consequences up to the system level to determine the end effects on system performance.

The Contractor shall perform the R-FMEA to the LLRU level in a format consistent with Table 6-5.

| Table 6-5 R-FMEA | | | | | | | | | | | | |
|---------------------------------|----------|-----------|----------|--------------|--------------|-----------------------------|-----------|--------|-----------|------------|----------------|--------------|
| No. | LLR U ID | LLRU Name | Function | Failure Mode | Failure Rate | Reliability Failure Effects | | | Detection | Mitigation | Time to Repair | Maint. Ratio |
| | | | | | | Local | Subsystem | System | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Overall Failure Rate (per hour) | | | | | | Overall MTTR (hours) | | | | | | |

The Contractor shall use failure rates developed in the reliability prediction task, in the R-FMEA.

6.4.7 Reliability Fault Tree Analysis (R-FTA)

The Contractor shall perform a R-FTA, or equivalent analysis, of potential Trainset passenger service interruptions and submit an R-FTA Report for Authority's SONO. The Contractor shall submit periodic R-FTA Report updates until the task is concluded. Trainset R-FTA Reports shall include fault trees and cut set tables of basic events, as well as probabilities of cut sets and bounds on top event probabilities.

The R-FTA shall be a structured, top-down deductive analysis that identifies combinations of Trainset basic events or conditions that cause or contribute to passenger service interruptions. The top-level item of the R-FTA shall be the service. For each top-level service failure listed in the PRA (called top events in the R-FTA), the R-FTA shall illustrate the logical relationship between the service failure and basic events that result in the occurrence of the service failure. Using each PRA service failure as a top-level event in a fault tree ensures that the R-FTA and following analyses investigate all significant causes, conditions, and mitigations related to the PRA service failure.

The Contractor shall perform the R-FTA per IEC 61025. Alternatively, the Contractor may perform Markov analyses where appropriate per IEC 61165. The Markov analyses shall incorporate age-dependent failure rates and repairs.

Basic event failure rates shall be consistent with the failure rates in reliability predictions.

6.4.8 Reliability Centered Maintenance (RCM)

The Contractor shall establish the RCM program per EN 60300-3-11, for Authority's SONO. The Contractor shall utilize an RCM approach to determine Trainset preventative maintenance (PM) intervals and activities. The approach shall:

- a) Minimize downtime.
- b) Maximize reliability and availability.
- c) Minimize life cycle costs.

The Contractor shall provide an RCM Report for review. The RCM Report shall describe the Contractor's RCM approach. The RCM Report shall include a RCM Decision Tool Record consistent in a format consistent with Table 6-6. The RCM Report shall define requirements for each PM task.

The Contractor shall establish life limits on safety-critical parts so that the probability of failure before life limits is acceptably small under normal deterioration and shall establish condition monitoring to detect whether deterioration was abnormal.

The RCM Report shall establish three PM task categories:

- a) Scheduled Restoration Tasks: Time-driven repair, regardless of condition. Also known as "Overhaul" or "Heavy Repair" maintenance. Example: Compressor overhaul.
- b) Scheduled Discard Tasks: Time-driven replacement, regardless of condition. Also known as "Remove and Replace" maintenance. Example: Oil and filter change.
- c) Scheduled On-Condition Tasks: Test for a condition that indicates a failure is about to occur or is occurring. Also known as "Predictive" maintenance. Example: Compressor vibration measurement.

The Contractor shall evaluate each FMEA failure mode per RCM decision tool logic to determine appropriate RCM failure management techniques for each mode. Figure 6-1 shows a typical RCM decision tool flowchart.

Figure 6-1

The RCM Decision Tool Flowchart

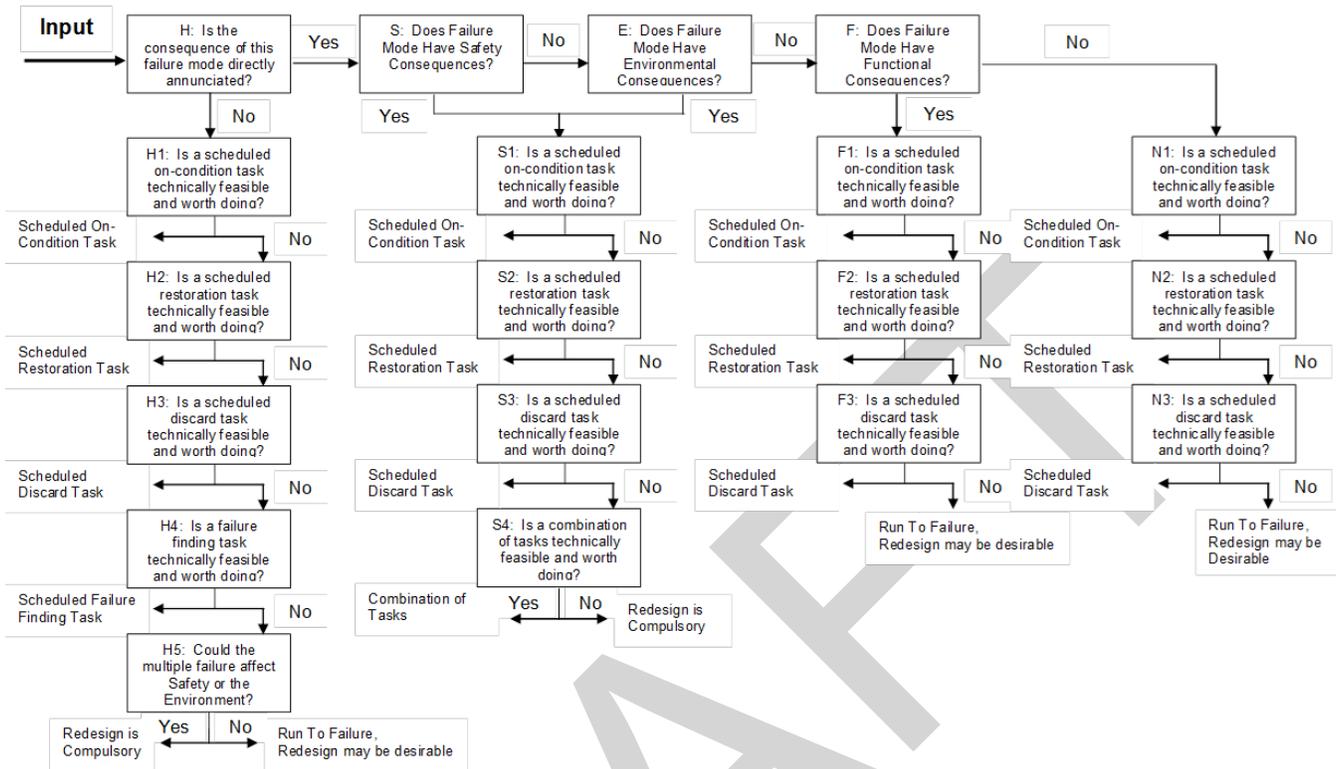


Table 6-6 shows a typical RCM decision tool output form.

| R-FMEA Item No. | Failure Mode | RCM Failure Mode Category | RCM Failure Management Technique | PM Task |
|-----------------|--------------|---------------------------|----------------------------------|---------|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

The RCM Report shall provide the following information for each PM task identified in the RCM:

- a) Task title.
- b) Task description.
- c) Task interval.
- d) Maintenance level.
- e) Personnel skill requirements.
- f) Number of persons.
- g) Task time per location.
- h) Number locations per subsystem.
- i) Total task man hours.

- j) Man hours per year.
- k) Total task cost.
- l) Task cost per year.
- m) Special tool requirements.

6.4.9 Corrective Maintenance Analysis (CMA)

The Contractor shall conduct a CMA and provide a CMA Report for Authority's SONO. The Contractor shall submit periodic CMA Report updates until the task is concluded.

CMA Reports shall provide MTTR and CM task summary tables, describe compliance with the CHSR RAM requirements and allocations, identify issues, and describe next steps.

The CMA shall consist of a tabular summary of subsystem and element CM Tasks, and MTTRs in a format consistent with Table 6-7. The CMA shall include each LLRU. Failure rates shall be per the R-FMEA. As necessary to distribute a LLRU failure rate among multiple failure modes, the Contractor shall use the Reliability Analysis Center (RiAC) failure mode apportionment guidelines (or similar) and/or engineering judgment.

| Table 6-7 Corrective Maintenance Analysis | | | | | | | | |
|---|---------|-----------|--------------------|-----|-----------------------------|---------------------|-------------------|-------|
| No. | LLRU ID | LLRU Name | Modal Failure Rate | Qty | Corrective Maintenance Task | Time to Repair | Maintenance Ratio | Notes |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |
| Overall Failure Rate | | | | | | Overall MTTR | | |
| <p style="text-align: center;">Maintenance Ratio = Failure Rate * MTTR Overall MTTR = [Sum of all Maintenance Ratios] / [Overall Failure Rate]</p> <p>The Maintenance Ratio depicts the number of man-hours of CM per hour of system operation. The Maintenance Ratio shall be used in the Maintainability Prediction worksheets to linearize the MTTR quantity so that the Maintenance Ratio can be linearly summed up to the system level from the subsystem/subsystem element/LLRU level.</p> | | | | | | | | |

6.4.10 Preventative Maintenance Analysis (PMA)

The Contractor shall conduct a PMA and provide a PMA Report for Authority's SONO. The Contractor shall submit periodic PMA Report updates until the task is concluded.

The PMA Report shall include a tabular summary of PM tasks, in a format consistent with Table 6-8 that includes the time to perform each task, and the interval at which the task is performed. The PM tasks shall be based on the RCM report.

| Table 6-8 RAM Analysis – Preventative Maintenance Summary | | | | | | |
|---|-------------------------|---------------|---------------|--------------------|--------------------|-------|
| System / Subsystem / | Preventative Task Title | Task Time Per | Task Interval | Task Justification | Materials, Special | Notes |
| | | | | | | |

| LLRU | | Location (Man- Hours) | (months) | | Tools | |
|------|--|-----------------------------|----------|--|-------|--|
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The PMA Report shall provide a summary table organizing PM tasks per interval and summarizing PM task time per interval.

6.4.11 Special Tools List (STL)

The Contractor shall provide a STL. The STL shall include special tools identified in the CMA and PMA, for Authority's SONO.

Special tools include tools, gauges, jigs, meters, diagnostic equipment, portable test units (PTU), laptop computers, etc. that will be necessary to operate, maintain, inspect, test, troubleshoot, and repair CHSR Trainset equipment throughout its design life.

The STL shall provide the special tool description, manufacturer, part number, and purpose, and shall include a cross-reference to the CMA and PMA tasks that require the special tools. This list shall include:

- a) Specialized tools for inspecting, repairing, removing, installing, maintaining or measuring components and systems.
- b) Diagnostic equipment to troubleshoot problems, determine component or system status, or condition, or interpret diagnostic information.
- c) Portable computer equipment required to view, change or monitor the operating parameters, downloadable record data, service history or digital programming for computerized or microprocessor controlled components or systems.
- d) All cables, connectors, software, power supplies, carrying cases and peripherals as required for use with the portable computers. All diagnostic, download and programming software shall be provided in Windows operating system format with no use restrictions so that the Authority can install the software on additional computers as intended.

The Contractor shall provide drawings, schematics, specifications, part numbers, and prices for all specialized tools and maintenance equipment to enable the purchase of additional quantities.

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6.4.13 Software Quality Assurance

The Contractor shall assure software quality by establishing and implementing a Software Quality Assurance Program (SQAP). The SQAP shall:

- a) Identify, monitor, and control all technical and managerial activities necessary to ensure that the software achieves the required quality.
- b) Ensure that an audit train is established which enables V&V that the SQAP activities were effectively completed.

The Contractor shall provide the Software Quality Assurance documents in Table 6-9 for Authority's SONO. Each document shall comply with the associated EN or IEEE standard.

| Table 6-9 CHSR Software Quality Assurance Plan Documentation | | |
|---|--------------------------------|----------------------|
| Documentation | European Standard | IEEE Standard |
| Software Project Management Plan | EN 50128 Section 5 | IEEE Std 1058 |
| Software Quality Assurance Plan | EN 50128 Section 6.5 | IEEE Std 730 |
| Software Configuration Management Plan | EN 50128 Sections 6.5, 6.6 | IEEE Std 828 |
| Software Verification and Validation Plan | EN 50128 Sections 6.2, 6.3 | IEEE Std 1012 |
| Software Requirements Specification | EN 50128 Section 7.2 | IEEE Std 830 |
| Software Design Description | EN 50128 Sections 7.3, 7.4 | IEEE Std 1016 |
| Software Verification and Validation Report | EN 50128 Sections 6.2, 6.3 | IEEE Std 1012 |
| Traceability | EN 50128 Section 5.3.2.7, D.58 | IEEE Std 1012-1998 |

The Contractor may use existing software documentation that complies with the relevant standard.

6.4.14 Reliability Demonstration

In coordination with the System-Wide System Integration RAM Qualification Test Plan (to be provided by Others), the Contractor shall perform a Trainset Reliability Demonstration Test (RDT), for a minimum 24 month test period, to verify that the Trainsets meet the required reliability performance requirements, when:

- a) Scheduled maintenance is performed in accordance with approved maintenance plans and maintenance manuals.
- b) The Trainsets are operated within the environmental limits described in the Design Criteria Manual (DCM) Chapter 1.9 (Climatic Conditions) and the Interface Specification (Section 12.3).

The Contractor shall:

- a) Develop and submit the RDT plan and procedures.
- b) Perform the RDT according to the approved plan and procedures.
- c) Provide monthly failure reports during the RDT.
- d) Provide a final RDT report.

All Trainset equipment shall be included in the demonstration. If the equipment has not met the reliability requirements, the Contractor shall implement design changes or

modifications as needed to meet them. The test shall then be extended to ensure that changes made result in achieving the requirements.

The Contractor shall submit a RDT Plan (RDTP) for Authority's SONO. The RDTP shall be consistent with MIL-HDBK-781. The RDTP shall establish the following to demonstrate Trainset compliance with reliability requirements:

- a) RDTP schedule.
- b) RDT procedures and forms for recording and submitting data.
- c) Success/failure criteria for measuring reliability values for individual equipment items and subsystems.
- d) Failure analysis of reported failures to identify the cause and need for corrective action.
- e) Failure Review Board (FRB) to meet with the Authority representatives, as required, to determine the need and depth of failure analysis.
- f) Change control procedures for implementing design changes.
- g) Format and location of test records, test logs, and data records.

The Contractor shall identify a qualified reliability engineer who shall oversee the Reliability Demonstration and associated activities.

RDT procedures shall include all information necessary to ensure the successful, accurate, and safe performance of the RDT. The RDT procedures shall include:

- a) Safety precautions.
- b) Identification of the reliability performance parameters that are verified by the test.
- c) Scope of the test (what is being tested and how many).
- d) Test equipment required.
- e) Personnel required.
- f) Any special conditions required, including condition of the equipment under test.
- g) Reference drawings or documents.
- h) Instructions for performing the test and test equipment set-up.
- i) Pass/fail criteria, including applicable tolerances.
- j) Data sheets to record test results, including confirmation of test equipment certification.
- k) Raw data correlation procedures.

RDT procedures shall address the following:

- a) Each equipment failure reported during the RDT shall be classified as relevant or non-relevant failures by the FRB. The assessment shall include all failures, whether occurring in or out of revenue service.
- b) The Contractor shall propose an organization for the FRB, consisting of the Contractor and Authority representatives, as appropriate. The FRB will direct system supplier representatives to meet with the FRB, as required, to classify failures which require specialized experience or skills.
- c) The procedure shall describe the details of the burn-in period preceding the RDT. All equipment failures during the burn-in shall be reported and recorded, but not counted in establishing reliability performance values.

- d) A procedure for corrective action shall be developed and included. The procedure shall identify a specific method for verifying the effectiveness of change(s).
- e) PM procedures specified for the equipment during the RDT shall be performed in accordance with the applicable Contract Terms and Conditions.
- f) The Contractor shall maintain and provide records which contain all the information necessary to calculate reliability performance for the system and major subsystems, and to verify satisfactory reliability requirements.
- g) The Contractor shall use a FRACAS to track and report on system failures. The FRACAS shall consist of a set of data management tools for capturing and reporting on equipment incident data, and a set of procedures which use the data management tools. The FRACAS procedures shall:
 - a. Implement key project functions of Reliability Demonstration and warranty administration.
 - b. Route failure information from the operating authority to the Contractor.
 - c. Assess compliance of delivered equipment with requirements.
 - d. Provide field and operating information to equipment and project design and analysis tasks.
 - e. Assess the effectiveness of modifications of equipment in the field.
- h) Where system failures indicate the possibility of non-compliant design, the FRACAS process shall consist of the following activities:
 - a. Communication of failure information from the operating authority to the Contractor.
 - b. Assessment of failure conditions, impacts, and possible causes by the Contractor Quality Assurance and Engineering departments, and by equipment suppliers.
 - c. Where appropriate, failure analysis by the equipment supplier.
 - d. Corrective action by the equipment supplier.
 - e. Once corrective action has been completed through field or factory action, verification by the Contractor that the implemented solution is adequate and acceptable.

A chargeable failure in the RDT is defined as any relevant failure that requires the repair or replacement of any Trainset component. Chargeable failures also include intermittent failures, unverified failures, and software failures.

Non-chargeable failures in the RDT are:

- a) Consumable items, except for those which are not achieving their specified life.
- b) A failure occurrence in equipment of another subsystem due to the primary failure.
- c) A failure to perform recommended PM actions.
- d) Vandalism or physical mistreatment of a human interface.
- e) Failures due to an accident.

The time, place, or type of service in which the Trainset was being operated at the time of a failure shall not be of any consequence. The data collection shall be made throughout the Reliability Demonstration period and continue until the test results are reviewed and provided for Authority's SONO.

The Contractor shall monitor failure mode rates during the RDT to identify Trainset defects.

The Contractor shall provide monthly Failure Reports during the RDT. The Contractor shall submit the format and structure of the report for Authority's SONO at least three months before commissioning begins. Monthly Failure Reports shall document the current and cumulative failure totals for Trainset equipment, comparing the totals to the reliability requirements.

The Contractor shall provide a RDT Report at the conclusion of the RDT, showing that the system meets reliability requirements.

The following general test requirements apply to the RDT:

- a) No test shall be considered complete until a test report has been received and approved by the Authority.
- b) Written reports of all test performed on Trainsets and their components shall be submitted within 30 calendar days of test performance to the Authority's representative for SONO.
- c) All reports shall clearly identify the equipment being tested, the date(s) of tests, any conditions that may have affected results, and pass/fail status. The test record sheet shall be signed by the personnel performing and witnessing the test. All measured data shall be recorded in numeric form on the reports. Applicable support data for the RDT shall be included with the RDT Report.

6.4.15 Maintainability Demonstration

The Contractor shall provide a Maintainability Demonstration Test Plan (MDTP) for Authority's SONO and shall conduct a Maintainability Demonstration. The duration of Maintainability Demonstration shall be identified in the MDTP.

The Maintainability Demonstration shall establish accuracy of task time and cost estimates for the PM and CM tasks described in the maintenance analyses, and/or maintenance manuals. The Contractor shall demonstrate servicing, PM, troubleshooting, change out of components, CM, and use of special tools.

The Contractor shall perform the Maintainability Demonstration according to the MDTP and provide a final test report for Authority SONO. All Systems shall be subject to a Maintainability Demonstration, which shall include the ability to understand the diagnostic systems' onboard and received wayside messages via displays in the cab and on PTUs.

6.4.16 Failure Reporting and Corrective Action System (FRACAS)

The Contractor shall provide a FRACAS that supports requirements of the RDT and Warranty Program. The FRACAS shall be consistent with RiAC's Reliability Toolkit: Commercial Practices Edition.

The FRACAS shall record actual Trainset RAM performance, including service dependability, PM activities, CM events, warranty failures, spares consumption, etc.

The Contractor shall provide a FRACAS and implementation plan for review. The FRACAS implementation plan shall describe all hardware and software necessary to implement the FRACAS, and all training required. The Contractor shall provide all required hardware, software, and training per the FRACAS implementation plan.

6.5 RAM DESIGN

The Contractor shall comply with all RAM Design Criteria in this Specification, DCM Chapter 30.4.5 (Rolling Stock RAM Design Criteria), and all other referenced specifications and standards. The Contractor shall develop a RAM Requirements Verification Traceability Matrix (RVTM) as part of the RVTM per the Interfaces Section 12.3, to demonstrate compliance with all applicable RAM Design Criteria.

The Contractor shall report on RAM design compliance at Design Reviews and at first article inspections (FAI).

6.6 SAFETY

6.6.1 Requirements and Information

The Trainsets shall be designed with consideration for the health and Safety of passengers, crew, emergency responders, and other third parties. The Contractor shall identify and mitigate Safety Hazards from the outset of the design process and report progress on Safety Work activities throughout the design phases of the project.

6.6.2 Product Safety Plan and the Authority's System Safety Program Plan

The Contractor shall develop, implement, and maintain a Product Safety Plan (PSP) for the Trainset that conforms to the guidelines and requirements including 49CFR Part 229 Subpart E, 49CFR Part 236 Subparts H and I, 49CFR Part 238 Subpart G, 49CFR Part 270, and Tier III requirements. The PSP shall ultimately form a part of the Authority's overall System Safety Program Plan (SSPP). The PSP shall be in conformance with the System Safety requirements of the Authority's Safety and Security Management Plan (SSMP). The Authority's SSMP is attached hereto as Section 13.2.c. Prior to revenue operations, the Authority's SSMP will be refined and developed as requirements mature. The Contractor shall review the amended documents and shall ensure that the PSP is updated to remain consistent and in conformance with the latest version of the Authority's SSMP.

The information provided in the Preliminary PSP submitted at the proposal stage shall be incorporated in the Contractor's PSP. The PSP shall be developed and submitted to the Authority for SONO at the Preliminary Design Review stage. The tracking of Safety hazard mitigations shall then be conducted on an ongoing basis throughout the project.

The Contractor shall identify Hazards and mitigations, which shall be subject to review and SONO by the Authority, and shall establish and maintain a hazard log throughout the Contract. A Safety certification report shall be submitted with delivery of each Trainset, updated through the commissioning of the Trainset and acceptance into Revenue service. This report shall verify risk mitigations, validating the effectiveness of the mitigations, and identifying the residual risk of all identified Hazards as so determined by the Contractor.

The PSP shall include a Software Safety Program, which applies to any embedded or external software or firmware which controls or monitors Safety-critical functions. Software

Safety requirements shall be treated as an integral part of a hardware/software System and shall comply with EN 50128 and EN 50129. Functions accomplished through the use of software shall be considered Safety critical unless an independent redundant hardware means is also provided to accomplish the same function.

The Software Safety Program shall include the following, at a minimum:

- a) Definition.
- b) Procedures for the implementation and oversight of the software design and verification process.
- c) Procedures for verifying the integrity of the documentation.
- d) Software Hazard Analysis.
- e) Safety Integrity Level (SIL).
- f) Software Safety reviews.
- g) Procedures for Software Hazard monitoring.
- h) Procedures for reporting and tracking.
- i) Procedures for Software integration with hardware at each stage of the design and testing process for components, Equipment, Subsystems, Systems, Vehicles, and Trainsets inclusive of software for Safety-critical functions.

7 TRAINSET-WIDE REQUIREMENTS

7.1 OPERATING ROUTES

7.1.1 Requirements and Information

The Trainsets shall operate as defined in the Interface Specification (Section 12.3).

7.2 TRAINSET PRODUCT PLATFORM

7.2.1 Requirements and Information

The Trainset width shall not be less than 3.2 m (10.5 feet) and shall not exceed the maximum allowable width as defined by the Authority's DCM Chapter 3.4 (Vehicle Clearance Envelopes) including referenced appendices, and inclusive of the Trainset's doors in the open position.

The Trainset shall interface with a platform having the following characteristics:

- Platform height above top of rail shall be 1219 mm - 1295 mm (48 inches – 51 inches)
- Platform edge from track centerline shall be 1.75 m – 1.8 m (5.75 feet – 5.92 feet)

7.3 TRAINSET CONFIGURATION

7.3.1 Requirements and Information

The Trainset length shall be such that all of the side entry doors of the Trainset in double traction can berth at a platform having a length of 407 m (1,335 feet). The overall length of the double traction Train shall be no more than 410 m (1345 feet).

7.4 ENERGY USAGE AND EFFICIENCY

7.4.1 Requirements and Information

The Trainset shall minimize the net energy drawn from the power supply Systems (during Operations, standby in stations, and storage in yards), consistent with the operational performance requirements for traction and auxiliary supplies defined in Sections 8.10 and 8.11, respectively.

The Trainset shall employ a regenerative braking system that captures kinetic energy during braking and facilitate its re-use both onboard the Trainset and by return to receptive traction power system.

When the regeneration limit is exceeded, the energy that cannot be used onboard the Trainset or returned to the traction power system shall be stored and/or dissipated by a power management System (e.g., capacitors, resistor grid, etc.).

The Trainset shall have an intelligent stabling function which limits energy consumption during out-of-use periods, but ensures that the Trainset can re-enter service when required.

The Trainset Automatic Train Control (ATC) provided by the ATC contractor will have an Automatic Train Operation (ATO) function to assist the Operator in driving in an economical manner (e.g., optimal energy usage during manual operation). The ATO function will use pre-loaded information of line gradient, speed profile, and timetable information to manage timekeeping and energy consumption.

The Trainset shall include Equipment to measure and report power and energy consumption and regeneration. The Train shall periodically upload this information to a central Data collection point provided by the Authority, while the Train is in service or powered storage. The information shall be provided in a form that will fulfill billing data requirements between the Authority and the power utility providers. Refer to Section 8.16 and the Interface Specification (Section 12.3) for communications Interface requirements.

7.5 NOISE

7.5.1 Requirements and Information

The minimum requirements for exterior pass-by noise shall be in accordance with the requirements of the High-Speed Rolling Stock Technical Specifications for Interoperability (HS RST TSI) as follows.

Pass-by noise, defined at a distance of 25 m (82 feet) from the centerline of the reference track and 3.5 m (11.5 feet) above the upper surface of the rails, shall not exceed a sound pressure level, $L_{pAeq,Tp}$ as defined in EN ISO 3095:2005, of:

- a) 88 dB(A) at 250 km/h (155 mph);
- b) 92 dB(A) at 300 km/h (186 mph);
- c) 93 dB(A) at 320 km/h (199 mph);
- d) 96 dB(A) at 354 km/h (220 mph).

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7.7 SYSTEM SECURITY

7.7.1 Requirements and Information

The Trainsets shall provide for the security of passengers and crew. The Contractor shall develop, implement, and document a program that reduces the security vulnerabilities of vandalism, misuse, and criminal behavior to the lowest practicable level. The Contractor shall accomplish this via the identification and mitigation of security vulnerabilities from the outset of the design process, and report progress, to the Authority, on security activities throughout the design phases of the project. The Contractor shall demonstrate conformance with all aspects of the System Security Plan defined in Section 7.7.2.

Train-side communication and control Equipment shall be redundant, provided with physical and cyber-security protection, and shall utilize diverse routing such that the chance of an effective attack on the Train Systems is mitigated as low as reasonably practicable (ALARP). The Contractor shall provide Network information and Data security to protect the network and control units from intrusions and unauthorized changes, and shall demonstrate compliance with this requirement to the Authority for review and SONO.

7.7.2 Security System Plan

The Contractor shall develop, implement, and maintain a Security System Plan that details how the Trainset will be designed and constructed to limit damage or harm from vandalism, misuse, sabotage, or other intentional criminal behavior. This includes security design elements such as fasteners and locks for internal and external areas (i.e., underbody panels, Cab access, access to Equipment compartments and security of internal compartments) to mitigate the risk of unauthorized admission or unintended opening. The Contractor shall submit the Security System Plan for Authority's SONO.

Other elements that shall be addressed include the application of Crime Prevention through Environmental Design (CPTED), that is, provision of clear sightlines, reduction of spaces that packages can be hidden from inspection, optimal placement of CCTV cameras for areas where natural surveillance is compromised, and provision of other security design elements that could mitigate vulnerabilities. Areas, spaces, or structures that provide concealment shall be avoided, particularly in Vehicle interior configurations, storage compartments, and rooms (e.g., bathrooms, vestibules). These design elements shall be assessed for their vulnerabilities and improved through organization of space, architecture, and lighting. Design shall focus on natural surveillance, natural access control, and territorial reinforcement. A critical portion of the plan is process for the assessment of the potential vulnerabilities of the Trainset and how the planned mitigations impact and reduce/mitigate potential vulnerabilities.

The Security System Plan shall include a cyber-security section which applies to safeguarding any embedded or external software or firmware which controls or monitors Safety-critical functions, providing for dependable Train operation. Train-side communication and control equipment shall be protected and/or provided with redundancy such that the risk of an effective cyber breach is as low as reasonably practicable.

An initial draft of the Security System Plan shall be developed and submitted to the Authority for SONO at the Preliminary Design Review stage. The Contractor shall track security vulnerability mitigations on an ongoing basis throughout the project. The

Contractor shall submit a final security report with delivery of the first Trainset, verifying applications of mitigations, validating the effectiveness of the mitigations, and confirming the residual risk of all identified Hazards.

7.8 FLEXIBILITY

7.8.1 Requirement and Information

Flexibility of the Trainset design, particularly with regard to the interior layout, is required, exclusive of the placement of toilets, equipment lockers, and crew office.

Trainset Systems and associated technologies shall be upwards-compatible and flexible to changes and updates in technology over the life of the Trainset, where practicable. For Trainset communications, the Contractor shall ensure maintenance access to components (e.g., computer servers, network hubs, access points, and roof antennas) and shall provide so future evolutions/changes to onboard Systems can be achieved.

7.9 ELECTROMAGNETIC COMPATIBILITY

7.9.1 Requirements and Information

The distribution and conversion of electrical energy in and to Trains can interfere with onboard, wayside, and neighboring Equipment by conduction through the overhead contact system (OCS) and rails, by inductive coupling, and by electromagnetic radiation. In addition, onboard Equipment can interfere with onboard, wayside, and neighboring Equipment located on the CHSR.

Requirements for electromagnetic compatibility (EMC) and electromagnetic interference (EMI) are in DCM Chapters 26 (Electromagnetic Compatibility and Interference) and 29 (Rolling Stock-Core Systems Interfaces). The Trainset shall comply with the criteria and design provisions identified in these DCM Chapters. These requirements cover emission and immunity limits, cabling, grounding, Equipment-level EMC, switching converter power and harmonics, motors and controllers, Equipment locations, track circuit compatibility, Federal Communications Commission (FCC) Type-Accepted radio Equipment, human exposure, and adjacent railroads and airports.

Trainset EMC provisions shall ensure the following:

- a) Safe and dependable operation of the Trainsets on CHSR lines.
- b) No interference within the Train and with passenger Equipment on the Train, with the onboard and wayside ATC System, with or from radio communications, or with or from neighbors.
- c) Compliance with human exposure limits including magnetic and electric fields and step and touch potentials.

The Trainset shall comply with the criteria and design provisions of DCM Chapter 29 (Rolling Stock-Core System Interfaces), Chapter 29.6.13 (Track Circuit – Rolling Stock Electromagnetic Compatibility), and Chapter 29.6.14 (Rolling Stock – Electromagnetic Field Exposure). The Contractor shall design, document, and test to ensure that Trainsets protect against Train inductive and conductive interference with track circuits or other wayside Devices, and against Cab signal interference. The Trainsets shall use interleaved unity power factor traction power converters/inverters and EMI filtering as required in DCM Chapter 29.4.5 (Power Factor) and 29.6.3 (Interface Requirements).

Design and maintenance provisions shall ensure that EMI cannot compromise the safety of Train operations.

Trainsets and Systems shall not have a negative impact on, nor be negatively impacted by:

- a) Operational electronics used by crewmembers, including radios, and wireless ticketing Devices.
- b) Consumer electronics used by passengers, including cell phones, computers, and radios.
- c) Wayside Equipment.
- d) Control Systems and electronics.
- e) Third party Systems and Equipment.

7.9.2 Electromagnetic Compatibility Control Program

The Contractor shall develop and implement a Trainset EMC Control Program. The Contractor shall:

- a) Develop and deliver a complete Contractor EMC Control Plan that covers all EMC requirements identified in this Section, in the Authority's Implementation Stage EMC Program Plan, and in the DCM, for the Contractor and all Equipment suppliers for the Trainset.
- b) Implement a Contractor EMC Control Program per the Contractor EMC Control Plan, provide all necessary reports and documentation, and track them in a compliant V&V process.
- c) Coordinate Trainset EMC activities with the Authority's infrastructure Program including Core Systems procurements.
- d) Design for and document compliance with all applicable EMC design guidelines and criteria in Trainset Equipment and construction. For the Final Design Review, submit a report which demonstrates adequate safety and dependability margins to protect against worst-case Train emissions affecting ATC equipment.
- e) Design and construct Equipment per EMC requirements in technical Contract documents.
- f) Perform required EMC Analysis, lab and field testing, and reporting.
- g) Integrate EMC design and Analysis results into lab and field test planning.
- h) Manage the EMC Interfaces between the Trainset and the CHSR elements, per Section 12.3.3 and 12.3.35 and coordinate EMC Work with related activities of other CHSR contractors.

The Contractor shall submit all EMC Control Program Work products identified above to the Authority for review and SONO.

8 VEHICLE AND SYSTEM PERFORMANCE REQUIREMENTS

8.1 GENERAL VEHICLE PERFORMANCE REQUIREMENTS

8.1.1 Requirements and Information

The Trainset shall have a service life of not less than 30 years.

The Trainsets shall fulfill the RAMS requirements of Section 6. The Contractor shall design the Trainset structures and Equipment for fatigue loadings and service duty cycles under the most adverse operating conditions that can be encountered on the routes provided in Section 5.1.1 and 13.2.a, which include tunnel lengths and free cross-sectional areas. The Contractor shall refer to the Interface Specification (Section 12.3) for specific information relating to environmental conditions.

The Contractor shall design and construct the Trainset in a modular fashion to facilitate replacement of elements due to structural collision, damage, and vandalism.

8.2 STRUCTURE AND CRASHWORTHINESS

8.2.1 General Description

The Trainsets shall comply with the requirements for Tier III Equipment. The Trainsets shall also comply with the requirements of EN 12663 and EN 15227, or comparable Standards to which the Authority provides SONO, unless otherwise noted in this Specification.

8.2.2 Vehicle Masses

The maximum payload depends on the number of seats for passengers and on the number of passengers in the standing areas. These values take into account any statutory regulations and give the mass for the payload and the number of passengers that are allowed to be transported in these Trainsets.

Per EN 15663, the typical weight of a passenger, with luggage is identified as 80 kg (176 lbs.). The typical weight of a crew member, with luggage and Equipment, is identified as 80 kg (176 lbs.). A review of U.S. Center for Disease Control (CDC) weight statistics for adult males and females has been conducted. Based on these statistics, by 2043, the average weight for a U.S. male is predicted to be 97.5 kg (215 lbs.), and the average weight for a female is predicted to be 84.2 kg (186 lbs.). To calculate payload, the Contractor shall utilize the predicted U.S. adult average weights identified above with a 50/50 gender distribution, and shall include a 7 kg (15 lbs) weight for luggage per person.

The weight, with luggage, of seated passengers (seating density specified in Section 8.4.6), 6 crew members, and 10% standees is the minimum payload weight the Contractor shall use for Trainset design.

For each Vehicle in the Trainset, the structural design payload shall include the number of standees that will fit into a single Vehicle, up to a maximum of 10% of the Trainset seating capacity. The Contractor shall calculate the load of the standees as 2 standees/m² in standing areas utilizing the adult average weights (inclusive of luggage) identified above.

The Contractor shall confirm that the structural design of the trainset can accommodate this payload, developed in accordance with EN 15663, utilizing the predicted U.S. adult average weights identified above. The Contractor shall submit this information to the Authority for review and SONO.

Full load conditions, as identified in this Specification, shall be inclusive of the maximum payload, 6 crew members, 10% standees, all materials needed for operation (e.g., lubricants, coolants, catering Equipment, toilet flushing medium, onboard fire suppression System medium, etc.), and two-thirds of consumables (e.g., sand, water, food, etc.).

8.2.3 Carbody Strength

The Contractor shall demonstrate, by means of calculations and tests, that the carbody strength and fatigue performance of the carbody and carbody interfaces is suitable for the service life of the Trainset within the expected loading conditions and mass distributions.

The carbody structure shall have, incorporated on each end, a means to pick up the carbody for the purpose of re-railing the car should a derailment occur. The carbody shall also have two jacking pads per side at the location of each bogie.

8.2.4 Crash Energy Management

Each Trainset shall be provided with crash energy management (CEM) provisions to dissipate kinetic energy during a collision. The System shall provide for controlled deformation and Collapse of designated sections within the unoccupied volumes to absorb collision energy and to reduce the decelerations on passengers and crewmembers resulting from dynamic forces transmitted to the Occupied Volumes.

8.2.5 Obstacle Deflector

Vehicles with a driving Cab shall be fitted with an obstacle deflector at the Cab end to reduce the risk of derailment resulting from impacts with objects or animals lying at, or near, rail level. The Contractor shall demonstrate that the deflector is comparable with that defined in EN 15227.

8.2.6 Load Cases for Equipment Attachments

Safety brackets, hangers, or other similar Devices shall carry the Equipment within the clearance envelope (as defined in DCM Chapter 3 (Trackway Clearances)) under Normal operating load conditions in case of Failure of the primary attachment System. With the Failure of any one of the attachments, the Equipment shall remain within the clearance envelope of the Vehicle. Further, Equipment attachment strength shall be demonstrated to the same levels as specified for interior fitting attachments per the requirements for Tier III Equipment.

8.2.7 Modes of Vibration

The natural modes of vibration of the carbody, under ready-to-run load (i.e., no passengers), half-seated load, and full load conditions, shall be separated, or otherwise decoupled, from the suspension frequencies to achieve acceptable ride quality per Section 8.19.10. The fundamental modes of vibration of items of Equipment, on their mountings and in all operating conditions, shall be separated, or otherwise decoupled, from the

modes of vibration of the carbody structure and suspension, to avoid undesirable responses.

The Contractor shall create finite element analysis (FEA) models of each System attached to the carbody and its respective mounting Equipment and provide to the Authority for SONO. Shock and vibration requirements for Trainset Equipment shall be in accordance with EN 61373.

8.2.8 Safety Appliance Mechanical Strength and Fasteners

During Design Review, drawings of all Safety appliances to be installed on the Trainsets shall be submitted to the Authority for review and SONO. Contractor preference for welding over mechanical fastening, if any, shall be justified to the Authority for evaluation with FRA. The size, location, and function for each Safety appliance shall be clearly described for presentation. Design and mounting of Safety appliances shall account for aerodynamic effects on and acoustic emissions from the Vehicle.

All Safety appliances and fasteners shall comply with FRA regulations. The Contractor shall develop Safety appliance drawings for the Trainset for submission to the FRA and participate in a Safety appliance sample Trainset inspection by the FRA.

8.2.9 Emergency Signage and Markings

Emergency exits shall be clearly identified to passengers and emergency responders by means of signs. Emergency signage shall be implemented as described within APTA PR-PS-S-002-98.

Emergency exits shall be clearly identified to passengers by means of low-location exit path markings as described within APTA PR-PS-S-004-99.

The Contractor shall develop emergency signage drawings, during Design Review, for submission to the FRA by the Authority, and shall conduct sample Vehicle inspections with the FRA for determination of compliance.

8.2.10 Evacuation via the Doors

Trainsets shall be equipped with emergency Devices allowing the evacuation of passengers via passenger access doors, when not present at a platform, to surfaces at heights encountered on the CHSR (such as ballast shoulder, raised walkway, top-of-rail (TOR) road crossing, tunnels and trenches where space may be limited, and walkway configurations as defined in DCM Chapter 3 (Trackway Clearances), etc.). Devices to assist in evacuations at doorways (portable ladders, stairs, etc.) shall be located in close proximity to doorways and stowed in accessible cabinets. These Devices shall accommodate deployment by passengers, without the assistance of onboard crewmembers, and shall be provided with a means to mechanically fasten to the Vehicle, adjacent to the door threshold. Evacuation methods shall not require an external power source for activation. Evacuation from the Equipment, with the associated times detailed in Section 8.13.1, shall be described in an emergency egress plan to be submitted for review and SONO by the Authority.

8.2.11 Emergency Roof Access

Each passenger Vehicle shall have a minimum of two emergency roof access locations. Emergency roof access shall be provided by means of an external conspicuously marked structural weak point in the roof for access by properly equipped emergency response personnel. Specific requirements for size and placement of emergency roof access points are described within 49CFR 238.123.

8.2.12 End-Facing, Side-Facing and Interior Glazing

The Trainsets shall be equipped with certified end-facing and side-facing glazing compliant with the requirements for Tier III Equipment. Further, all glazing, inclusive of Trainset interior glazing, shall conform to EN 15152 and Relevant Standards.

Each exterior window shall remain in place when subjected to air pressure differences caused by two passing high speed Trains travelling at maximum velocity in opposite directions, at the minimum separation for two adjacent tracks, and by a Trainset entering a tunnel.

Side-facing glazing shall also meet the passenger and crew containment requirements of GM/RT 2100, Issue 4, December 2010 Appendix C.

8.2.13 Carbody Aerodynamic Provisions

The Contractor shall demonstrate that the body profile, nose shape, and structural response of the Trainsets have been designed to accommodate the requirements of the HS RST TSI.

8.2.14 Corrosion Protection

Materials shall be compatible with the ambient conditions and environments specified in the Interface Specification (Section 12.3).

Anti-corrosion measures, including the prevention of water buildup, shall be incorporated. The Contractor shall provide the following information for Authority review and SONO:

- a) The type and location of anti-corrosion measures and design features.
- b) Protective measures employed where dissimilar metals are in contact.
- c) Recommended Maintenance requirements, if special attention is required.
- d) Protective measures to be taken during shipping and prior to the commencement of operation.

8.3 EXTERIOR REQUIREMENTS

8.3.1 Exterior Equipment

At a minimum, underfloor Equipment shall be protected from airborne debris, ice, and ballast.

Equipment cover latches shall not violate the Trainset dynamic clearance outline when not engaged, and shall hold the cover firmly to the box without rattling in the engaged condition. Safety catches shall be provided for each Equipment box cover. The catches shall retain the cover within the Trainset dynamic clearance envelope at all speeds without the cover latches engaged.

8.3.2 Exterior Finishing

The Trainset exterior, including Front End and skirting, shall be painted in accordance with the color schemes developed by the Contractor and approved by the Authority.

The Contractor shall propose cleaners compatible with the Trainset finishes, glazing, and cleaning cycles.

8.3.3 Exterior Graphics

Graphics shall be provided to provide passengers with information. The graphics shall comply with the FRA's requirements, and shall not cover retro-reflective material for the purposes of emergency instructions and access identifications. All exterior graphics shall be developed by the Contractor and subjected to Authority SONO.

The Trainset number (fixed) shall be provided on the front end and side of each Cab Vehicle.

8.3.4 Side Skirts

Side skirts shall be provided outboard of the Bogies and elsewhere as required to complement the overall aerodynamic and aesthetic design.

8.4 INTERIOR DESIGN

8.4.1 Requirements and Information

The interior of the Vehicle shall be designed and constructed with consideration for Safety, security, comfort, durability, convenience, and service to the passenger, while also ensuring the efficient use of space and specified seating capacity.

There shall be First Class and Business Class Vehicle designs, both of which shall meet requirements specified by ADA. The First Class and Business Class areas of each Trainset shall be distinguishable through the use of interior colors, designs, patterns, and finishes of materials. Both classes shall be representative of a premier class of service. Interior colors, designs, patterns, and finishes of materials shall be developed by the Contractor and approved by the Authority.

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8.4.3 Basic Features of All Vehicle Types

The Trainset shall facilitate the following:

- a) Compliance with CPTED principles, as defined in Section 7.7.2, with emphasis on natural surveillance, which supports the placement of physical features, activities, and people in such a way so as to provide visibility and foster positive social interaction among legitimate users.
- b) Interior furnishing shall be placed to eliminate spaces where items can be placed out of sight.
- c) Space for passengers to be able to move through the Trainset to access onboard facilities (e.g., restrooms, luggage stacks, etc.) during their journeys.

- d) Evacuation under emergency conditions (e.g., reduced lighting, smoke, etc.) to locations on the CHSR.
- e) The ability for the Train Crew to service the needs of passengers, including catering of hot/cold meals and drinks from a trolley and the ability to maintain the temperature of such food via onboard food storage Equipment.
- f) Flexible/modular internal layout, allowing refurbishment and/or relocation of interior furniture in the future.
- g) Seats shall be fixed and non-rotating with a mix of forward-facing, rear-facing, table and accessible seating provided in accordance with the desired proportion of seats per class, as identified in Section 8.4.7.
- h) The design for the table shall use a cantilever design to allow for maximum legroom and minimal obstructions.
- i) Interior materials, parts, and design elements shall contribute to decrease the overall noise level within the rail Vehicle.
- j) The Vehicle interior shall be finished with high durability, low-Maintenance materials. All materials and visible surfaces shall be selected to retain their initial appearance for a period not less than 15 years.
- k) The interior furnishing shall facilitate cleaning using railway and industrial cleaning methods and Equipment.
- l) The interior finishing shall not contain volatile organic compounds (VOC) that, at a minimum, exceed South Coast Air Quality Management District Specifications for painting, coatings, sealants, and adhesives, or the requirements in a stricter standard identified by the Contractor.
- m) The interior design shall permit compartmentalization for control of smoke/fire spread.
- n) Cabin lighting shall utilize light emitting diodes (LED) or other equivalent long-life sources of light.
- o) Windows shall be provided with tinted glazing. All windows in the passenger seating areas shall be equipped with passenger operated blinds or side curtains to provide protection against the glare of the sun. Curtains or shades shall be replaceable and cleanable without the need to remove wall panels.
- p) The passenger seating and food service areas shall be separated from the vestibule/passageway by doors.
- q) ADA-compliant accessible seating shall be provided in all passenger Vehicles. ADA seating areas shall not be located directly in front of the accessible restroom door.
- r) Handholds shall be located in circulation areas of the Trainset (i.e., vestibules) to enable safe circulation throughout the Train.

8.4.4 THIS SECTION INTENTIONALLY LEFT BLANK

8.4.5 General Requirements

The Trainset shall accommodate changes to the interior finish and layout. Interior components including, but not limited to, the seats, tables, draft screens, partitions, and

luggage modules shall be reconfigurable in a maintenance facility to allow for changes in capacity ratios.

Within the passenger areas, the floor area shall be kept clear of under seat Equipment that could limit interior flexibility for future layouts. Interior draft screens and other intermediate partitions shall not be structural.

A crew office shall be provided on the Trainset with a table, charging ports, and Equipment storage to accommodate two crewmembers, and to provide access to Train communications (including public address/intercom (PA/IC)), Train diagnostics and information.

The Contractor shall submit, to the Authority for review and SONO, supporting technical and material datasheets for liners, masks and associated trim pieces, bulkheads, end walls, and other Trainset surfaces.

Carpeting shall be industrial grade. Walls and ceilings surfaces shall not be carpeted. Flooring in toilets and food service areas shall not be carpeted, shall be non-slip, even when wet, and colored so as to not accentuate the presence of stains. The floor shall be sealed to prevent moisture infiltration and shall either be integral with the walls or connected to them by a sealed joint so as to prevent the leakage of liquids into the Vehicle structure.

The Contractor shall submit, for Authority review and SONO, samples of each floor covering along with the supporting technical/material datasheets. Information Details for the interior arrangement of the floor coverings and for their installation and removal shall be included.

Paint shall not be used on any wall surfaces.

8.4.6 Seating Provision

The Trainset baseline interior layout shall provide a minimum of 450 passenger seats.

Tip-up seats shall not be included in the passenger seat count. Wheel chair passenger locations can be included in the passenger seat count.

A transverse seating configuration in a mixture of both passenger table and unidirectional seating layouts is required. These ratios may be adjusted by the Contractor, to make best use of the available space relative to the constraints that the product platform may dictate.

Tables with tops that can be stowed independently (e.g., flip-up, slide-in) at each seat shall be provided at all table seat positions.

All unidirectional seating shall be provided with folding tray tables that can accommodate the ergonomic usage of a laptop with a 381 mm (15 inch) screen, and that can support a minimum weight of 10 kg (22 lbs) without deformation of the table or support. It shall be possible to stow the table when it is not in use.

At least one 120 VAC, 60 Hz ground fault interrupter (GFI) protected power socket and one universal serial bus (USB) port (charging only) shall be provided for use at each passenger seat. Additional power sockets shall be provided, as needed, to support

efficient Maintenance and cleaning of Trainset interiors. All power sockets on the Trainset shall be GFI protected. All USB ports shall be in accordance with the latest standard.

Each seat shall contain storage space for personal electronic Devices and other miscellaneous items.

A cup holder shall be provided at each seat that does not require the tray table to be in the lowered position in order to be used.

The seats shall include headrests, adjustable footrests, and armrests. Armrests shall be padded and comfortable and shall accommodate the U.S. 5th-percentile female and the 95-percentile male population in terms of length. Leather seating, or comparable alternative, shall be utilized in all classes of service. The quality of the seat and cushion design shall vary based on the class of service, with First Class offering the highest quality. Samples of all Vehicle seat types and materials to be used shall be provided for evaluation and SONO by the Authority.

Vehicle interior configuration shall vary based on class of service.

Attendant call buttons which annunciate to crew members shall be available at all designated ADA accessible seating positions.

8.4.7 Seating Classification

First Class accommodations shall represent 15% \pm 2% of the total Trainset seating capacity.

Business Class accommodations shall constitute the balance of the Trainset seating capacity.

First Class seating shall be situated together in the Trainset in adjacent locations.

8.4.8 First Class Seating

The First Class areas of each Trainset shall be representative of a premier class of service when compared to the finishes provided in the Business Class Vehicles, including but not limited to pod-style seat design, or equivalent, and upgraded finishes.

Seating shall be provided with spacing equivalent to 1067 mm (42 inches) of Pitch, minimum. The Contractor shall identify the equivalent spacing, measured in accordance with UIC 660:2002 Appendix D, for review and SONO by the Authority.

The minimum seat width shall be 508 mm (20 inches) measured from the inside edges of the arm rests.

Seating configuration shall ensure that another passenger's comfort is not impeded by a fully reclined seat.

8.4.9 Business Class Seating

Business Class seating shall be provided in 2+2 configuration, in both table and unidirectional seating layouts.

Seating shall be provided with spacing equivalent to 991 mm (39 inches) of Pitch, minimum. The Contractor shall identify the equivalent spacing, measured in accordance with UIC 660:2002 Appendix D, for review and SONO by the Authority.

The minimum seat width shall be 508 mm (20 inches) measured from the inside edges of the arm rests.

Seating configuration shall ensure that another passenger's comfort is not impeded by a fully reclined forward seat.

8.4.10 Tip-Up Seating

Tip-up seats shall be provided in the spaces reserved for wheelchairs. The tip-up seats cushions shall be similar in width, shape, and contour to the standard seat cushion, complete with upholstery, and shall be suitable for use by the U.S. 5th-percentile female and 95th-percentile male.

The seat shall normally remain in the down position until the wheelchair space is needed. The seat shall then be raised by a wheelchair occupant. Once raised, the seat shall remain in the folded position.

8.4.11 Toilet Facilities

The toilet facilities provided shall reflect the needs of a prestige service. The design of the First Class and Business Class toilet facilities shall be identified by the Contractor for review and SONO by the Authority.

Toilet facilities shall be provided on the Trainset per a maximum of 57 passengers per toilet ratio.

The Trainsets shall be fitted with vacuum-type, controlled-emission toilets, and shall fully retain all waste and odor between servicing on all routes and service patterns. Facilities shall have the capacity of storing, operating, and supplying full passenger loads for two consecutive days without servicing. The Contractor shall size the fresh water and waste water tanks based on the requirements of UIC 563.

All toilet facilities shall permit cleaning using railway and industrial cleaning methods and Equipment. All toilet modules shall be completely sealed and shall incorporate features to prevent fluid leakage into the passenger area and/or Vehicle underframe. All toilet seats shall incorporate damping mechanisms.

Toilet waste retention tanks shall be drained via a vacuum System during Normal servicing. The retention tank shall be designed and constructed to eliminate areas that prevent waste from being drained.

Electrical and plumbing connections shall be designed to facilitate maintenance. The tanks and all piping shall be protected from damage from freezing and from corrosion. The waste System shall operate over all operating and environmental conditions outlined in this Specification.

A door-locking System with a door lock light shall be included that indicates occupancy status on the inside and outside of the door to prevent accidental intrusion by another passenger.

All restroom doors shall incorporate a Device to allow the door lock to be overridden and opened by crew when “locked.” This Device shall be protected or located so as to avoid being used or tampered with by passengers. In the event of Device Failure, passengers shall not be locked in the toilet module.

All restroom doors shall incorporate a means for crew to lock the door out of service and clearly identify to passengers that the facility is “locked out of service.”

Faucets/water taps, electric hand dryers, paper towel dispensers, soap dispensers, and toilet flushers shall be provided with non-touch controls. All water faucets/taps shall include the ability to provide both hot and cold water. Hot water temperature range shall be 43°C to 49°C (110°F to 120°F). Hot water shall be available at all sinks.

Hanging hooks which can accommodate a maximum load of 10 kg (22 lbs), which shall be flush to the wall when not in use, and shelving for toiletries, purses, and coats shall be provided in all toilet facilities.

All ADA restrooms shall have powered doors. A fold-down baby changing table shall be present in all ADA restrooms.

A trash receptacle with a hands-free lid that is wall or cabinet-mounted shall be provided by the sink in all toilet facilities. This receptacle shall not intrude into the clear space of the ADA restroom such that it hampers wheelchair access.

A perfuming or fragrance-dispensing System shall be provided in all restrooms.

All toilet facilities shall be provided with general and task lighting, and a mirror with lighting.

All toilet facilities shall incorporate fresh air ventilation per Section 8.14.7.

Fire and smoke detection devices shall be provided in all toilet facilities.

Emergency/Safety attendant call buttons, which annunciate to the crew members, shall be located in the restroom.

8.4.12 Luggage Storage

Stacks for luggage storage at the ends of each Vehicle shall be provided at a minimum volume of 0.045 m³ (1.6 ft³) per passenger. Overhead luggage storage shall be provided to accommodate a fully loaded Trainset.

Luggage stowed in overhead racks shall be visible from seated positions directly below and by crew walking through the Trainset.

8.4.13 Bicycle Storage

A bicycle storage area shall be provided, and shall accommodate a minimum of 8 bicycles per Trainset. A maximum of two dedicated bicycle storage areas shall be provided per Trainset, reducing inconvenience to passengers. Bicycle storage areas shall be separate

from wheelchair spaces and shall not block or otherwise impede emergency egress and access.

Guide rails shall be provided to help steer the bicycle into the correct position. Surrounding surfaces shall be protected against mechanical damage and scratches caused by the bicycles. Bicycles shall be secured and the lifting of bicycles over fixed objects shall be avoided.

Graphics shall be provided on the exterior of the Vehicle, identifying the doors to be used for bicycle access. Interior graphics shall also provide instructions for using the bicycle racks.

8.4.14 Trash and Recycling

Litter and recycling bins shall be provided throughout all passenger areas, and identified in the Contractor's interior layout. The passenger and food service areas shall be equipped with receptacles for trash and discarded recyclable items. The quantity, useable volume and placement of these receptacles shall be equivalent to or better than the Reference System, and such information shall be provided for Authority review and SONO.

8.4.15 Vehicle Passageways

Vehicle passageways (e.g., intercar gangways) shall provide access between all Vehicles allowing the free flow of passengers along the Trainset in Normal and emergency conditions. The passageway width, floor, and all level transitions shall not be a source of tripping hazards or noise while the Trainset is in motion.

The passageways shall be sealed against the ingress of water, drafts, dust, and external noise. They shall also be insulated against thermal losses and gains.

The passageways shall allow the passage of passengers in wheelchairs, passengers carrying luggage, and food service trolleys. It shall have an appearance consistent with that of the vestibule. It shall also be free of any protrusions and shall not have any gaps that may be exposed during Train movements.

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8.4.17 Interior Graphics

Graphics shall be provided to provide passengers with information. The graphics shall comply with FRA requirements, and shall not cover retro-reflective material for the purposes of emergency instructions and access identifications. All interior graphics shall be developed by the Contractor and subjected to Authority SONO.

8.4.18 Emergency Facilities

An emergency Equipment locker and associated Equipment shall be provided in each Vehicle of the Trainset. Each locker shall be marked with emergency Equipment signage that is compliant with FRA emergency signage standards.

8.5 FOOD SERVICE

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8.5.2 Food Service Requirements

Food and beverage services shall be available for purchase in all accommodations. These services shall comprise of hot/cold meals and drinks, served from a trolley at the passenger's seat. The food will be brought onto the Trainset pre-heated/pre-cooled. A means of maintaining the temperature of the food shall be provided and shall be in accordance with all Applicable Laws.

The size and layout of the area(s) dedicated to the provision of food service (e.g., heated/cooled trolley storage, beverage storage/preparation) shall be equivalent or better than the Reference System. The size and layout for the food service area shall be developed by the Contractor and approved by the Authority.

If an external loading door solely for Trainset provisioning is provided, the size of the door may be smaller than the ADA requirement. This door shall be connected to the door Safety System (i.e., door summary circuit).

8.6 CLEANABILITY

8.6.1 Requirements and Information

All interior components shall be durable and retain their appearance and physical properties throughout all environmental conditions taking full account of passenger loadings, and the cleaning and Maintenance cycles.

Lighting assemblies shall be sealed against the ingress of dust and dirt.

All heating and air conditioning ducts shall be protected against the build-up of dust, dirt, moisture, and combustible detritus, and shall be fitted with covers to both allow access for cleaning yet prevent access by passengers.

8.7 AMERICANS WITH DISABILITIES ACT REQUIREMENTS

8.7.1 Requirements and Information

The Contractor shall comply with all applicable U.S. laws and regulations as they pertain to Americans with Disabilities Act of 1990, 42 USC 12101, et seq., as amended ("ADA") and the Rehabilitation Act of 1973, 29 USC Section 701, et seq. ("Rehab Act"), and all applicable regulations under both laws.

8.8 CAB

8.8.1 Requirements and Information

The Trainset shall have a fully-functional and identical driving Cab at each end. The layout of the driving Cab shall be arranged for operation by an unaccompanied Operator and shall provide seating for two additional occupants.

The Operator's seat and footrests shall be adjustable such that the operator has unobstructed forward visibility out the windshield and clear view of the speedometer, gauges, and Cab displays.

8.8.2 Cab, Cab Desk, and Driving Simulator

A standardized Cab and Cab desk in accordance with UIC 612-0, shall be provided.

The driving Cab at each end shall provide a safe and ergonomically designed environment and shall address the following:

- a) Architecture/ergonomics for Operators ranging from the U.S. 5th-percentile female to 95th-percentile male.
- b) Safety/security of the occupants. Vulnerabilities to criminal behavior, including hijacking, shall be addressed.
- c) Comfort of the Operator.
- d) Cab access and egress from ground level.
- e) Cab environment provided to the Operator, as necessary, to allow operation during all times of day and night.
- f) High efficiency Cab heating, ventilation, and air conditioning (HVAC) System (low noise, high Reliability).
- g) Cab lighting requirements.
- h) Rear viewing capability of trailing Trainset and station platform.

The Contractor shall provide one full-scale Cab Mock-up (refer to Section 11.3).

The Contractor shall also provide one full-motion 3D driving simulator that is in compliance with 49CFR Part 240 Type 1. The Contractor will be required to update the simulator with the Authority route and characteristics as they are finalized.

8.8.3 Gauges, Instruments, and Display Screens

ATC and Positive Train Control (PTC) information will be integrated on one screen.

Gauges shall be integrated electronically with the display screens. Redundant screens shall be provided to display all essential operating information.

Speed set control and alerter Systems shall be provided. The Cab signal and PTC System acknowledgement shall reset the alerter timing cycle.

8.8.4 Forward External Visibility

The Cab shall be compliant with the signal sighting requirements as identified in the HS RST TSI.

8.8.5 Facilities for Use by Cab Crew

Cab crew facilities shall be provided to store crew's clothing and Equipment in or near the Operator's Cab. Additional Operator facilities/provisions shall include:

- a) 120 VAC, 60 Hz GFI protected power sockets and three USB ports (for charging).
- b) Three cup holder accessible in the Normal seated positions.

- c) Three coat hooks.
- d) Removable waste bin made of corrosion resistant material.
- e) Desktop Train order holder to hold a 279.4 mm (11 inch) by 279.4 mm (11 inch) document.
- f) A suitably sized holder for FRA inspection cards and forms.
- g) Crew refrigerator.
- h) Fusees containers.

8.8.6 Emergency Equipment Locker

An emergency Equipment locker shall be provided in each Cab. The locker shall contain the Equipment specified in 49CFR Part 239.101. The Contractor shall develop a list of emergency tools to be submitted to the Authority for review and SONO.

8.8.7 Warning Bell and Horn

Warning Devices consisting of an electric bell and horn shall be provided on the exterior of the Cab. These Devices shall be activated from the Operator's cab desk. The bell shall produce a repeating sound with a one second repetition rate in response to switch activation. The sound level emitted by the bell shall be a minimum of 75 dBA at 15.2 m (50 feet). The horn shall meet the requirements of 49CFR Part 229.119.

8.8.8 Windshield and Wipers

The windshield shall be replaceable from the exterior of the Vehicle and shall limit external glare and reflections from inside the Cab when the Train is operated at night with all interior illumination on.

A windshield wiper and washer Assembly shall be provided for each Cab that covers the Operator's sight line area, when seated. The windshield wipers shall be effective in the environmental conditions specified in the Interface Specification (Section 12.3), and shall have variable speed and intermittent time-delayed operation.

When stopped, the windscreen wiper blades shall park in the rest position automatically and shall not interfere with the Operator's forward external visibility as identified in Section 8.8.4. The wiper blades shall maintain this position regardless of the speed of the Trainset.

A System for defogging/defrosting of the windshield and an adjustable front windshield visor shall be provided. This System shall be effective at the environmental conditions specified in the Interface Specification (Section 12.3).

The capacity of the Trainset windshield wash System shall support two days of Trainset service operation between fills. Replenishment of the windshield wash fluid shall be accomplished via an exterior fill location.

8.9 CURRENT COLLECTION EQUIPMENT

8.9.1 Pantograph

The Contractor shall be responsible for interfacing/integrating the pantograph with the Authority's OCS and high voltage Equipment, as specified in the Interface Specification (Section 12.3).

Two pantographs shall be supplied per Trainset; however, current collection during Normal operation shall be performed by only one pantograph. The pantograph contact wear strip material shall be identified by the Contractor for review and SONO by the Authority.

The pantograph shall provide current collection at all speeds up to 390 km/h (242 mph).

The pantograph shall have an operating range for wire heights from 4.5 m (14.83 feet) to 7.5 m (24.5 feet). The pantograph shall be raised and lowered from either cab and shall be grounded during pantograph inspections. The Contractor shall submit to the Authority for SONO all required safety equipment, procedures and processes that will be required for safe operating and inspection tasks.

8.9.2 Arrangement of Pantographs

The maximum spacing between the first and last pantograph for two coupled Trainsets shall be less than 400 m (1,312 feet) in order to negotiate the specified types of separation sections. Where two pantographs are simultaneously in contact with the OCS during Normal operation at maximum speed, the minimum spacing between the pantographs shall be 200 m (656 feet). Multiple pantographs shall not have electrical links (e.g., via isolation switches) between the pantographs in use.

8.9.3 Automatic Lowering Device

Trainsets shall be equipped with a Device to automatically lower the pantograph head if a contact strip becomes damaged in any position along its length so as to not cause consequential damage to the OCS Equipment.

The pantograph shall have weak points integrated throughout its structure that break or have means to allow the pantograph to lower and prevent wire damage in the event of entanglement with the OCS. The pantograph mounting design shall prevent pantograph debris from breaching the Trainset roof.

8.9.4 Running through Phase Separation Sections

Trainsets shall be fitted with Systems that receive information from wayside control-command and signaling Devices that communicate the requirements of separation sections on a line to Trains. Subsequent actions shall be triggered automatically, and after re-energization, all Trainset Equipment shall return to its intended operating levels and output. The Contractor shall provide and integrate the onboard portions of the Systems, and shall integrate the onboard portions with the wayside portions which will be provided by the Authority.

8.9.5 THIS SECTION INTENTIONALLY LEFT BLANK

8.10 TRACTION

8.10.1 General Description

The propulsion System shall achieve the propulsion and braking performances identified in the Sections below and as required to fulfill RAMS requirements. The System shall take into account the full range of loading conditions and permit rescue of disabled Trainsets.

8.10.2 Operating Speed

The Trainset shall accommodate a continuous, maximum Operating Speed of 354 km/h (220 mph) on level track, under full load conditions, and a testing speed of 390 km/h (242 mph).

The Contractor shall determine the wheel/rail adhesion limits necessary to meet the performance requirements for Authority review and SONO.

8.10.3 Mean Acceleration

The Contractor shall submit the acceleration rates and permissible jerk rates to the Authority for review and SONO. Details on how the jerk rate will be controlled to be within the permissible limits shall also be provided.

At 354 km/h (220 mph) and on straight level track, with new or worn wheels, the Trainset shall provide a minimum residual acceleration of 0.05 m/s² (0.11 mphps).

8.10.4 Service Braking

Service braking shall be configured to use Electric Braking, in accordance with Section 8.12.2, prior to supplementing with friction brake effort to achieve the necessary brake rate for Operations. Blended braking can be achieved using Electric Braking modes alone and Electric Brake and friction brake. Service braking shall be compatible with the Authority's infrastructure, and any temporary and permanent speed and civil restrictions.

The maximum speed shall be automatically limited when any Electric Brake unit has failed. The maximum speed reduction shall compensate for the loss of braking capability, so the Train maintains safe braking performance per DCM sections including 24.3.10 (Safe Braking), 29.6.3 (Interface Requirements), 29.6.4 (Automatic Train Control Technology Information), 29.6.7 (Rolling Stock Parameters), and 29.6.8 (Environmental), and so the Train performance reduction is not reduced out of proportion to the loss of braking. The speed limit shall be contained within the control logic, and shall be user programmable, with suitable provisions to prevent inadvertent or unauthorized modification of safety-critical parameters. The reduced maximum speed shall be identified by the Contractor, taking into account the level of degradation of the Electric Brake, required braking effort and the thermal limitations of the friction braking System.

The propulsion System shall regenerate into the Trainset's auxiliary power supply (APS) during Dynamic Braking. The remaining energy shall regenerate into the OCS so long as the OCS is receptive. If the OCS is not receptive, the onboard power management system shall store/dissipate the remaining energy to limit the use of friction braking to achieve the required brake rates. Additional requirements for the onboard power management system as identified in Section 8.12.4 shall be adhered to.

8.10.5 Abnormal Operating Conditions

The Trainset shall be capable of restarting its forward motion on a 3.5% gradient under full load conditions with only 75% traction available.

A single Failure of power Equipment feeding the traction modules shall not deprive a Trainset of more than 50% of its traction power.

When operating the Trainset with one failed traction module, loss of 50% of its traction power, or Train pushing or towing a disabled Trainset under maximum load from any point of the route to the end of the line, making all station stops and observing all speed restrictions, there shall be:

- a) No Equipment damage.
- b) No activation of any protective Devices which is obstructive to this operating mode.
- c) No operating temperatures in excess of equipment design limits.
- d) No reduction of the life of the traction motors, converters/inverters, or main transformer below the design life of the Trainset.
- e) No reduction of speed below 50% of the authorized speed.

OCS voltages are included in the Interface Specification (Section 12.3).

The Contractor shall submit a traction System description that identifies the traction system's main components, including all heat exchangers and continuous ratings to substantiate and detail how the traction System will accommodate the abnormal operating conditions identified in this Section, for Authority review and SONO.

8.10.6 Harmonic Characteristics and Related Over-Voltages on the OCS

During Design Review, the Contractor shall perform a compatibility assessment on Trains with single and double traction configuration as a whole, including all power units which can generate harmonics into the traction power system, per EN 50388:2005 Section 10, and shall demonstrate that the Train with single or double traction configuration does not generate harmonics beyond the defined limits.

The Trainsets harmonic characteristics and current and voltage distortion limits shall conform to requirements in the Interface Specification (Section 12.3).

The Contractor shall plan, design, construct, test, and report to ensure and demonstrate that Train harmonics conform to the requirements of DCM sections 26.9.8 (Equipment Emission and Immunity Limits), 29.4.7 (Overvoltages Generated by Harmonics), and 29.6.14 (Rolling Stock-Electromagnetic Field Exposure). These requirements include the propulsion System, the Auxiliary Power System, and all other Trainset power systems, in any Train configuration, including when one or more propulsion, auxiliary power, or other power units fails. The elements of the work to achieve harmonic integration shall be submitted for Authority SONO review.

8.10.7 Electrical Protection Coordination with the Primary Power Supply

Electrical protection coordination and conformity assessment shall comply with the requirements detailed in EN 50388.

Propulsion System components shall be protected from damage due to reductions in cooling and complete cooling Failure and from water ingestion into the cooling air supply.

If forced air cooling is provided, high voltage elements (with the exception of brake resistors, if used) shall be isolated from the cooling air stream. There shall be no electrically live external surface of enclosures. Liquid cooling Systems shall be sealed and all components shall be rated for continuous exposure to the liquid. Environmentally friendly, non-toxic, biodegradable, non-flammable or fire-resistant, and non-conductive liquid compounds shall be used.

Correctly rated and coordinated electrical protection shall be provided to protect all Systems from permanent damage from overheating, reductions in cooling and complete loss of cooling, overvoltage, overcurrent, voltage flashovers, electrical Faults, ground Faults, and other potential problems.

8.10.8 Traction Motors

The traction motors shall be of robust construction to avoid damage by airborne ballast or debris, and shall limit unsprung mass. Traction motor cooling air intakes and exhausts shall be protected against the admission of debris.

The motor shall have Bogie clearances to permit each motor and gear unit combination to be removed from the Bogie without interference with members of the Bogie frame. The traction motor shall be removed from above the Bogie without requiring removal of the gear unit. Traction motor bearing scheduled maintenance shall be achievable without the removal of the traction motor from the bogie. Lifting lugs or other means shall be provided for attaching lifting Devices.

The motor shall be provided with Safety straps, tabs, or hangers to prevent the motor from falling in the event of Failure of the primary motor mounts.

A monitoring System shall be supplied to detect and report rotor bearing, gearbox bearing, and/or traction motor to gearbox coupling Failures.

8.10.9 Gearboxes

Gear unit duty cycle, torque ratings, maximum speed, and other applicable factors shall equal or exceed expected dynamic requirements.

The gear unit lubrication System shall be accessible without necessitating the removal of Bogies and shall prevent overfilling. If sight glasses are utilized, debris guards shall be supplied.

Gearboxes shall be mounted to limit transmission of vibration into the trackwork and to reduce unsprung mass. The gear unit shall be provided with Safety straps, tabs, or hangers to prevent the gear unit from falling in the event of Failure of the primary mounts.

8.10.10 Master Controller

The manual control of propulsion and braking shall be accomplished through a master controller provided in each Cab, located on the Operator's cab desk. The master controller may provide for either a one-handle or two-handle operation. The design of the master controller shall match the overall aesthetic concept of the Cab and console and meet Safety and ergonomic requirements while utilizing components of traction power System quality in its construction.

Should a Trainset be required to be pushed by a rescue Trainset, the master controller in the leading Cab shall remain functional even if propulsion is cutout on that same Trainset.

The Contractor shall integrate the modes and operation of the Master Controller with the modes and operation of the onboard ATC equipment provided by the ATC contractor.

8.10.11 System Interfaces

The propulsion System shall be fully coordinated with the traction power supply (TPS), uninterruptible power supply (UPS), OCS, main transformer, auxiliary power Systems, Cab control, signaling System, friction braking, door interlocks, no motion detection, and Trainset Fault monitoring and diagnostic System and all other Systems that interface with the propulsion System, including as required by DCM Chapter 29 (Rolling Stock-Core System Interfaces). The Contractor shall be responsible for coordination of Interfaces of the propulsion and brake systems and the applicable hard wired trainline functionalities.

8.10.12 System Faults

The operational status of the electric portion of the brake System, and all critical, Safety-related propulsion System Faults, and any fault that can disrupt the scheduled operation or performance of the Train, shall be displayed for the Operator in the control Cab. The display shall also depict the total tractive effort, wheel slip conditions, and acceleration and deceleration rates.

8.10.13 Data Logger and Status Indication

The Trainset Train Control and Monitoring System/Onboard Computer (TCMS/OBC) shall be equipped with a Data logger that shall receive and record performance information regarding the propulsion and braking Systems in the Train, by date and time. The Data logger shall be part of the TCMS/OBC, as specified in Section 8.17.

The Contractor shall identify the status and Fault indications that will be logged by the Data logger, for review and SONO by the Authority.

8.11 AUXILIARY POWER SUPPLY

8.11.1 General Description

Electrical Equipment shall be supplied with redundancies/backups, and shall supply power to the Trainset's control circuits when it is energized, so that the Trains achieve the RAM targets. Proposals offering new technologies or implementation of design changes to existing Systems may be considered given that the Contractor can provide Data to indicate that the proposed Electrical Equipment meets all of the requirements specified.

8.11.2 Low Voltage Power

The Trainset shall include a load shedding scheme for staged degraded operations based on battery capacity (including sustaining of emergency operations (such as emergency communications, lighting, etc.)). The Contractor shall supply a UPS for the purpose of supplying power for the control circuits of the Trainset when the APS is not energized or functioning. The UPS may utilize batteries; if used, the UPS shall be supplied with a

battery charging device and the battery maintenance shall be covered in the Trainset RAM allocations, plans, and procedures. The Contractor shall develop this scheme for the Authority's review and SONO.

8.11.3 Shop Power Supply Receptacle

Auxiliary power receptacles and jumper cables shall be installed on each end on both sides of the Trainset. Jumper cables shall not be permanently attached to the Trainset.

The components shall allow 480 VAC 3 phase to be supplied to all Trainset Systems from a Maintenance facility standby power station.

The auxiliary power System shall be interlocked with the shop power supply to prevent double feed.

8.11.4 Test, Download and Adjustment Points for Troubleshooting and Testing

Local Fault logs, along with System status indicators shall be provided to aid troubleshooting activities.

Ports shall be provided to observe and record parameters required to troubleshoot or to verify proper operation of the Equipment, or to initiate diagnostic tests. These tasks shall be performed using a PTU.

8.12 BRAKING

8.12.1 General Description

The braking performance shall be compliant with the HS RST TSI, relative to the maximum speed of 354 km/h (220 mph). The Contractor shall advise of the braking performance of the Trainset for speeds in excess of 354 km/h (220 mph), up to the maximum testing speed of 390 km/h (242 mph), for Authority SONO.

The brake Equipment shall:

- a) Comply with the performance and RAMS requirements detailed in this Specification.
- b) Provide wheel slip/slide protection (WSP) for all traction and braking cases to limit wheel damage.
- c) Provide and display System monitoring and Fault indications.

In the case of partial or complete loss of Electric Brake, the friction brake shall achieve the desired speed reduction rates and maximum mandated stop distances under all operating conditions.

Loss of power or Failure of the Electric Brake shall not result in exceeding the allowable stopping distance as defined in this Specification and in DCM Chapters 24.3.10 (Safe Braking), 29.6.3 (Interface Requirements), 29.6.4 (Automatic Train Control Technology Information), 29.6.7 (Rolling Stock Parameters), and 29.6.8 (Environmental).

The friction brake alone shall be able to safely stop the Train under all operating conditions defined in this Specification. The friction brakes shall be sized to permit the completion of the Trainset's daily assignment, with friction brakes alone, allowing for one emergency

friction brake application per trip at any location. Other than increased wear of consumable components, there shall be no damage to the braking System as a result of such duty.

An Interface between friction brakes, Cab signal, alerter, ATC/PTC System provided by the ATC contractor, and Train diagnostic and monitoring Systems shall be provided.

A redundant multi-master brake control configuration shall be provided. For the Trainset, 49CFR Part 238.431 mandates an independent failure detection System that shall compare brake commands with brake System output to determine if a failure has occurred. At individual car level, beside the wheel slip control (WSC) element, the detection of non-rotating axles (DNRA) shall serve as a secondary brake control element, in case of a WSC failure.

The control of the braking System shall be governed by and documented to achieve the RAMS program requirements. The brake control unit (BCU) shall be configured for graduated release only (i.e., the brake system is designed to release (reduce) the brake cylinders' pressure in proportion to the brake pipe pressure rise, incrementally, from brake full service to brake release condition).

The Trainset shall provide a continuous application of partial brake, at a minimum on one Vehicle, during the brake test segment of the pre-departure test, to hold position at terminal stations.

Provisions shall be made to allow application and release of the Trainset parking brakes using an independent means in emergency situations (i.e., Trainset stopped in a tunnel), when the power from the Trainset batteries is not available.

8.12.2 Types of Brake Systems

The Trainset braking System shall utilize Electric Braking and friction braking to achieve the specified Trainset braking rates and stopping distances.

Electric Braking may consist of Dynamic Braking, and, if applicable, eddy current braking. Eddy current track braking will be permitted on the dedicated segments.

If tread brakes are not part of the Trainset friction brake design, alternative provisions shall be made to account for tread cleaning, as required to meet the specified performance requirements.

The friction brake shall have the capacity to brake the Train to a standstill, within the safe braking distance on the track over which the Train is operating, from the maximum Operating Speed, in emergency, with all of the Electric Braking Systems inoperable. Other than increased wear of consumable components, there shall be no damage to the braking System as a result of such duty.

The Contractor shall demonstrate, through Analysis and testing, that the braking System does not exceed the thermal duty cycle of the brake components under any braking scenario, while respecting the maximum stop distance identified for safe operation.

Electric Braking shall provide a minimum of 90% of the total Trainset braking effort required.

The Operator shall be able to apply and release the mechanical brakes from the driving Cab. The Contractor shall document the application times for all braking modes, per DCM Chapter 29.6.7 (Rolling Stock Parameters).

The Contractor shall provide the control logic necessary to ensure smooth integration of the friction brake and wheel slip/slide Equipment and to coordinate electric and friction brake blending.

An “insufficient brake” detection circuit shall be provided on each Vehicle. The “insufficient brake” detection System shall be configured to detect actual levels of brake cylinder pressure and Electric Brake effort. The TCMS/OBC shall interface bi-directionally with each car’s BCU for health, status, fault condition monitoring and self-testing tasks.

8.12.3 Protection of an Immobilized Train

The Train shall remain stationary with a full load for an unlimited period of time under normal operating conditions, (i.e., air is available/compressor is working) on all gradients to be encountered on the CHSR with the maximum operational brake cylinder pressure applied and without assistance from the parking brakes.

The Train shall remain stationary with a full load for an unlimited period on the maximum gradient to be encountered with parking brakes applied.

The parking brakes for the Train shall be applied and released from the Operator’s Normal seated position in any Cab of the Train. Each Vehicle shall be equipped with a means to release the parking brake manually, preferably from the interior of the Trainset.

8.12.4 Power Management System

An onboard power management System shall be provided to store and/or to dissipate Dynamic Braking energy when the OCS is non-receptive and the maximum amount of energy has been supplied to auxiliary loads.

Braking resistors, if used, shall be double insulated and sized for duty cycles without any dependency upon Regenerative Braking to dissipate all Dynamic Braking energy commanded by the brake management System. Power dissipating resistors shall be ventilated to prevent overheating under worst-case operating conditions. Power dissipation grids shall be designed and installed to prevent combustion between resistor elements and isolated from combustible material.

8.12.5 Wheel Slip/Slide Protection (WSP)

A WSP shall be fitted to each Vehicle to reduce wheel slide (resulting from brake applications) and wheel slip (resulting from traction applications) in situations where wheel/rail adhesion is temporarily impaired (e.g., inclement weather conditions, fouling of the rail), and shall prevent wheels from locking. The Contractor shall outline the control philosophy for the WSP, which shall be redundant and act independently on all axles or Bogies under its control. The Contractor shall submit details describing how the WSP System has been designed for use at high speeds in the Authority’s environment, and documenting that the WSP fulfills the applicable safety requirements for safe braking distance.

The function shall operate with all wheel sizes and shall maintain performance with degraded rail conditions. The WSP shall be interfaced with the sanding trainlines, if provided.

During Design Review, the design and operation of the WSP shall be submitted to the Authority for review and SONO.

The Trainsets shall also be provided with rotation monitoring Equipment that is independent of the WSP, to detect locked axles and to indicate this condition in the Controlling Cab through an audible and/or visual alarm.

8.12.6 Emergency Brake Devices

The Trainsets shall be provided with emergency brake Devices, in each Cab and crew office, that can be used to initiate an emergency brake application. An emergency brake Device shall be accessible to a member of the crew, other than the Operator, from that crew member's position in the cab. The Operator shall not be able to release the brakes until the Train has come to a complete stop.

8.12.7 Passenger Brake Alarms

A passenger brake alarm shall be provided in the passenger compartment that initiates a retrievable penalty brake application, which uses a brake rate consistent with prevailing adhesion, passenger Safety, and brake System thermal capacity. The Operator shall be able to release the brakes to allow the Trainset to be stopped at a safe location.

8.12.8 Pre-Departure Test

It shall be possible for the Operator to initiate pre-departure brake tests from the driving Cab. Such tests shall also include WSP System tests.

8.12.9 Rescue Operations

The brake System shall allow a disabled Train's friction brakes to be controlled by a Rescue Vehicle, during a rescue operation. The Contractor shall provide any Interface units that may be required between the Rescue Vehicle and the disabled Train. The Rescue Vehicle shall only supply main reservoir pressure, and brake pipe pressure control (refer to Section 8.22).

8.13 DOORS

8.13.1 General Requirements

Each passenger Vehicle shall have a minimum of one electrically controlled, power operated entrance door per side. The side entry door System shall be designed and constructed to fulfill all applicable safety requirements and such that no single point malfunction of door System components shall create an unsafe condition.

During Design Review, the Contractor shall submit a Train Egress Report outlining the number and size of side entry doors that shall facilitate the complete evacuation of a fully operational, fully loaded Trains to an adjacent platform within three minutes of the Train stopping. The Trainset shall provide for the evacuation of a fully operational, fully loaded

Train to a location other than an adjacent platform (e.g., at-grade along the right of way) within ten minutes of the Train stopping. The Contractor is to consider that Train Crew members and other passengers will be available to assist passengers with disabilities.

Also to be included in the report are specific features incorporated on the Trainset to permit crew, passengers, and passengers with disabilities to emergency evacuate the Train safely in a tunnel, trench, or aerial structure and in the absence of platforms.

The Contractor shall provide an assessment of boarding/egress times to/from the Train that demonstrates that the Train permits the required dwell times to be consistently achieved during Normal operation, including the periods of peak passenger boarding and alighting with luggage. The maximum dwell time shall be 2 minutes for normal operation.

Doors, doorways, and vestibules shall not have surfaces or edges capable of causing injury to passengers and crew or of damaging or dirtying their clothes or baggage. Thresholds including the overhangs shall have an anti-slip surface that allows for the safe entry and exit of passengers and crew in all weather conditions, and shall be provided with drains and heaters to prevent buildup of snow and ice. The anti-slip abrasive surface shall have contrasting Safety markings.

Interior end doors, with powered door operators, shall be provided to separate the vestibule/passageway from the passenger seating and food service areas. Details of the door design shall be submitted for Authority's review and SONO.

Passenger doors closest to each Cab shall have a key switch to allow access by authorized crew from the exterior. These doors shall be operable from battery power. The key switch shall be accessible both from the track and at platform levels.

8.13.2 Door Operation

The Operator shall enable the door operation system from the cab. Powered door operation shall be initiated by the Train Crew or via passenger enabled pushbuttons at each door location.

Controls shall be provided for the Train Crew to close/lock the passenger doors. All doors on the platform side of the Train that are not adjacent to a platform, or are on the opposite side of the Train, shall remain closed and locked.

A visual and audible indication shall be given to passengers in the vestibule whenever a door is released.

Door operation signal shall be interlocked with a zero speed command and interfaced with the door summary circuit.

Each passenger Vehicle shall have pushbuttons provided on the exterior and the interior at each side door location so passengers can control the powered operation of local doors. Operating instructions shall be posted adjacent to the pushbutton.

8.13.3 Door Closing

When the locking control for one door is under crew control at the door control panel and is activated, it shall be permissible for this door to remain open when the other doors close.

The crew shall close and lock this door subsequently, and it shall be closed prior to the Train departing.

When closed, the doors shall be weathertight and pressure-sealed.

At the end of the close cycle, each door shall be fully closed and mechanically locked to prevent un-commanded door opening. Each door shall provide detection to the door summary circuit indicating the door is closed and locked.

8.13.4 Door Obstruction

Each side entry door shall be equipped with an obstruction detection System. The Contractor shall provide a detailed assessment of the obstruction detection System, including theory of System operation, service history, Reliability and Maintainability, compliance with applicable standards, and Safety Analysis.

8.13.5 Door Control Panel

A door control panel shall be provided at each doorway to control the operation of the side entry door, or other doors on that Vehicle, or other Vehicles in the Train via trainline control signals. The panel shall be accessible to the Train Crew via a locking cover opened by a crew key.

8.13.6 Information Available to the Train Crew

The TCMS/OBC shall indicate to the Operator and the Train Crew that all of the doors (except for the door under local control of the Train Crew) are closed and locked. A subsequent indication shall inform the Operator that the door under local control of the Train Crew is closed and locked. An indication shall be provided to the Operator or the Train Crew of any Fault in the door closing operation. The TCMS/OBC shall also indicate door status such as locked out, emergency release activated and health and fault monitoring of each exterior door controller and door operator.

8.13.7 Locking a Door Out of Service

Each door shall be equipped with a cutout/lockout mechanism providing door closed indication to the summary circuit. The cutout/lockout feature shall not be accessible to unauthorized personnel and shall be overridden by the door emergency release.

The cutout/lockout shall be provided adjacent to the door inside the Train to enable the Train Crew to lock a defective door out-of-service in the closed and locked position.

8.13.8 Emergency Release

Each side entry door shall have an internal emergency release Device, accessible to passengers, and designed and constructed to prevent accidental or malicious operation. The Contractor shall provide the Authority with the details of a speed interlock that will prevent the door from opening when the train is in motion, for review and SONO. This Device must be fail-safe. This Device, when activated, shall cause an alarm to sound at the door, remove traction power, unlatch the door, remove the door isolation lock, release seal (if so equipped), remove power from the door operator or controls, move the door

manually towards the open position, and send an indication to the Operator. This Device shall unlock a door that has been locked out-of-service.

Each door shall also be equipped with an external emergency release Device, accessible to rescue crew, to allow the door to be opened for emergency reasons. This Device shall also unlock a door locked out-of-service and shall be protected or located so as to prohibit unauthorized entry into the Vehicle.

8.13.9 Door Summary Circuit

A fail-safe trainline door summary circuit (or equivalent function via software) shall be provided to give indication to the Cab that all exterior side doors are closed and latched, and/or locked out with the door cutout lock.

The door summary circuit (or equivalent function via software) shall include functionality to inhibit tractive effort until the Train reads zero speed condition and all passenger entry doors are closed and locked. Also, if the door summary circuit (or equivalent function via software) senses a passenger side door open when the Train is in motion, the tractive power shall be removed. The door summary circuit or function shall fulfill all applicable safety requirements.

8.13.10 Door Summary Circuit Bypass

Cabs shall be equipped with two summary circuit bypass switches provided to override the door closed summary circuit, one for each side of the Train.

The switches shall have provisions for sealing in the "Normal" position and shall provide an indication to the Operator and Operations Control Center (OCC) when the Train is operating in bypass.

8.13.11 Audible and Visual Indicators

The Contractor shall provide audible and visual indicators at each passenger door prior to the opening and closing cycles. The audible and visual indications (type, location, frequency, duration) shall be submitted, during Design Review, for review and SONO by the Authority.

8.13.12 Driving Cab Internal and External Access Doors

The door between the driving Cab and the end of the nearest passenger area shall be fitted with slam-locks. The doors shall be capable of being locked from the outside by means of a key operated security lock. The same key shall open and lock the driving Cabs of all Trainsets. Operation of the door internal handle shall release the security lock to allow the Operator to exit the cab.

The driving Cab shall be accessible from ground and platform level, from either side of the Trainset. A minimum of two access points to each driving Cab, one per side, shall be equipped with hand rails and footsteps so that the Train Crew can get on and off the Vehicle safely. The hand rails and footsteps shall allow crew to enter or leave the driving Cab from or to ground level. Refer to Section 8.13.1 for exterior key switch requirements.

Crew side doors, if provided, shall not be accessible to passengers. Crew side doors shall include the same requirements as Cab side doors.

The Contractor shall justify the size and location of any non-passenger access doors.

8.13.13 Door Data Logger

The Trainset shall be equipped with a Data logger function to receive and record the door System performance and Fault information. The Data logger shall be part of the TCMS/OBC, as specified in Section 8.17.

8.13.14 Maintenance/Accessibility

All door mechanisms requiring Maintenance or adjustment shall be accessible via access panels or other alternative means from inside the Vehicle. Access shall be provided from inside the Vehicle to all points necessary for inspection, service, installation, or removal.

8.14 HEATING, VENTILATION, AND COOLING

8.14.1 General Description

The Contractor shall, using information provided in this Specification, evaluate and select the worst-case conditions, and provide an HVAC System that meets the performance criteria. This shall be verified through calculations submitted to the Authority for SONO.

The HVAC System shall include all of the necessary components to provide the required level of passenger and crew thermal comfort. The integrated, microprocessor-controlled HVAC Equipment shall include separate temperature controls for the Operator's Cab and the passenger areas with continuous monitoring of outside and inside temperatures to maintain the proper interior thermal comfort.

The HVAC Equipment shall not only provide thermal comfort and proper ventilation during both Normal and emergency conditions, but shall control the pressure inside the Vehicle to avoid pressure fluctuation.

8.14.2 Passenger Comfort

The HVAC System shall provide comfort air inside the Trainset per Figure 5 and Chapter 9 of the ASHRAE Fundamentals Handbook. ASHRAE Standard 55-2010 shall be used to determine the interior thermal environmental factors that will provide environmental conditions acceptable to passengers.

8.14.3 Ambient Conditions

The climatological design Data provided in the Climatic Design Information chapter of the ASHRAE Fundamentals Handbook shall be used for design ambient conditions.

For cooling, ASHRAE 0.4% cooling dry-bulb temperature/mean coincident wet-bulb temperature Data shall be used.

For heating, ASHRAE 99.6% heating dry-bulb temperature Data shall be used.

8.14.4 Interior Conditions

The thermal comfort conditions defined in ASHRAE Standard 55-2010 shall be maintained within the Vehicle, including toilet rooms and Cab, throughout the entire exterior ambient design conditions defined in the table below:

| Outside Ambient | Interior Vehicle Temperature |
|-------------------------------------|---|
| Below -25 °C (-13 °F) | Equipment shall be operable within 5 K under the outside ambient. |
| -25 °C to +15 °C (-13 °F to +60 °F) | 21 °C ± 1 °C (±2 °C for toilet room) 70 °F ± 2 °F (±4 °F for toilet room) |
| 15 °C to 43 °C (60 °F to 110 °F) | 23 °C ± 1 °C (±2 °C for toilet room) 74 °F ± 2 °F (±4 °F for toilet room) |
| Above 43 °C (110 °F) | Equipment shall be operable within 5 K over the outside ambient. If the Equipment is placed in the underframe, it shall be operable within 10 K over the outside ambient. |
| Layover Cool Mode | 29 °C ± 1 °C (±2 °C for toilet room) 85 °F ± 2 °F (±4 °F for toilet room) |
| Layover Heat Mode | 10 °C ± 1 °C (±2 °C for toilet room) 50 °F ± 2 °F (±4 °F for toilet room) |

8.14.5 Heating

The Cab shall be provided with proper ventilation in accordance with ASHRAE 62.1-2010 at a minimum, and with a heating arrangement that maintains a temperature equivalent to that found in the passenger compartment.

The Contractor shall determine Equipment requiring freeze protection and incorporate controls in the HVAC temperature control System. Freeze protection requiring power shall be automatically energized at an ambient set point temperature determined by the Contractor.

8.14.6 Safety and Protective Devices

All heating Equipment shall incorporate overheat protection in accordance with the U.S. National Electrical Code.

If applicable, where airflow is required to maintain temperature of heating Devices, power to heating devices shall be interrupted upon loss of airflow.

Surfaces accessible to passengers shall not exceed 51.7 °C (125 °F) for metallic surfaces and 62.2 °C (144 °F) for non-metallic surfaces.

8.14.7 Ventilation

Passenger areas, including toilets and food service areas, shall be ventilated at least at the minimum rates required in ASHRAE 62.1-2010. Ventilation shall include a mixed airflow, comprising fresh air and re-circulated air. Operator Cabs shall be ventilated by a minimum fresh airflow of 30 m³/hr (17.7 ft³/min) per person.

The Contractor shall provide a means of exhausting stale air and odor from the food service galleys and restrooms, respectively.

The ventilation System shall maintain a Vehicle internal positive static pressure at all Trainset speeds, and alignment conditions, including higher altitudes and within tunnels. Intake of filtered fresh air shall be provided to maintain positive pressurization.

Emergency ventilation of at least 6 m³/hr (3.5 ft³/min) per person of fresh air shall be provided in the event the HVAC System fails or auxiliary power supply is lost. Such ventilation shall be available for at least 30 minutes thereafter.

8.14.8 Sealing of Trainsets

The Trainsets shall be configured to seal and/or automatically ventilate to ensure aural comfort for passengers when Trainsets enter/leave tunnels. If the Trainset incorporates intake and exhaust flaps to maintain carbody sealing, the intake and exhaust flaps shall be automatically closed prior to the Trainset entering a tunnel. The pressure experienced by the Train Crew and passengers onboard the Train shall not exceed the limits specified in UIC 660, and UIC 779 (for sealed Trains). The Contractor shall verify that the Trainset can achieve the medical health criteria for basic tunnel cross-section using the UIC software SEALTUN during the design phase. If needed, the Train shall receive and use information on the locations of tunnels received via a wayside system provided by the Authority, with the onboard functionality provided and integrated by the Contractor.

8.14.9 Air Conditioning

Refrigeration Equipment shall be protected against lock-out due to temporary extremes such as when running through tunnels and during pulldown.

Chlorofluorocarbon (CFC)-based refrigerants are not allowed.

8.14.10 Pre-Conditioning

A means shall be provided to remotely (e.g., via a programmable timer, external signal) start the HVAC System to pre-heat or pre-cool the Trainset to the interior temperatures specified.

8.14.11 Protection against Smoke and Fumes

Measures to protect against the propagation of smoke and fumes in the event of a fire shall be provided in order to achieve a tenable environment for passengers and Train Crew. The switching off or closing of all means of external ventilation and the switching off of air conditioning shall be triggered by remote control by the Operator, for the entire Train, or by a crew member, for the individual Vehicle.

Should fumes be detected within the Trainset, the HVAC System(s) of the affected Vehicle(s) shall be switched off. Such actions shall be automatically triggered by the fire/smoke detection System. Means to initiate such actions shall also be made available at the Operator's console.

The Operator shall return the HVAC System to Normal operation in the Vehicle(s) not affected by fire or smoke.

Such overriding action shall be recorded by the event recorder.

8.14.12 HVAC Controls

Heating and cooling control shall be controlled by a microprocessor using solid state Devices. The output of the microprocessor shall control electrical power to the heater elements, motors, and various control Devices. The changeover between heating and cooling shall be automatic and, except for the reheat stage of overhead heat, shall preclude the simultaneous operation of heating and air conditioning.

A PTU shall be provided allowing service personnel full control of the HVAC microprocessor. The PTU shall also have the capability of changing any variable set points within the System.

Each HVAC unit shall have local diagnostic indicators to aid troubleshooting Faults on the unit. HVAC System Faults, self test, health and status shall be reported to the TCMS/OBC.

Each HVAC unit shall be equipped with a Data logger that shall receive and record the performance and Fault information regarding the HVAC units. A list of these Data shall be provided for review and SONO by the Authority. The Data logger shall be part of the TCMS/OBC, as specified in Section 8.17.

8.15 LIGHTING

8.15.1 Requirements and Information

Lighting fixtures shall be dust-proof and moisture-proof. Those installed on the Trainset exterior, and in the interior within 610 mm (24 inches) of a doorway (with the exception of the interior ceiling lights), shall be watertight.

All lighting fixtures shall provide for installation, removal/replacement, change-out, adjustment, and cleaning (including diffusers, lamps, and ballasts). Lighting levels shall be adjustable by crew members. Parts of lighting Equipment shall not deteriorate or discolor as a result of continuous exposures. Interior, exterior, and indicator lights shall be of the long-life LED type, or other equivalent sources of light.

8.15.2 Interior Lighting and Passenger Reading Light

Design and tests of the Normal interior lighting shall follow the guidance contained in APTA PR-E-RP-012-99.

An individually switched reading light shall illuminate the reading area of the respective passenger seat. The Contractor shall demonstrate that the position of the reading light and its control are suitable for a U.S. 5th-percentile female to a 95th-percentile male.

8.15.3 Cab Lighting

The Operator's Cab shall have lights that provide illumination for the control instruments, meters, and gauges to enable the crew to make accurate readings from their Normal positions in the Cab. These lights shall be located, constructed, and maintained so that light shines only on those parts requiring illumination and does not interfere with the Operator's vision of the track and signals.

Each Cab shall also have a light that can be turned on and off to provide illumination to read Train orders and timetables.

To avoid glare on the windshield, dimmer control and directional adjustment of the Cab lighting shall be provided.

8.15.4 Exterior Side Door Threshold Light

All exterior side doors shall be equipped with LED door boarding lights to illuminate the side door threshold.

8.15.5 Standby/Emergency Lighting

The Trainsets shall be equipped with LED emergency lighting utilizing self-contained battery packs and/or capacitors that are capable of self-test to confirm functionality.

At a minimum, as a standby mode, 30% of all Normal lighting in the main passenger areas (evenly distributed throughout the Vehicle) and 100% of all emergency lighting shall be operational during power interruptions. Reduced Normal lighting shall not de-energize until after 90 minutes. Emergency lighting shall remain functional for a minimum operating time of three hours.

Low-location exit path markings shall continue to be operable for a minimum of 90 minutes after the loss of power from standby lighting.

8.15.6 Headlights

Two white headlights (also known as headlamps), each producing a peak intensity of no less than 200,000 candelas, shall be provided at the front end of each Cab Vehicle.

8.15.7 Auxiliary Lights

Two white auxiliary lights, each producing a peak intensity of no less than 200,000 candelas, shall be provided at the front end of each Cab Vehicle to form the points of a triangle with the headlights.

The auxiliary lights shall be arranged to burn steadily or flash. The flashing feature shall be activated automatically, but shall also accommodate manual activation and deactivation by the Operator.

8.15.8 Rear End Marking Devices/Marker Lights

Two red marker lights, with intensity greater than 100 candelas and less than 1000 candelas, shall be provided at the front end of each Cab Vehicle. Marker lights shall be LEDs.

The marker lights shall be arranged to burn steadily when on the trailing end of the Train. The marker lights at the rear end of the Train shall also be automatically switched on whenever the headlights are operational at the front end. In the event that the Train cannot recognize the Train direction, the marker lights shall be on at both ends.

8.15.9 Combined Lamps

Combined lamps (i.e., lamps capable of different functions) shall be permitted only where the requirements for the individual lamp functions are achieved.

8.15.10 Lamp Controls

The Operator shall control the headlights and auxiliary lights from the Normal driving position.

The following functions shall be provided:

- a) All lamps off.
- b) Full auxiliary lights on (daytime and night time use by Operator's choice).
- c) Dimmed headlights on (daytime and night time use by Operator's choice).
- d) Full-beam headlights on (daytime and night time use by Operator's choice).

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8.15.12 Door Indicator Lights

LED door indicator lights shall be provided for each exterior door on the Trainset. The door open indicator light of each door shall be illuminated when the door is not closed and locked.

8.16 TRAINSET COMMUNICATIONS, PASSENGER INFORMATION, AND INTERFACES

8.16.1 General Description

The communications System shall allow both simple and logical uses to be made under Normal operating conditions while ensuring that all necessary communications and Data transmissions can be made reliably when emergency situations arise.

Additional requirements/Interfaces for the Authority's communication System are defined in the Interface Specification (Section 12.3).

8.16.2 Centralized Time Display

The Contractor shall link all communications Systems, Data recorders and event recorders that are controlled by time and provide a time stamp to the Pacific Time zone. This System shall interface with the Global Positioning System (GPS) Global network timing system provided by an interfacing contractor.

In addition, the standard reference time provided by this System shall be displayed on the Operator's Cab console, in the crew office, and on the internal electronic passenger information displays. The clock shall show the standard reference time in hours, minutes, and seconds.

8.16.3 Radio System

The Contractor shall provide the Interface points, as specified further in the Interface Specification (Section 12.3).

The radio System shall be compatible with handheld radio Devices used onboard and any associated antennas shall be provided if required to ensure radio communications.

8.16.4 Controls – Cab

The Contractor shall provide all communications Equipment and visual and audible indications necessary to meet the functional requirements of the communications section in the driving Cab. This shall include an Integrated Control Panel (ICP) which shall integrate the PA and IC Systems.

The Contractor shall advise of the design and functions of the ICP for Authority review and SONO.

8.16.5 Controls – Crew Office

A communications console shall be provided in the crew office for use by the crew to communicate with each other, passengers, or the control center. The layout of this console shall be presented to the Authority for review and SONO.

8.16.6 Controls – Vestibule

The Contractor shall provide the PA and Operator-to-Trainmaster IC communications Equipment for Train Crew in the vestibule.

8.16.7 Public Address/Intercom System (PA/IC)

All passenger Vehicles shall be equipped with a PA System that provides a means for a Train Crew member to communicate by voice to the passengers.

The PA System shall provide means for intercommunication between Train Crewmembers and for a Train Crewmember to communicate by voice in an emergency situation to persons in the immediate vicinity of the Train (e.g., persons on the station platform).

Means shall be provided onboard the Trainset for the triggering of pre-recorded PA messages from onboard or wayside. It shall be possible for the Authority to record, distribute, and maintain such pre-recorded messages.

The PA System shall interface with the interior electronic displays to provide dual-mode communications (audio and visual) to accommodate deaf, hard-of-hearing, and visually impaired individuals. Assistive listening Devices (e.g., hearing loops such as an Assistive Listening System (ALS) that is T-coil compatible) shall be provided and shall interface with the PA System.

All passenger Vehicles shall be equipped with an IC System that provides a means for passengers to communicate by voice with crewmembers and OCC in an emergency situation. The System shall record the conversation, once the IC is activated, and provide for downloading of the recording. The Contractor shall interface and integrate the IC function with the radio system to be provided under a separate contract.

At least one IC that is accessible to passengers without using a tool or other implement shall be located in each end (half) of each Vehicle. The location of each IC intended for passenger use shall be conspicuously marked with photo-luminescent material.

Legible and understandable operating instructions printed on photo-luminescent material shall be posted at or near each such IC.

8.16.8 THIS SECTION INTENTIONALLY LEFT BLANK

8.16.9 Emergency Communication

The backup power System shall power each pertinent System for emergency communications, independent from the main energy source, to allow communication via the radio, PA, and IC for a minimum period of three hours and continuous communication for the last 15 minutes at the end of the three hour period.

The communication System shall continue to operate no less than 50% of (distributed throughout the Trainset) its loudspeakers in the event of a Failure in one of its transmission elements, or another means of communication shall be available to inform the passengers.

The structural loading requirements which appear in the requirements for Tier III Equipment also apply (under the same conditions) to back-up power systems for the onboard PA/IC system.

8.16.10 Passenger Information Signs

All Vehicle interiors shall be conspicuously and legibly posted with passenger information signs. The Contractor shall submit renderings of the signs and their respective designs for Authority SONO.

All Vehicles interiors shall be conspicuously and legibly posted with emergency signs and instructions (e.g., on Vehicle bulkhead signs, seatback decals) that shall be visible at all lighting levels. Requirements for emergency signage and markings are identified in Section 8.2.9.

Each seat shall have a designated seat number that is displayed at the seat via integrated signage. In addition, the Contractor shall provide dynamic at-seat signage that indicates that a seat is reserved, triggered by the Train Crew via a central interface point located in the crew office.

The location, function, and appearance of all signage, graphics, and displays shall be submitted for Authority review and SONO.

The Contractor shall develop a seat-back Safety information card illustrating the type, location, and use of Safety features available to the passenger, emergency Equipment, emergency signage, and emergency exit pathways for each Vehicle type. This Safety card shall include a clear Braille overlay. The safety card shall be provided to the Authority for review and SONO.

Refer to Section 12.3.40 for communications Interface requirements.

8.16.11 Passenger Alarm System

A passenger alarm System accessible by all passengers shall be provided. The Contractor shall provide details of the System for review and SONO by the Authority.

Operating instructions, printed on photo-luminescent material and in Braille, of the passenger alarm shall be posted adjacent to the Device.

Back-up power for the passenger alarm System shall be available for a minimum period of three hours.

8.16.12 ADA Compliant Call-for-Aid Signal

A "Call-for-Aid" signal is required at each ADA seating location and toilet. Indication of the call shall be identified to the crew by location.

8.16.13 General Alarm

The Trainset shall have a general alarm in the communications control unit (CCU) to allow an Operator to alert all Trains within a radio ground station transmission area of major emergencies such as derailment, landslide, fire, or flood.

8.16.14 Video and Audio Recorders

A color digital video and audio recorder shall be provided in each Trainset to continuously record each of the camera and audio inputs for each Vehicle whenever the Trainset is in operating service (this includes both in motion and stopped at a station and in revenue and non-revenue capacities). The recorder shall also record camera and audio inputs for each Vehicle during non-revenue/non-operating hours.

The recorder(s) shall be located in the Trainset protected against damage that might occur in the event of a collision. The recorder shall have a removable memory module.

The monitoring and recording system shall adhere to the recommendations of APTA IT-CCTV-RP-001-11.

A CCTV system plan shall be provided by the Contractor prior to final design/construction to document how the System incorporates the contract requirements. This plan shall be submitted to the Authority for review and SONO.

8.16.15 External Video Cameras – Platform Monitoring

Externally mounted color video cameras shall be mounted on both sides of the Trainset at each Cab end to allow the Operator to monitor platforms at stations. The cameras shall operate at low illumination levels (e.g., during nighttime). Signals shall be provided from the door control pushbuttons to enable and display the correct cameras on the Operator's video monitors. Should doors on both sides of the Trainset be selected, the left side cameras shall be displayed on the left (split screen) and the right side cameras on the right.

8.16.16 External Video Cameras – Forward Facing Cameras

Color video camera(s) shall be mounted on the front of the Trainset to provide a full forward facing view. The camera(s) shall be mounted in a manner that protects them from the elements and is accessible to maintenance personnel.

The cameras shall operate at low illumination (e.g., during nighttime) levels. These cameras shall continuously record all activities in front of the Trainset. It shall be possible for the rear facing camera(s) to function at the same time to facilitate maintenance inspections. Functionality shall be provided for real-time review and indexing of the video while Authority maintenance personnel are seated in the rear cab. It shall be possible to transmit indexed, captured video to the wayside once the Trainset has returned to a maintenance facility or when Trains are stationary at yards.

8.16.17 Pantograph Camera

Monitoring of pantograph operation shall include means to visually observe operation in either direction, in real-time via a permanently installed camera. Capacity to store a minimum of two operating days of Data shall be provided.

Data from the pantograph cameras shall be stored onboard the Trainset. It shall be possible to offload the data to the wayside when the Train is stationary (i.e., not in real time). However, the Contractor shall not preclude real-time offloading of this video data.

8.16.18 External Cameras and Housings

External camera housings shall be provided to accommodate the external video cameras.

The external camera housings shall be aerodynamically integrated into the Trainset bodyside.

External cameras shall have anti-fog, de-icing capability, and aiming adjustment (e.g., pan, tilt, and zoom) features and shall be modular, and vandal-resistant. The cameras shall be accessible for repair by Maintenance personnel. The camera lens covers shall not deteriorate due to the abrasive effects of airborne particulates.

8.16.19 Internal Video Cameras

Internally mounted color video cameras shall be provided in each Vehicle to allow recording and monitoring capability of passenger activity inside the Vehicle. This System shall provide real time visual communication with all Vehicles in the Train to the Operator. In addition, the System shall allow for the OCC to select and monitor at least one real-time video feed from cameras onboard the Train.

Internal cameras shall be integrated into the ceiling so as to present a clean, neat, vandal resistant installation. The adequacy of coverage shall be demonstrated to the Authority during the Mock-up evaluation.

In the event of the activation of a passenger-to-Train Crew IC, passenger alarm, or the passenger emergency manual door release handle, the System shall automatically select the two internal cameras that best cover this area and display it on the Operator's video display. Should the use of the passenger-to-Train Crew IC initiate this coverage, an audio track shall record both sides of the conversation.

8.16.20 Cab Video Monitoring

Internally mounted color video cameras shall be provided to allow monitoring and recording inside the Cab. Internal cameras shall be integrated into the Cab paneling so as to present a clean, neat, vandal resistant installation. The System shall record entry into the Cab area and all activities within this area.

It shall be possible to offload the in-cab recording once the Trainset has returned to a maintenance facility or when Trains are stationary at yards.

The adequacy of coverage shall be demonstrated to the Authority in the Mock-up evaluation.

8.16.21 Cab Audio Monitoring

Microphones shall be provided in the Cab to be able to continuously monitor/record all audio conversations in the Cab area. They shall be concealed and installed so as to prevent any deliberate or accidental damage or disablement. The placement of microphones shall be such that all conversations in the Cab area can be clearly understood.

The Contractor shall interface and integrate the cab audio monitoring with the radio system so the OCC can listen to or play back the recorded cab audio.

It shall be possible to offload the in-cab recording once the Trainset has returned to a maintenance facility or when Trains are stationary at yards.

8.16.22 Operator's Video Monitors

A pair of liquid crystal display (LCD) color monitors, or equivalent, or alternatively a single larger split screen LCD color video monitor, shall be fitted in the Cab desk for the viewing of any or all internal and/or external camera images, in arrangements selected by the Operator, and subject to Authority's SONO.

8.16.23 Mobile Phones

The Contractor shall ensure that mobile phones can operate inside all Vehicles within the Trainset, under all operating conditions and at all locations along the CHSR, provided that the necessary external facilities have been installed by others.

8.16.24 Internal and External Electronic Displays

Internal and external electronic displays shall be provided.

Interior and exterior displays shall be integrated with the Vehicle lighting System and shall adjust for brightness under all lighting modes.

Information for the display shall be consistent with the station, PA, customer information System, and the Train control System. Train Crew shall have the ability to control the displays via a central interface point located in the crew office. It shall be possible for the Authority to record, distribute, update, and maintain contents of variable message signs. The Contractor shall provide the Authority with acceptable means for the Train Crew and

OCC crew to determine the content and sequence of information on variable message signs.

The passenger information System, which includes both hardware and software, shall provide passengers with both audible (e.g., pre-recorded automated announcements) and visual information, through electronic signs (e.g., travel status updates) and displays (e.g., moving maps, news, sports).

Displays and signs shall include, at a minimum:

- a) Passenger Entry Area Display.
- b) General Information Display.
- c) Network Location Display/Sign.
- d) Toilet Room Sign.
- e) Exterior Display.
- f) Food Service Display/Sign.

The external electronic passenger information display shall be fitted at a position within or adjacent to each passenger door and at a height that allows for reading by a passenger standing on a station platform.

Information for the display shall be consistent with the station, PA, customer information System, and the Train control System.

8.16.25 Antennas

Provision of antennas is not part of the Contractor's scope. Mountings, cabling pathway provisions, and access points for all antennas for the different communication Systems shall be provided. The antenna locations shall conform with the Trainset clearance envelope, whereby the antenna may avoid damage from Vehicle wash brushes, achieve the required signal strength, and eliminate any electrical interference.

8.16.26 Onboard Wireless Internet Access

The Trainset shall allow passengers to access a broadband wireless network while onboard the Trainsets at all times. Capacity shall be provided to accommodate the maximum passenger load, be compatible with the Authority's infrastructure and commercial decisions, and be upwardly compatible with emerging technology.

The solution shall operate over the entire length of the Trainset and be compatible with a combination of multiple wireless Interfaces to establish bi-directional broadband connections to the wayside (e.g., Wi-Fi, Worldwide Interoperability for Microwave Access (WiMAX), High Speed Packet Access (HSPA), and Evolution Data Optimized (EV-DO)), spectrum bands (cellular, 2.4 GHz, and 5.x GHz, and 4G) to provide throughput, bandwidth, performance, coverage and redundancy.

8.16.27 Food Service Point-of-Sale

Three Point-of-sale (POS) units shall be provided per Trainset. The POS shall utilize the onboard network to transmit Data to wayside locations via radio communications provided by the Authority and integrated on the Trainset by the Contractor. Including the following types of Data, at a minimum:

- a) Credit card approval.
- b) Transmission of onboard sales information to remote sites.
- c) Automatic ordering of inventory.

All information, communications, and Data Systems shall provide a web-based graphical user Interface (GUI) for reporting, alerting, and management reporting. The System design shall enable the Authority to process credit transactions securely in accordance with payment card industry (PCI) standards.

8.16.28 Train Communication Network

The Train communications network shall transmit the following information to onboard communications Equipment (e.g., displays, PA), at a minimum:

- a) Travel status updates.
- b) Train destination.
- c) Current location or station.
- d) Next station and time to next station.
- e) Time and date.
- f) Service alert messages.
- g) Pre-recorded messages.
- h) Visual graphics for inside displays (i.e., maps, advertisements, video, etc.).

In addition to traditional, baseband analog, twisted-pair trainlines, a digital trainline network shall be provided to network onboard Devices and Systems using non-proprietary, open networking standards, and Interfaces. The digital trainline network shall transmit inter- and intra-Vehicle communication of digitized passenger information, intercom, internal and external sign Data, radio Data, video Data, fire alarm Data, monitoring and diagnostic Data, and infotainment Data. The Data capacity and latency of the digital trainline network shall support the performance of interconnected Systems with 20% reserve capacity for expansion. The digital trainline network shall be provided via mechanically hardened, dedicated mechanical copper or fiber coupler cable, over a shared medium-voltage coupler cable, integrated into the mechanical coupler or implemented via a wireless link in acquirable spectrum. Alternatives may be proposed by the Contractor and shall be subject to Authority SONO. In any implementation, the digital trainline network shall be secure, electromagnetically compatible, shall not interfere with reconfiguration of Vehicles (if needed) and shall not have a single point of Failure.

The Train communications network shall transmit and receive information as needed via radio communications provided by the Authority and integrated by the Contractor. The Contractor shall interface and integrate the Train communications network with the radio system so the OCC systems can provide and receive data from all onboard Systems, as needed to provide full functionality and monitoring.

8.16.29 Onboard Media Content Delivery

The passenger information System shall integrate with the onboard Wi-Fi network for its Internet communication to send and receive real-time and stored messages and content to and from the Authority's designated control center. Content may include, but is not limited to, the following:

- a) Downloaded movies.

- b) Streamed television channels stored on local digital video recorder for delayed local transmission onboard.
- c) AM/FM radio station broadcasts.
- d) Train schedule information (Train numbers and associated schedule including station stops and arrival times).
- e) Menus.
- f) Advertising.

There shall be the ability to deliver Authority-controlled content that is stored locally on the Train to display units in all cars over the passenger information System or to passengers' personal Devices over the passenger Wi-Fi network.

There shall be the ability to update the stored media content with over-the-air updates from centralized command and control points without requiring physical access to onboard computer servers.

The delivery of media content and updates shall be performed remotely for:

- a) Entire fleet.
- b) Sub-groups of fleet.
- c) An individual Train.

Food service signage shall have the ability to display rich media, such as images and animations, from an onboard media server for the purpose of displaying and making real time changes to the menu.

8.17 TRAIN CONTROL AND MONITORING SYSTEM/ONBOARD COMPUTER (TCMS/OBC)

8.17.1 Requirements and Information

The Contractor shall provide a TCMS/OBC integrated into the Trainset and the Trainset's Systems.

The TCMS/OBC shall:

- a) Collect, archive, advise, and display status information relevant to the operational conditions of the Trainset's Systems and Subsystems, and their respective Equipment and functions. The Trainset Systems and Subsystems shall monitor and archive their status/health and send information about anomalies to the central diagnostic system of the Train.
- b) Be based on a redundant architecture (operational independence of the Train functions, simplicity, standardization of components, etc.).
- c) Permit management of modifications and software revisions, and their validation (independence of functions, reserve capacity for future updates in terms of memory capacity and intrinsic flexibility).
- d) Provide management of Data exchange (local diagnostics, event recording, Data transfer both onboard and import/export from the Trainset) via radio communications provided by the Authority and integrated by the Contractor.
- e) Provide interfaces for both Operations and Maintenance.
- f) Permit Maintenance personnel to troubleshoot any problems to the LRUs without the need to use external test Equipment.

- g) Permit reprogramming of less critical functions, without need for revalidation or testing of critical Systems.

At a minimum, the TCMS/OBC shall be comprised of:

- a) A local diagnostics unit (carrying out of self-test at power up and during operation, detection and management of anomalies during the different phases of operation, signaling to the central diagnostics of the Trainset and the OCC).
- b) A human-machine interface (HMI) in the Cabs and the crew office composed of a display unit and of a control unit that shows the operational status of all of the Trainset Systems, Subsystems, Equipment, and functions having diagnostics. Alarm messages shall be displayed on the diagnostic pages to the engineer (HMI located in the Cab) and the crew (HMI located in the crew office) depending on the information required.
- c) A suite of standardized interfaces (Data exchange with the Trainset environment, data exchange with Maintenance tools, use of radio communications provided by the Authority and integrated by the Contractor, etc.).
- d) The ability for automatic System resets for those functions that do not compromise Safety. Automatic resets shall be logged for Maintenance purposes. The Contractor shall propose selective resets, their associated reset times, and the risks associated with any general reset for Authority SONO.

The TCMS/OBC shall collect, transmit, and display the following for the Trainset:

- a) Real-time telemetry as allowed by the wayside Equipment, and associated reception between the Trainset and the wayside Equipment via radio communications provided by the Authority and integrated by the Contractor.
- b) Real-time health status and diagnostics (both analog and digital inputs/outputs).
- c) Real-time Fault logs and monitoring parameters.
- d) Real-time System alerts via email/text message as allowed by the wayside Equipment, and associated reception between the Trainset and the wayside Equipment.
- e) Data transfer from the Train's onboard Systems to the Authority's database and/or monitoring System via radio communications provided by the Authority and integrated by the Contractor.
- f) Internal, external, and Cab camera recording.
- g) Trainset location, direction, and speed.

The Contractor shall provide a listing of Systems, Subsystems, Equipment, and functions that will be monitored and identify how their statuses will be displayed. This monitoring shall be continuous, or at a frequency to ensure reliable detection of Failure. Indication and source of a Failure shall be provided to the Operator and via Authority radio communications to the OCC, upon detection. The Trainset shall be Fault tolerant, with no Failure mechanism that could result in a "false departure" of the Trainset.

To allow traceability, the TCMS/OBC shall also store all alarm messages displayed to the Operator or the crew or necessary for Maintenance purposes until the information is successfully transmitted to the wayside.

When any System, Subsystem, Equipment, or function is operating outside of its predetermined Safety parameters, the Operator shall be alerted, and the relevant alarms shall be transmitted to the Operator console and OCC. The TCMS/OBC shall transmit collected Data (e.g., alarm messages of the central diagnostic System) over the Authority-provided communication infrastructure (this infrastructure to be determined) to a wayside facility. The Data to be collected shall be identified by the Contractor for Authority SONO.

The monitoring System shall work reliably and without loss of alarm messages relevant for Maintenance purposes or alarm messages displayed to the Operator or the crew. If the performance of the TCMS/OBC system is reduced, the TCMS/OBC system shall alert the Operator and automatically revert to a redundant TCMS/OBC.

Trains operating as a single Trainset and/or two Trainsets coupled together shall have all Faults, statuses, and indications displayed in the Controlling Cab. The Data stored on the TCMS/OBC shall be secure and shall not be deleted without proper password protected authority.

8.17.2 Event Recorders

One of the Subsystems of the TCMS/OBC shall be event recorders, which primarily collect Train operational Data.

Event recorders shall be in full compliance with 49CFR Part 229 Appendix D, 49CFR Part 229.135, and Tier III requirements. The event recorder shall also record a minimum of an additional 25 events as required by the Authority.

The event recorder shall record the most recent 168 hours of Train operation Data.

The information stored shall not be corrupted as a result of any technical malfunction. One event recorder shall be associated with each driving Cab of a Trainset and both shall be functional whenever the Trainset is in service.

The Contractor shall provide examples of how the captured Data will be displayed during playback along with the format, content, and Data retention duration requirements specified in the PSP that is required to be submitted to the Authority for SONO during the Design Review Process.

8.17.3 Trainset Preparation/Pre-Departure Test

Basic departure tests shall be carried out automatically upon each power up and their successful completion recorded as a timed event on the TCMS/OBC. Pass/fail indications shall be incorporated to indicate the status of the System.

The Contractor shall submit the list of Trainset preparation/Trainset pre-departure checks, together with details of the test functionality, for Authority review and SONO.

8.17.4 Monitoring Systems

A vehicle-track interaction (VTI) monitoring System shall be provided to detect unintended accelerations on the carbody, Bogie, gearbox, and axles. The System shall be autonomous and function without Operator intervention. The Contractor shall provide details of this System to the Authority for SONO.

The Contractor shall develop a plan that identifies available space and integration elements for the future installation of autonomous OCS, track and associated infrastructure inspection equipment that will be provided by the Authority. These inspections will be conducted on a regular basis to determine the condition of the OCS, track, and associated infrastructure, and will indicate need for Maintenance. It is intended that this inspection equipment will be installed on two fully functional revenue trainsets. The Contractor shall provide this plan to the Authority for review and SONO.

Data on each detected exception shall be transmitted to the TCMS/OBS and the Maintenance Management Information System (MMIS) described in Section 12.3. When the Authority-provided radio communication network is not available, the System shall queue Data transmission until coverage is available. Measures shall be provided to ensure Data is not lost during this period.

The information shall also be available for review and Analysis on a secure Web Site. The information on each exception shall include, at a minimum:

- a) Vehicle ID.
- b) Date/Time of detection.
- c) Trainset speed during detection.
- d) Location of exception (GPS coordinates, etc.).
- e) Value of the acceleration/force.
- f) Estimated force of wheel impacts.
- g) Waveforms associated with the event.
- h) Pantograph mean contact force.
- i) Percentage of arcing.
- j) Contact wire uplift.

8.17.5 Operational Alarms

The Trainsets shall be provided with operational alarms. These alarms include those that may potentially affect passenger safety and service.

There are two types of operational alarms:

- a) Alarms generated by the Operator, crew member, and/or passenger.
- b) Alarms generated by the Trainset.

The TCMS/OBC shall be configured to control, monitor, advise, display, diagnose, and, if applicable, conduct performance tests on both types of operational alarms. There shall be two ways to indicate alarm condition, audible and visual. The Contractor shall provide the list and types of alarm conditions for Authority review and SONO.

8.17.6 Technical/Maintenance Alarms

The Trainset's TCMS/OBC shall be provided with technical/Maintenance alarms. These alarms are generated upon detection by Systems and/or Subsystems Equipment and indicate the Failure status of such Equipment being monitored.

8.17.7 TCMS/OBC Fault Log

Detected Faults shall be stored in the TCMS/OBC Fault log. The Fault log shall record any Fault/alarm generated in the most recent 168 hours. After the 168 hour period, the oldest Data shall be deleted and the newest Data shall be entered on a first-in/first-out basis. Loss of alarm messages shall be avoided by means of the fault log System or by transmission to the wayside. The information stored shall not be corrupted as a result of any technical malfunction. The Data in the Fault log shall include the date, time, location/source of the Fault, Fault status, and the location of occurrence on the network. The Contractor shall provide the detailed description of Fault log management for railroad the Authority's SONO.

8.17.8 Portable Test Unit (PTU)

A means to extract Data from the TCMS/OBC memory shall be provided. The Contractor shall provide four complete sets of PTU for use by the Authority to view and analyze the retrieved Data. The information shall be downloadable to the PTU. The Contractor shall provide all the necessary hardware (e.g. cables) and software for the PTU to perform all necessary diagnostic functions.

8.17.9 TCMS/OBC Terminal Unit

Each Vehicle shall be provided with a TCMS/OBC Terminal Unit, including master terminal units that shall be installed in both Cabs of the Trainset. A Terminal Unit shall also be provided for the crew office. In addition to the requirements above, this unit shall also transmit Data to the crew member's handheld display unit.

8.18 FIRE SAFETY SYSTEMS

8.18.1 Requirements and Information

The fire precautions on the Trainsets shall be in accordance with the best practices applicable to a high speed rail operation, taking into account operating conditions including tunnels, underground stations, viaducts, and trench sections.

The Trainsets shall conform with TSI category B requirements for fire Safety, as modified within Section 8.18.

The primary means of evacuation of the Train is egress to a station platform. The Trainset shall be designed so as to provide a tenable environment for passengers and crew to allow movement of the Train to the nearest station platform at any location along the CHSR.

The Contractor shall select and use interior materials available to the transportation industry, taking full account of the toxicity and combustibility requirements. All materials used in the Trainset construction shall comply with the fire safety requirement of 49CFR Part 238 at a minimum and shall be tested for toxicity in accordance with BSS 7239 following the below table adopted from the document "Recommended Fire Safety Practices for Rail Transit Materials Selection," as prepared by the National Association of State Fire Marshals.

| FUNCTION OF MATERIAL | TEST METHOD | PERFORMANCE CRITERIA |
|---|-------------|----------------------|
| All that require the ASTM E 662-01 smoke density test | BSS 7239 | HCN < 150 ppm |
| | | CO < 3500 ppm |
| | | NO/NO2 < 100 ppm |
| | | SO2 < 100 ppm |
| | | HF < 200 ppm |
| | | HCL < 500 ppm |

8.18.2 Fire Detection

A System shall be provided for the automatic detection of fire in all Vehicles. The fire detection System shall interface with the event recorder and the TCMS/OBC so as to provide a record and display the location of the detection and any automatic action taken. The System shall be integrated into the TCMS/OBC to identify all alarms, activations and system health, and shall be interfaced and integrated with the wayside fire alarm system via the Authority provided radio communications system. Refer to DCM Chapter 29.7 (Communications Interfaces) for Interface requirements for the fire detection system.

The detection System shall accommodate simultaneous or sequential detections of fire.

Upon activation of the detection System, the following automatic actions shall be required:

- a) Activation of alarms.
- b) Shut down of forced ventilation and high voltage energy supply to the affected Equipment that could cause the fire to develop or spread.

Details of the fire detection System shall be submitted to the Authority for review and SONO.

8.18.3 Fire Suppression Systems

The Trainset electrical compartments and cabinets shall be equipped with automatic fire suppression Systems to extinguish a fire upon detection in the affected location, in all cases and at all Trainset speeds. The fire suppression System shall operate such that the fire does not continue burning after the end of the extinguishing process.

During Design Review, each system's performance shall be demonstrated by a full-scale test of the system in a mock-up of the application area. Fire test protocols shall be submitted for each system. Each system shall be designed, furnished and installed to a nationally recognized standard for that type of system.

The automatic fire suppression Systems shall be equipped with a self-test feature that will monitor the integrity of the piping and valves, and shall provide an indication of the Availability of the System to the TCMS/OBC. This self-test feature shall be automatic, and shall not require involvement from any additional Maintenance crew. The status of the fire detection and suppression Systems shall be available to the Operator on the TCMS/OBC display in the cab, upon request.

Details of these Systems shall be submitted to the Authority for review and SONO.

8.18.4 System Requirements in the Event of Fire

The HVAC System shall be isolated in the area affected by the fire to prevent the spread of fire. The System of control shall be completely automatic and shall be triggered by the fire detection System. The Operator shall also initiate operation from the Operator's desk. The Operator shall have the capability to return the HVAC System in that part of the Trainset unaffected by fire or smoke to Normal operation. Such overriding action shall be recorded by the event recorder and TCMS/OBC.

8.18.5 Fire Resistance and Compartmentalization

The Trainsets shall have the capability to continue to operate for a minimum of 30 minutes upon detection of a fire.

The Trainsets shall be equipped with fire barriers and partitions. Upon detection of fire, held open fire doors shall either close automatically or be closed by manually-initiated remote control.

All power-operated doors, including access doors and internal doors, shall accommodate manual operation in the event of Failure of pneumatic or electric power.

The Contractor shall demonstrate how the design of the interior configuration shall inhibit the spread of smoke/fire, through compartmentalization, for Authority SONO.

The partition tests shall be carried out in accordance with the requirements of ASTM E119. The floors of all Vehicles in the Trainset shall provide a fire barrier, with a test period not less than 30 minutes. The full cross section partitions/doors within passenger/staff areas of each vehicle, walls and doors of any Equipment areas within a carbody, and the rear wall of the driving Cab shall provide a fire barrier for at least the same period as that provided by the floors.

8.18.6 Materials

Materials used in constructing the Trainsets shall meet the test performance criteria for Flammability and smoke emission characteristics identified in 49CFR Part 238.103. A materials matrix shall be developed as part of the fire Safety Analysis. The matrix shall contain the total weight of all materials, where used, Flammability and smoke emission test identity, test facility, test requirements, test results, and nature and quantity of the products of combustion shall be submitted by the Contractor during the Design Review.

8.18.7 Fire Safety Analysis

The Contractor shall complete a written fire safety Analysis, in accordance with 49CFR Part 238.103 and the Contract, for the Trainsets, and provide it for Authority review and SONO.

In addition, in accordance with NFPA 130, the Contractor shall demonstrate compliance with the engineering analysis requirements contained in Chapter 8 Vehicles, for Authority review and SONO.

8.19 BOGIE REQUIREMENTS

8.19.1 Requirements and Information

The Trainset, in single and double traction, shall provide smooth and safe performance, in accordance with the ride quality and safety requirements set out in this Specification, at all speeds and track profiles experienced on the CHSR. Contractor requirements for wheel/rail Interface criteria are defined in the Interface Specification (Section 12.3).

The bogies shall be demonstrated as being compliant with all Specification requirements through FEA, Vehicle dynamic simulation, and instrumented testing at approved testing facilities and on the CHSR.

8.19.2 Wheel Truing

Wheel reprofiling shall be performed with Bogies mounted on the Vehicle.

8.19.3 Suspension

The secondary suspension shall incorporate automatic carbody-to-Bogie height adjustment, which shall be functional for all loading conditions, and shall include auxiliary spring units, or equivalent, to ensure safe performance at all speeds in the event of secondary suspension Failure. If the secondary suspension utilizes air springs, the air pressure of the springs shall be monitored by the TCMS/OBC System.

Protective construction, such as Equipment Safety hangers, shall be provided as required. Vertical and lateral stops shall be incorporated to limit Vehicle displacement to remain inside the clearance envelope in the event of primary or secondary suspension Failure.

Provisions shall be made for vertical adjustment to compensate for wheel wear to maintain the TOR-to-floor height within the vertical tolerance. Wheel wear shall not be compensated at the primary suspension. The Contractor shall provide details of these measures to the Authority for SONO.

8.19.4 Component Commonality

Components used shall be identical and interchangeable between the Bogie types:

- a) Each powered axle shall be identical and use identical Equipment.
- b) Each unpowered axle shall be identical.

8.19.5 Lifting and Jacking Locations

Each Bogie shall be provided with slip resistant pads to allow lifting by floor jacks.

8.19.6 Bogie Mounted ATC/PTC and ATO Equipment

The Bogie shall include the allocation of space and provision of mounting points and means for ATC/PTC and ATO Equipment integration.

8.19.7 Alignment Protection Devices

The Bogie shall incorporate passive Safety measures for maintaining the alignment of the Trainset with respect to the running rail in the event of a derailment. The Bogie shall provide a mechanical means to keep the Trainset in-line with the track in case of a derailment by guiding the rail between the back of the wheelset and a major Bogie-mounted component, such as a traction motor or gearbox.

The Contractor shall provide details of these measures to the Authority for SONO.

8.19.8 Trainset Dynamic Behavior

The Contractor shall demonstrate safe operation of the Vehicle operating over track classes four and above. The Contractor shall conduct Minimally Compliant Analytical Track (MCAT) simulations on track Classes 2-9, as defined in the amended Track Safety Standards 49CFR Part 213 Appendix D for track Classes 6-9 and in the Interface Specification (Section 12.3) for track Classes 2-5.

The Contractor shall conduct analyses and testing of Vehicle-track performance to demonstrate compliance with the VTI Safety limits in 49CFR Part 213.333.

The Contractor shall describe its approach during the conceptual stage of the Design Review Process to mitigating low-speed wheel-climb derailments and conduct analyses in accordance with the FRA Low Speed Derailment Safety Advisory SA-2013-02.

Trainsets shall be stable and free from hunting oscillations at all Operating Speeds plus 10%, under worst-case conditions that include any combination of poor weather, track conditions, Vehicle component wear, etc.

8.19.9 Bogie Instability and Defective Gearbox Monitoring

Bogie instability and gearbox performance defects shall be monitored as part of the TCMS/OBC System.

The criteria for the activation of an onboard instability alarm shall be identified by the Contractor for review and SONO by the Authority. The TCMS/OBC System shall advise the Operator to reduce speed in the event of instability exceeding the criteria for activation of this alarm as defined by the Contractor.

8.19.10 Ride Quality

Ride comfort shall be equivalent or better than the Reference System, and shall be evaluated using the guidelines of the ISO 2631 standard, for all speeds. The Contractor shall provide the evaluation of human exposure to whole-body vibration and repeated shock for assessment with respect to effects on passengers' health. Any vibration that is caused by Equipment operation (e.g., compressors, blowers, electromagnetic Equipment, circuit breakers, motors, etc.) and emitted by the Trainset shall not be felt by passengers and crew.

The lateral and vertical comfort indices shall be defined by the Contractor and shall be a weighted acceleration. The Contractor shall define all filters, types, and bandwidths utilized in deriving the weighted acceleration.

8.19.11 Clearance Limits

The completely assembled Bogies with motors, brakes and other Equipment shall not exceed the clearance limits required between Bogie and carbody, or between Bogie and track and wayside structures, with maximum wear and load, over minimum-radius curves and on tangent track as described in this Specification.

The maximum vertical and lateral deflection and maximum roll shall not exceed those values which will keep the complete Vehicle within the Authority's static and dynamic clearance outlines.

The Bogie and all connections between the Bogie and the carbody shall accommodate the full range of relative movement between the Bogie and the carbody. The maximum range of motion through horizontal and vertical curves shall accommodate the radii defined/referenced in the Interface Specification (Section 12.3).

8.19.12 Electrical Resistance

The wheelset shall facilitate operation of track circuits. The electrical resistance of each wheelset, measured from wheel rim to wheel rim shall meet the requirements of the Authority's ATC Systems (refer to Section 12.3).

8.19.13 Derailment Detection System

Derailment detection Systems shall be installed on the Trainsets. The System shall be identified by the Contractor for Authority SONO.

8.19.14 Machine-Based Measurement/Inspection

The Contractor shall submit, for Authority review and SONO, how the Trainset design and construction facilitates wayside-based monitoring and inspection Systems to evaluate components en route including, but not limited to, wheels, brake pads and rigging, and bearing housings.

8.19.15 Axle Bearing Health Monitoring

The health of wheelset bearings on the Trainsets shall be monitored by onboard detection Equipment. This Equipment shall detect a deterioration of the wheelset bearing health, either by monitoring its temperature, its dynamic frequencies, its acoustic signatures or some other wheelset bearing health condition characteristic. A Maintenance requirement shall be generated by this Equipment and indicate a need for operational restrictions when necessary depending on the extent of the wheelset bearing deterioration. The detection System shall be located entirely onboard and diagnostic messages, along with the Vehicle position in the Trainset and the journal box location on the identified Vehicle, shall be communicated to the Operator. The Contractor shall provide details of the condition monitoring System for Authority review and SONO.

Provision of an onboard axle bearing health monitoring System must not interfere with the operational effectiveness of wayside detection Systems.

8.19.16 Hot Axle Box Detection

To prevent Trainsets triggering an incorrect alarm of trackside hot axle box detection (HABD) Equipment, the Trainsets shall have no component or Vehicle part, or commodity that generates heat in the target area that triggers an alarm. Additionally, no onboard Equipment shall mask or cover the journal bearing area, obstructing HABDs from detecting true bearing temperatures.

8.19.17 Carbody Monitoring

The Trainsets shall be equipped with permanent Devices that monitor carbody accelerations in accordance with 49CFR Part 213.333.j(3). The Devices shall monitor vertical and lateral accelerations. The accelerometers shall be placed below the floor of the Vehicle near the center of a Bogie, and shall be monitored by the TCMS/OBC.

8.19.18 Flange Lubrication

If flange lubricators are deemed necessary by the Authority, the Contractor shall indicate which wheelsets will be equipped and identify the type of Equipment to be supplied. After lubrication occurs, the wheel/rail contact area shall not be contaminated. The Contractor shall provide details, for Authority review and SONO, on environmentally-friendly and effective methods for reducing flange and rail wear.

8.19.19 Sanding

If applicable, sanding Devices shall be provided for improving the braking and traction performance of the Trainset. Automatic sanding Systems shall be inhibited at specific locations as required. The method on how the sanding System receives information about where to inhibit sanding, and associated System interfaces required, is to be identified by the Contractor for review and SONO.

8.20 SIGNAL AND CONTROL

8.20.1 Requirements and Information

The Authority's ATC/PTC wayside System will consist of track circuits, transponders, radio frequency (RF) links, bidirectional digital communications, and a network of distributed wayside Equipment.

The onboard ATC and PTC Systems provided by the Authority and integrated by the Contractor will perform the following objectives and functionalities, at a minimum:

- a) Integration of ATC and PTC Systems for a minimum of three mainline systems.
- b) Speed enforcement in all modes of revenue and non-revenue Operations.
- c) Integration of ATC and PTC Systems for Shared Right-of-Way Operations, and highway crossing protection.
- d) Complete redundancy with no single point of Failure.
- e) Protection against unauthorized movements onto the main line, Maintenance depots, and yards.
- f) Enforcement of Vital supervision for permanent and temporary speed restrictions (e.g., in Work zones).
- g) ATO with timetabled operation.

- h) Self-tests of ATC/PTC and ATO functions during the Trainset's pre-departure test for compliance with applicable FRA regulations.
- i) Communications Interface with the Train monitoring System for applicable ATC/PTC Data.
- j) Hazardous condition prevention during all modes of Train operation.

The Authority's onboard PTC System will interface with the associated wayside System to reliably and functionally prevent:

- a) Train-to-Train collisions.
- b) Overspeed derailments.
- c) Incursions into established Work zone limits without first receiving authority and verification from the OCC or roadway worker-in-charge.
- d) The movement of a Train through a Mainline switch in the improper position

The Contractor shall integrate the Onboard ATC/PTC equipment with the Trainset, and provide the Interface points, and install wiring/networks, interface Equipment and provide space, structural mounts, environment, and complete health monitoring by the TCMS/OBC. Refer to the specified requirements in the Interface Specification (Section 12.3).

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8.20.5 Operating Profiles

The Authority's onboard ATC/PTC equipment will constantly generate normal speed profiles based on information provided by the wayside and stored in the onboard map/route database. Such Data will include, at a minimum, track circuit/RF-link information, number of cleared sections, route classifications, speed restrictions, and civil infrastructure information.

8.20.6 Braking Profiles

The Authority's onboard ATC/PTC System will supervise Train Operations and automatically apply the brakes when necessary to maintain Safety.

The braking profiles will be created by the ATC contractor taking into consideration the Train performance provided by the Contractor per DCM Chapter 29.6.3, such as deceleration/acceleration rates as well as civil infrastructure conditions and speed restrictions.

8.20.7 Onboard Map/Route Database

New or revised maps/routes will be uploadable to the onboard ATC/PTC system map/route database. The ATC contractor will determine the procedure to control the uploaded Data and to verify their versions.

8.20.8 ATC/PTC System Monitoring

The TCMS/OBC shall continuously monitor the health of the ATC/PTC onboard System and its operational status.

All events and changes relative to the ATC/PTC onboard System shall be monitored and logged. Monitored events, operational Data, and failures shall be recorded and made available for downloading.

8.20.9 ATC/PTC Onboard Equipment Inspections

ATC/PTC daily Equipment inspections will occur as part of the Trainset pre-departure test prior to its entry into service. The ATC contractor will supply all ATC/PTC functional inspection specifics. The ATC/PTC 92-day functional inspection will be performed independently from each end of the Trainset.

8.20.10 Restricted Manual Mode Operations (ATC/PTC Isolated)

In the case of a Failure of the ATC/PTC onboard System, the Train shall have a restricted manual mode under which the Operator can move the Train with the ATC/PTC fully isolated. In this mode, the Trainset shall be under Operator control with a maximum permitted speed of 95 km/h (59 mph) limited by a speed governor; the governor shall be adjustable by the Authority to accommodate future changes in the maximum permitted speed. In the event of an overspeed condition, an emergency brake application shall occur.

8.20.11 Direction and Rollback Detection

In all ATC/PTC supervision modes on the Mainline, the ATC/PTC will not permit the Train to roll back by more than 2 m (6.6 feet). In the event that this default value is exceeded, the ATC/PTC will immediately apply emergency braking.

8.20.12 Automatic Train Operation

The ATO function provided by the ATC contractor and integrated by the Contractor shall allow for the automatic control of propulsion and brake commands to operate Trains between stations and from other stopping locations.

The Contractor provisions for ATO shall, at a minimum, allow and perform:

- a) Command of the Train speed within the limits of the Normal speed profile and service brake profile imposed by the ATC/PTC onboard System.
- b) Smooth ride quality based on operating rules, Train number and timetable, and energy efficiencies.
- c) An automatic service brake application, as required, to reduce Train speeds when approaching a civil Work speed restriction or a temporary speed restriction.
- d) Control of the Train to a platform stopping location.
- e) Enable of the door release and/or open and close processes.

During coupling procedures, the Contractor provisions shall limit the Trainset speed to less than the maximum allowable coupling speed. The Contractor provisions shall also limit the Trainset speed to less than the maximum allowable speed through a Trainwash facility. If

these values are exceeded, the onboard Systems shall provide a predetermined penalty brake application to stop the Trainset.

During Trainset startup, the ATC/PTC will automatically perform a self-diagnostics test to verify that the ATC/PTC is operative. The ATO System will have fault-tolerance, so that if one ATO unit fails, the second ATO unit will continue ATO functions without delay.

8.20.13 ATC/PTC Displays

ATC and PTC information required for Trainset operations shall be consolidated onto one screen.

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8.20.15 Trainset Location and Identification

Each Trainset shall be equipped with an automatic location and identification System and Data Analysis and geo-fencing to determine geographical position and orientation as part of the infrastructure monitoring System.

The Authority shall have the ability to create, update, and delete geo-fences for the purpose of reporting and monitoring Trainset movement.

The Data from the Trainset location and identification System shall be accessible remotely via the Authority-supplied radio system.

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8.22 COUPLERS AND END OF TRAINSET INTERFACES

8.22.1 Requirements and Information

The couplers on the Trainsets shall operate safely through curves for all permitted speeds and combinations of horizontal and vertical radii and reverse curves and permitted track irregularities on the CHSR.

The couplers shall have the strength to allow recovery of a double traction configuration by a Rescue Trainset or a Rescue Locomotive.

8.22.2 Leading and Trailing End Couplers

The Trainsets shall be equipped, at each end of the Trainset, with an automatic center buffer coupler, geometrically and functionally compatible with a "Type 10 latch System automatic center buffer coupler" ("Scharfenberg" System, or equivalent). The coupler shroud shall be remotely opened/closed, and the coupler shall automatically couple mechanically, pneumatically, and electrically on impact and uncouple by activation of an uncoupling mechanism that does not require a person to go between the Equipment units.

Electric couplers on Trains shall be bi-directional such that a Train operating through a wye would not affect the Train coupling capability.

The height above TOR of the coupler center shall be identified and submitted by the Contractor to the Authority for review and SONO.

8.22.3 Intermediate Couplers

The intermediate sections of the Trainset shall be semi-permanently coupled.

8.22.4 End Handholds

If, during depot/Maintenance facility and/or rescue operations, two Trainsets are coupled to form a single Train that is not semi-permanently coupled, and the coupling operation requires an individual to manually couple or uncouple the Trainsets, the coupled ends shall be equipped with end handholds that are located and installed so that an individual can safely couple and uncouple the Trainsets.

8.22.5 Coupler Adapter

One Coupler Adapter per Trainset shall be provided to permit the recovery of the Train by standard AAR-compliant locomotives. The adapter shall couple with the Type 10 latch coupler and the recovery unit's Type H tightlock coupler. Its Interface with the Rescue Vehicle shall have a pulling face center height of 876.3 mm \pm 12.7 mm (34.5 inch \pm 0.5 inch) above TOR.

The Contractor shall specify and submit the maximum tensile and compressive force values for the Coupler Adapter, along with the Safety factors, for Authority review and SONO.

8.22.6 Friction Brake Equipment Requirements for Rescue Operations

The Contractor shall make provisions so the Trainset to be recovered will be connected to the brake pipe (or equivalent if the Rescue Vehicle is a Trainset that utilizes wired control) and the main reservoir of the Rescue Vehicle. Should a Trainset be required to be pulled by a Rescue Vehicle, the Contractor shall make provisions so the Controlling Cab will be located within the Rescue Vehicle. The Contractor shall ensure that all Trainsets can be moved safely and braked through connection of the Rescue Vehicle's brake pipe only. Should the design of the Trainset braking System include wired control, the Contractor shall be responsible to provide Interface units that are required between the Rescue Vehicle and the disabled Trainset.

8.22.7 Auxiliary Power/Control Requirements for Rescue Operations

Auxiliary power and control connectors shall be included at each end of the Trainset to accommodate the provision of auxiliary power and control signals to the disabled Trainset by either a Rescue Trainset or a Rescue Locomotive. Auxiliary power will be provided at 480 VAC, 3-phase, 60 Hz.

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10 GENERAL INFORMATION REQUIREMENTS

10.1 STANDARD PRODUCT DESIGN CUSTOMIZATION

10.1.1 Requirements and Information

The Contractor, as part of the Design Review Process, shall provide details of the extent of customization required to their standard product platform in order to meet the requirements contained in this Specification, and how it intends to manage any changes in order to preserve the inherent benefits of the standard product platform.

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11 TRAINSET EXHIBITS AND MOCK-UPS

11.1 GENERAL

11.1.1 Requirements and Information

Full scale (1:1) Mock-ups for the Trainset environments/areas identified in Sections 11.3 and 11.4 shall be produced to allow the Authority to evaluate the Trainset design against its respective requirements as well as support the Design Review process, that will include external stakeholders and user groups involvement. The Mock-ups will be evaluated for approval by the Authority.

The finalized Mock-ups shall be located in the U.S., (location to be identified by the Authority) and shall be transportable.

The standard of construction adopted by the Contractor shall be commensurate with the use of each Mock-up as a design development and stakeholder review tool. The Mock-ups will be used for public display or storage/use outdoors.

Hard Mock-ups, as a minimum, shall be provided for all areas/environments called out in the Sections 11.3 and 11.4 below. Where considered beneficial for design advancement and early review, and upon concurrence with the Authority, the Contractor may make use of Soft Mock-ups to convey initial concepts and general arrangement of Equipment.

11.2 TRAINSET EXHIBITS

11.2.1 Exterior Aesthetic Design Concepts

During Design Review, the Contractor shall develop a minimum of three distinctly different exterior concept packages.

These packages shall be representative of the Contractor's concepts, from multiple views, and shall detail the aesthetics (e.g., livery scheme) of the leading and trailing Vehicles, and present the overall Trainset configuration and Equipment arrangement. The concepts

shall take into consideration the operating environment and overall Maintainability (e.g., appearance of cleanliness, repair of damaged surfaces, etc.).

11.2.2 Interior Aesthetic Design Concepts

During Design Review, the Contractor shall advance detailed versions of the minimum three different interior concept packages. These packages shall be representative of the Contractor's concepts, from multiple views, and shall detail the aesthetics (e.g., color scheme) of leading and trailing Vehicles, First Class, Business Class areas, and the overall interior Trainset configuration, inclusive of passenger and crew facilities and Equipment arrangement. The concepts shall take into consideration the class of service, operating environment, and overall Maintainability (e.g., cleaning ability, resistance to wear, repair of damaged surfaces, etc.).

11.2.3 Dimensioned Interior Layout Concepts

The Contractor shall advance detailed versions of the minimum three different interior layouts.

These layouts shall illustrate the locations of First and Business Class seating areas and locations of onboard facilities (e.g., ADA seating locations, food service, toilets, luggage areas, bicycle storage locations, etc.). These layouts shall identify seat width, seat Pitch, aisle, vestibule, and gangway width, and shall identify the overall passenger seating capacity of each layout.

11.2.4 Schematics for Rescue Personnel

Once the Trainset design is finalized, the Contractor shall provide Trainset schematics suitable for first responder and law enforcement training that detail, at a minimum:

- a) Door/window placement and locations for emergency access/egress;
- b) Placement of critical life safety and security systems;
- c) Power shutdown;
- d) Location of emergency equipment;
- e) Systems relevant to rescue operations.

11.3 CAB MOCK-UP

11.3.1 Requirements and Information

A Cab Mock-up shall be provided. The Cab Mock-up shall present the cab Equipment layout, ergonomics and driver/human-machine Interfaces (DMI/HMI) including all primary controls, for review purposes. Primary controls in this context are those controls and indicators that the Operator handles during Normal driving Operations of the Trainset. The Mock-up will be used as part of the Design Review Process for developing the Cab design arrangement and identifying Hazards and risks. The Mock-up shall also:

- a) Include the Operator's seat positioned properly to determine lines of sight and wayside signal visibility.
- b) Include complete console (including assistant's side, if applicable) with the actual throttle and brake controllers and reverser, resets, communications Equipment and required switches.
- c) Have a non-functional windscreen wiper and arm mounted on the Cab.

- d) Include all specified emergency accessories.
- e) Include operational headlights, auxiliary lights, marker lights, and number lights.
- f) Include a rapid means of emergency egress.
- g) Include all displays.

11.4 PASSENGER/ONBOARD CREW AREA MOCK-UP

11.4.1 Requirements and Information

The Contractor shall provide a full-scale set of passenger/onboard crew area Mock-ups for review purposes. The Mock-ups will be used to inform decisions around 3D-space planning, form, function and aesthetics as well as compliance with ADA requirements.

Mock-ups shall be required for the following passenger and onboard crew areas:

- a) First Class seating and environment.
- b) Business Class seating and environment.
- c) Toilet modules (First Class and Business Class).
- d) Vestibule with gangway.
- e) Food preparation/storage area, trolley storage area, and passenger environment.

By the final Design Review stage, the Mock-ups shall provide:

- a) First and Business Class seating environment – Working seat Mock-ups for both classes of environment with final colors, materials, and finishes including final carpeting and wall and ceiling paneling. Working lighting shall be installed in order to see the seats fully in context. Each type of seat configuration shall be represented in the Mock-up. Minimum quantities shall include 1 seat mocked-up as above combined with 3 other seats and a table in order to see the spatial environment. Seats shall have moving parts and perform as required by this Specification.
- b) First and Business Class Toilet Modules – Mock-ups with actual materials to show space and situation of key functionality (e.g., toilet, sink, hand-dryer, baby change, flush, etc.) plus the colors, materials, and finishes for both First and Business Class toilets. The Mock-ups shall demonstrate ADA compliance, cleanability and Maintainability. It shall not be necessary to have a fully functioning toilet with working flush, working hand-dryers, etc.
- c) Vestibule – A Mock-up clearly demonstrating space and situation of key functionality (e.g., luggage, doors (including emergency egress facilities/functions), access for wheelchair users navigating from the vestibule to the ADA seating space in the passenger areas as well as the toilet module, etc.) plus the colors, materials, and finishes for both First and Business Class vestibules. The Mock-up shall have working lighting effects in order to see the space in context.
- d) Food Preparation and Storage Area – A Mock-up showing space and situation of key functionalities (e.g., countertops, carts galley, partitions, etc.) plus the colors, materials, and finishes. The Mock-up shall demonstrate the position of all key Equipment (though this need not be functioning) and to assess cleanability and Maintainability. The Mock-up shall have working lighting effects in order to see the

space in context and the carts shall be functional to simulate their circulation and loading in the car galley area.

11.4.2 Models

The Contractor shall supply three G scale (1:22.5) models of the as-built Trainsets. The model construction shall be configured so that the interior decor and layout may be viewed. In addition, 50 N scale (1:160) models of the full as-built Trainsets, and 100 N scale models of the lead car shall be provided. All models shall be non-operating.

12 INTERFACES

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12.3 INTERFACE SPECIFICATION

12.3.1 Introduction

The Trainsets shall operate on both dedicated and shared (blended Operations) Right-of-Ways.

Authority Trainset-to-Core System Interfaces, Authority infrastructure designs, clearances and restrictions, and other related Interface requirements and information are specified in this Section and shall apply to the Trainsets and rail services on the California High-Speed Rail System (CHSR).

12.3.2 Verification and Validation (V&V)

The Contractor shall develop and implement a V&V process to confirm to the Authority that by examination and provision of objective evidence, the technical Contract requirements (verification) and the requirements for specific intended use (validation) have been fulfilled by the Trainsets and documentation provided by the Contractor.

Systems Engineering Management Approach: The Contractor shall develop a Systems Engineering Management Plan (SEMP). The SEMP shall address the Technical, Project, Agreement, and Organizational Project Enabling Processes as applicable for a Trainset Procurement project in accordance with INCOSE Systems Engineering Handbook and the ISO/IEC 15288. Change/Configuration Management shall follow the general provisions of the ISO/IEC 10007. The SEMP shall address the Contract life cycle phases, stakeholder coordination, inputs, outputs (deliverables), tools and methods used for each phase, activities for each deliverable, roles and responsibilities, and metrics used to measure and report progress. Each life-cycle phase shall be described separately. Activities for each life-cycle phase shall be provided as individual step-by-step procedures (Figure 12-1). A Draft SEMP shall be submitted 60 days after NTP. The final SEMP shall be submitted 120 days after NTP.

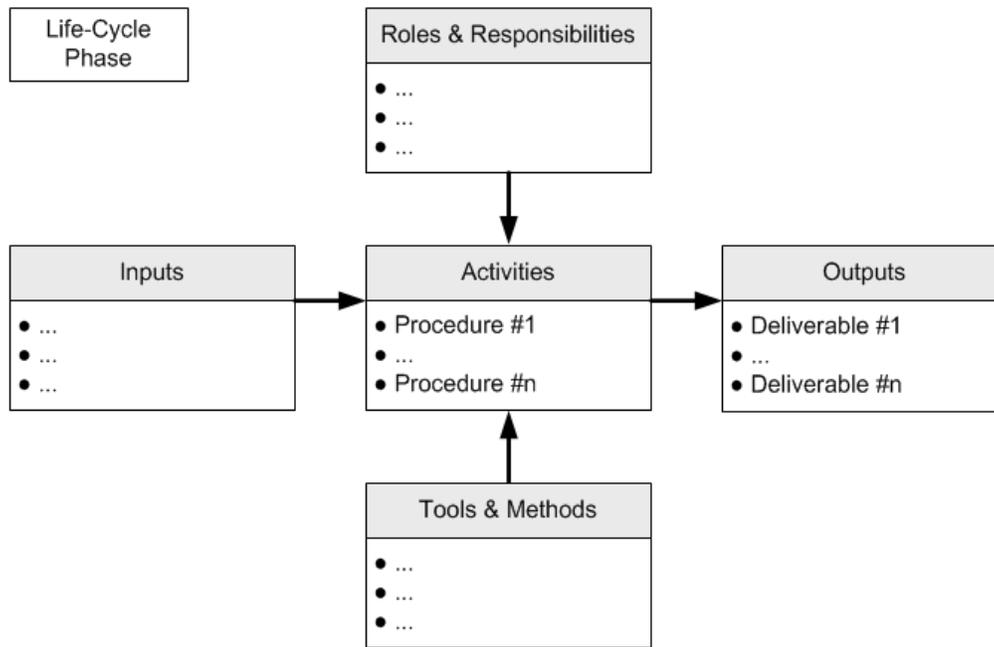


Figure 12-1: Contractor Systems Engineering Management Plan – Life-Cycle Phase

Requirements Management Tool: The Contractor shall parse, capture, document, analyze, derive, apportion, trace, manage, verify, and validate the technical Contract requirements using a Requirements Management (RM) tool. Technical Contract requirements are defined as Contract requirements specifying the characteristics of the final Trainset deliverable including related design, production, testing, commissioning, and acceptance requirements. The RM tool shall be IBM Rational DOORS, version 9.3 or 9.5. Requirements parsing, capturing, documenting, analyzing, deriving and apportion shall occur prior to the start of the design. Requirements managing shall include the update of the requirements to reflect any approved changes (e.g. design variations) or clarifications (e.g. Request for Information). Requirements tracing, verifying and validating shall occur prior to submittal of the contract deliverable. The RM tool content shall be structured as shown in Figure 12-2. The Contractor shall create a CHSR project within the RM tool and submit the exported CHSR project monthly as a project archive (.dpa file). The Contractor shall provide the Authority with full real-time readability web access to the CHSR project within the RM tool, and shall describe the use of the RM tool during each life-cycle phase in detail in the SEMP.

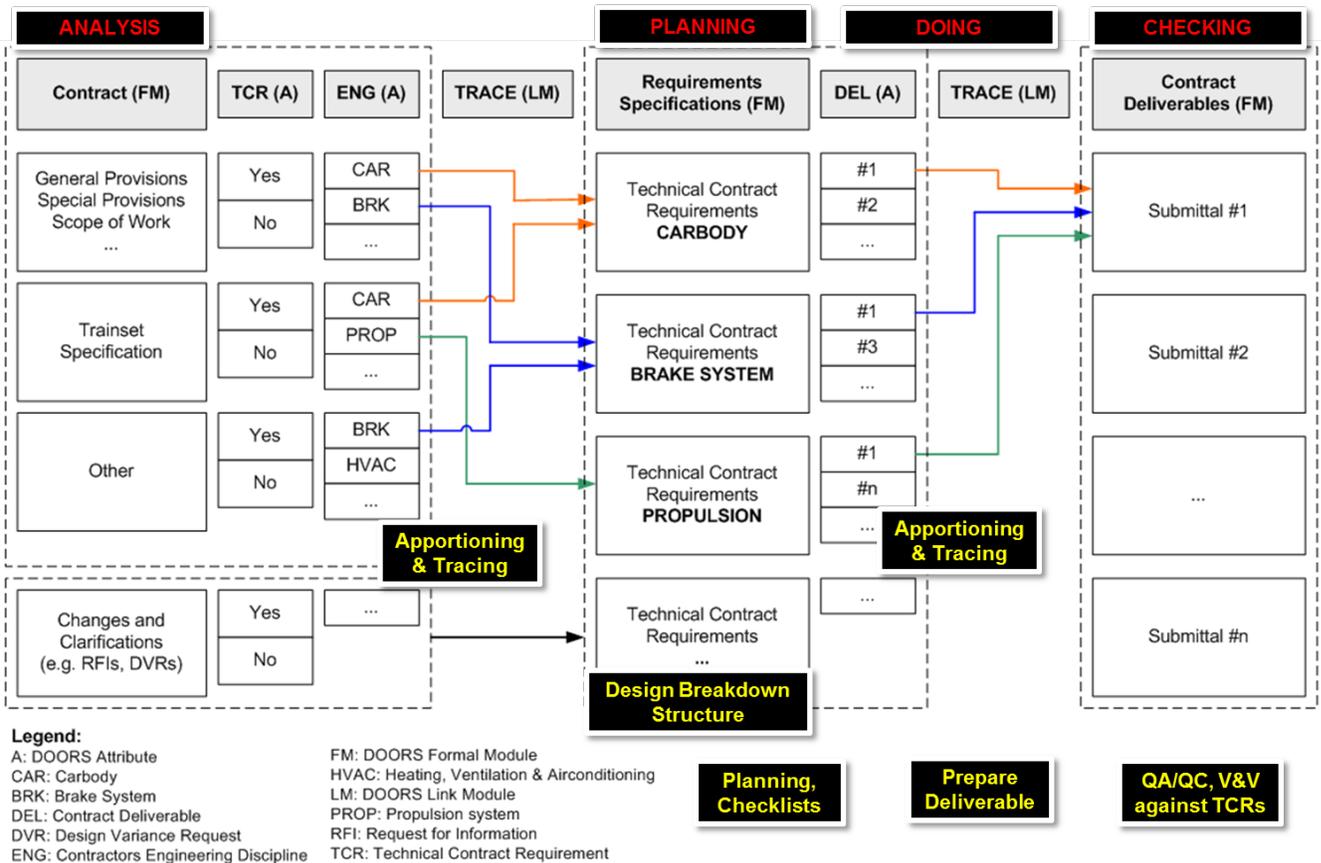


Figure 12-2: Requirements Management Tool – Module Structure

Requirements Verification Traceability Matrix (RVTM): The Contractor shall demonstrate compliance to the technical Contract requirements using the RVTM. The RVTM shall identify the section references to the design, production, testing, commissioning, and acceptance documents for each technical Contract requirement. The Contractor shall use the RVTM template as shown in Figure 12-3. The RVTM shall be managed within the RM tool. Section references to these documents shall explain how each technical Contract requirement is met, tested, and accepted by the Contractor's design and production. Section references shall be provided to the lowest practical level of precision, for example to the smallest numbered section in a document and unique drawing numbers. The Contractor shall submit an RVTM including the applicable technical Contract requirements with each Technical Contract Submittal (TCS). TCS are defined as the Contract submittals that address the technical Contract requirements. At the time of submittal the RVTM shall be exported from the RM tool and provided with the TCS as portable document format (PDF) file. The Contractor shall describe the use of the RVTM during each life-cycle phase in detail in the SEMP.

| Technical Contract Requirements | | | | Requirements Management | | | | Contract Deliverable | | |
|---------------------------------|---------------|---------------------------|--|-------------------------|-----|---|-----|----------------------|-----------|--------------|
| Req. ID | Doc. ID | Doc. Section | Requirements Text | TCR | ENG | Apportioned & Derived Requirements Text | DEL | Del. ID | Del. Name | Del. Section |
| 1 | Trainset Spec | 12.3.17. Static Axle Load | The maximum static axle load on the track shall be 17 tonnes (18.7 tons) | ... | ... | ... | ... | ... | ... | ... |
| 2 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| n | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

Figure 12-3: RVTM Template

Certifiable Items List (CIL): The Contractor shall demonstrate compliance to the critical items using CILs and manage the CIL in the RM tool. Critical items are the following: CHSR performance requirements (such as RAMS), applicable environmental requirements and mitigations as found in the environmental documents including EIR/S, ROD, permits, and approvals; Safety requirements including Hazard mitigations; security requirements including threat mitigations; and interoperability items with other CHSR contracts. CILs shall be tailored as needed for the specific certification processes, such as for Safety and security certifications, including management of preliminary Hazard analyses (PHA) and threat and vulnerability assessments (TVA). CIL shall be developed based on the RVTM, with extra columns or fields to include the date and initials of the verifier, certifying that the critical item has been incorporated into the design and production, tested, commissioned, and accepted at each stage of development. The CIL Document ID, Document Section and Requirements Text shall reference the CHSR program critical item (e.g. CEHL #, TVA #, IF #, etc.). The Contractor shall submit a CIL including the applicable critical items with each TCS. The completeness of the CIL shall reflect the completeness of the submittal. At the time of submittal the CIL shall be exported from the RM tool and provided with the TCS as PDF file. Signed certification packages are required at the end of design, after inspection, testing, and acceptance. Certification packages shall contain a cover sheet with signatures, the CIL, and excerpts of the section references as objective evidence. The Contractor shall describe the use of the CIL during each life-cycle phase in detail in the SEMP.

V&V Report: The Contractor shall provide a V&V report that accompanies every technical Contract submittal. The report shall provide an executive summary and certification of compliance with the technical Contract requirements. Additional explanation shall be provided, as necessary, on how the technical Contract submittal meets the technical Contract requirements that are not available from the RVTM or CILs. Variances between the technical Contract requirements and the technical Contract submittal shall be explicitly identified and discussed. The certification of compliance shall include the confirmation that the references to the objective evidence provided in the RVTM and CILs have been checked by the Contractor's quality assurance/quality control (QA/QC) process, and have been confirmed as complete and correct. The Contractor may choose to provide the content of the V&V report as part of the submittal letter.

12.3.3 Interface Management and Coordination

Many external Interfaces and dependencies exist between this Contract and other CHSR contracts, including the guideway, trackwork, stations, traction electrification, signals, communications, and Operations, Safety, and security. These apply to the dedicated high speed Train corridors as well as shared-corridors.

Interface Management: As part of the SEMP, the Contractor shall develop and implement an Interface management (IM) process, defining how interfaces are identified, specified, implemented, verified and validated, integrated, and certified. The IM process shall describe the management of both inter-contract as well as intra-contract Interfaces.

Interface Register: The Contractor shall create an Interface register with the contents in an Interface breakdown structure (IBS), including the following:

- a) Level 1: Other CHSR contracts interfacing with this Contract.
- b) Level 2: Systems of other project contracts and Core Systems.
- c) Level 3: Interface categories.
- d) Level 4: Actual Interfaces.

The Contractor shall populate the Interface register initially with the Interfaces identified in the HS RST TSI (Functional and technical Specification of the Interfaces).

The Contractor shall manage the Interfaces top-down (e.g., the Trainset dynamic envelope shall be compliant with the imposed CHSR Trainset static and dynamic envelopes (Level 4) as identified in the DCM. Interface Level 1 should be defined as "Guideway," Level 2 should be defined as "Trackway Clearances," and Level 3 should be defined as "Vehicle Clearance Envelope.") The Contractor shall manage the Interface register in the RM tool. All Interfaces are considered critical items. The Contractor shall demonstrate compliance using CILs.

Interface Control Documents: The Contractor shall develop an Interface Control Document (ICD) for each Interface, identifying the applicable Interface requirements, corresponding Interface design, and the planned Trainset V&V. An ICD shall provide detail for independent conformity assessment and independent development and implementation of the interfacing entity. Many Interfaces are initially defined on a performance level. The Contractor shall Work with the interfacing contracts and the Authority in defining the details of each Interface as required for the ICDs. In the event that interfacing contracts have yet to be executed, the Contractor shall Work with the Authority in defining the details of each Interface as required for the ICDs. Signed ICD packages are required at the end of design, after inspection, testing, and acceptance. ICD packages shall contain a cover sheet with signatures, the applicable CIL, and excerpts of the section references as objective evidence.

The Authority may reject proposed Interface characteristics if any of the following conditions apply:

- a) The Contractor does not provide an open, fully documented Interface.
- b) Interfaces will preclude competitive Procurement in the future (e.g., due to a proprietary Interface).
- c) Systems integration with a future Contract is deemed by the Authority to be a high-risk.
- d) CHSR performance requirements are not met.

Interface Workshops: The Contractor shall form an Interface Control Team (ICT) and conduct Interface coordination workshops (ICW) with the Authority, interfacing contractors, third parties, and other entities no less than monthly, or at other times as required.

- a) The ICW will be used to discuss the specifics of the Interfaces, to resolve conflicts, and to monitor and track the incorporation of the Interfaces.
- b) The ICT will demonstrate that the Trainset is being designed and executed such that facilities, Systems, functions, and characteristics identified in the design criteria, Specifications, and/or drawings are being accommodated without functional or spatial constraints.
- c) The workshops shall be used to identify new Interfaces which may affect the design, construction, and production, and to reach a common agreement on the management approach to addressing the Interface and any constraint on this or future Contract(s).
- d) New Interfaces shall be incorporated into the Interface register of the RM tool.

Progress Reporting: The Contractor shall produce and present a matrix or tracking sheet for the workshops that provides updates, activities and responsible parties of Interface and integration activities. The Contractor shall produce output reports from the RM Tool to demonstrate progress on Interface and integration activities.

12.3.4 Applicability of Authority's Design Criteria Manual

The Contractor shall be responsible for compliance with requirements of certain Sections of the DCM (attached hereto as Section 13.2.b) as referenced in this Specification, and any applicable cross-referenced Sections (but not any other Sections).

12.3.5 Safety and Security Certification

The Contractor shall produce a Safety and Security Certification Package in compliance with the requirements of the CHSRP SSMP and the CHSRP V&V Management Plan. The Safety and Security Certification Package shall be compiled and submitted by the Contractor when all Safety and Security CILs for a particular Subsystem are completed at final design and construction. The Safety and Security Certification Package shall consist of a signed Certificate of Conformance for Vehicle Final Design and Vehicle Acceptance, the Subsystem element, all completed CILs, a completed Certifiable Elements; and Hazards Log, Open Items Lists, a plan for non-conformance of Critical Items, and all supporting documentation such as hazard analysis, drawings, and design element descriptions. The Safety and Security Certification Packages shall be submitted for Authority review and SONO.

12.3.6 System Alignment

The CHSR segment from San Francisco to Los Angeles/Anaheim is approximately 840 km (520 miles). Future extensions to Sacramento and San Diego will complete the 1300 km (800 miles) CHSR. The majority of the track is dedicated to high speed rail; however, there will be sections of corridor and/or track that will involve operation at lower speeds and sharing tracks with other rail Equipment and Operators.

See the Authority's San Jose-LA Union Station Alignment attached hereto as Section 13.2.a.

A Train consisting of a single Trainset or two coupled Trainsets shall operate to the satisfaction of the Authority, over the CHSR, inclusive of crossovers, sidings, station platforms, Maintenance facilities, etc.

12.3.7 Climatic and Environmental Conditions

The Contractor shall demonstrate that the Trainset Equipment, Subsystems, and Systems meet all of the requirements of the Contract and protect against the following, at a minimum, at all speeds:

- a) Ingress and consequent degradation of performance/damage, by water, dirt, dust, sleet, snow, ice, organisms, etc.
- b) Heat degradation and/or power limitation while operating on gradients.
- c) Damage by salty or polluted air.
- d) Damage by flying ballast or similar objects from the track bed.
- e) Damage by electrical spikes and surges to electrical and electronic Equipment.
- f) Damage caused by lightning strikes or EMI.
- g) Seismic activities.
- h) Heat and condensation.
- i) Fog.
- j) Relative humidity.
- k) Sudden changes in air temperature, particularly occurring when entering and leaving tunnels. Tunnels with interior temperatures up to 45° C (113° F) and 100% humidity shall be the minimum criteria.
- l) Changes in air pressure, particularly when entering and leaving tunnels.
- m) Formation of ice on Equipment installed both inside and outside of the Trainset.
- n) Noise and vibration.
- o) Vandalism and debris strikes.
- p) Damage by birds in flight or animals at ground level.
- q) Enclosed terminus stations.

The Trainset shall operate in all climatic and environmental conditions present as referenced in DCM Chapter 1.9, including but not limited to the following conditions:

- a) An altitude between 43 m (140 feet) below sea level and 1400 m (4,600 feet) above sea level.
- b) External ambient air temperature ranging from -25 °C (-13 °F) to 50 °C (122 °F).
- c) Wind speed, up to a maximum of 50 m/s (112 mph). The Trainset shall meet the requirements of the HS RST TSI for crosswind.
- d) Rainfall in 24 hours of 26 cm (10.4 inches) and a snowfall in 24 hours of 60 cm (23.6 inches). The effect of rain and snow shall be considered together with wind and car movement.
- e) Snow accumulations and other climatic characteristics occurring in Tehachapi, California (zip code: 93581) shall be accommodated.
- f) Equipment exposed to the effects of solar radiation shall remain unaffected.

12.3.8 Seismic Events

The Trainset performance shall meet requirements of DCM Chapter 11.5.1 (Seismic Performance Criteria) and Chapter 11.5.2 (Design Earthquakes) with consideration for the following key criteria:

- a) Upon notification of an Operating Basis Earthquake (OBE) (86% probability of exceedance in 100 years), the Train shall brake safely to a complete stop from any speed, within the safe stopping distance applicable to the track location and speed. During a seismic event, the brake command will be initiated by the ATC System, based on signals received from the seismic early warning System.
- b) Under the Maximum Considered Earthquake (MCE) (10% probability of exceedance in 100 years), passenger Safety shall be maintained throughout the seismic event. In the event of a derailment, the Trainset characteristics shall allow passengers to evacuate from the Train safely after such an event.

At the Final Design Review, the Contractor shall provide Trainset Seismic Specifications and Analysis methodology for ensuring that Train operation and Safety performance requirements under OBE and MCE events can be met.

Trainset Seismic Specifications shall include dynamic Trainset characteristics, component details, and functions necessary for meeting seismic performance requirements, including evacuation after derailment. These dynamic characteristics and component details shall be supported by results from the Analysis methodology and other calculations, as applicable. Trainset Seismic Specifications shall specify Trainset functions and staff procedures for response to seismic early warning Systems.

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12.3.10 Environmental Assessment

The Contractor shall perform an environmental assessment to determine those issues that may give rise to impacts on the environment. The Contractor shall, at a minimum, complete the following in performance of this assessment:

- a) Collect Data to assess baseline conditions (for actual noise, vibration, and air quality).
- b) Review all available/relevant information and scheme options within the context of the issue being assessed.
- c) Provide details on mitigating solutions for consideration. It is noted that these solutions may be beyond compliance with current laws.
- d) Develop procedures for interior and exterior noise and vibration assessment and prediction models.
- e) Develop noise and vibration prediction model software.

The environmental assessment shall be provided to the Authority for review during the Design Process.

12.3.11 Track Geometry

Trainsets shall operate in accordance with, at a minimum, the requirements of 49CFR Part 213 for each speed range defined for track class four and above, including up to the maximum testing speed of 390 km/h (242 mph) on Class 9 track.

Refer to DCM Chapter 4 for requirements pertaining to required Trainset attributes and the Authority's rail line geometry on which the Trainset shall operate.

Trainsets shall accommodate a minimum horizontal curve radius of 175 m (575 feet) and a minimum vertical curve radius of 500 m (1,640 feet).

12.3.12 Gradients

Trains shall start, operate, and stop on the maximum gradients on all the lines for which they are designed and over which they are planned to operate. Refer to DCM Chapter 4.5.1 (Grades) for requirements pertaining to required Trainset operating grades. In addition, the Trainset shall be able to operate on sustained grades of 2.8% over a distance of 21 km (13 miles).

12.3.13 Wheel/Rail Interface

The CHSR will utilize continuously welded rail for dedicated high speed tracks. The Trainset wheel profile shall be fully compatible with the CHSR rail profile as described in 12.3.15 and 12.3.16. The Trainset shall operate in accordance with these Specifications on CHSR track under all conditions.

The Contractor shall be responsible for specifying the wheel/rail Interface criteria (e.g., wheel profile, back-to-back dimensions, etc.) to provide smooth and safe movement of the Trainset, and of two Trainsets coupled together, at all specified speeds and track conditions.

The Contractor shall survey existing rail profiles in shared track territories and take these Data into consideration when optimizing wheel/rail Interface criteria.

Space and/or Equipment shall be provided on the Trainset for the autonomous inspection of track (refer to Section 8.17.4).

Refer to Section 12.3.48, and to DCM Chapter 4 and Chapter 5 for additional information.

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12.3.15 Track Structure

Both ballasted and non-ballasted track forms will be used. Refer to DCM Chapter 5.4.1 (Selected Section) for information on rail section for use on the Authority's high speed tracks. Other rail sections will be found in shared (blended operation) corridors.

The track modulus will be in the range of 20.7 MPa (3,000 lb/in/in) and 27.6 MPa (4,000 lb/in/in).

Refer to DCM Chapter 5 for additional information.

12.3.16 Additional Rail Sections

Refer to DCM Chapter 5.11.2 (Switch Rails) for information on switch rail sections.

Refer to DCM Chapter 5.11.4 (Turnout Guard Rails) for information on check rail sections.

12.3.17 Other Track Material

Refer to DCM Chapter 5.7.2 (Bumping Posts – Sliding and Fixed) for information on bumping posts.

Refer to DCM Chapter 5.7.3.1 (Switch Point Derails) for information on switch point derails.

12.3.18 Static Axle Load

The Contractor shall design the Trainsets to achieve an axle load compatible with meeting the functional and technical requirements identified in this Specification.

The maximum static axle load on the track shall be 17 tonnes (18.7 tons) and shall meet this requirements under the full load condition specified in Section 8.2.2.

The maximum total static axle load of the Train (total mass of the Train) shall not be greater than 102% of the sum of all nominal static axle loads of the Train.

The maximum individual static axle load of any axle shall not be greater than 104% of the nominal individual static axle load.

The difference in static wheel load between any wheel on the same Bogie or running gear shall not exceed 6% of the average wheel load of that Bogie or running gear.

Individual static axle loads shall not be less than 5 tonnes (5.5 tons).

12.3.19 Clearances

Authority Trainsets shall comply with the static gauge and the corresponding dynamic envelopes identified in DCM Chapter 3.4 (Vehicle Clearance Envelopes) including appendices.

The Contractor shall demonstrate that the Trainset will not strike any wayside object, structure, platform, or passing Train during operation, under all conditions identified below, at a minimum:

- a) All Trainset load conditions.
- b) All permissible wheel diameters.
- c) All body build and suspension tolerances.
- d) All Maintenance tolerance conditions (e.g., worn wheels, deflated or over/under-inflated air springs).
- e) Damaged suspension components and structural detachments.
- f) Track geometry tolerances.
- g) All permitted speeds.
- h) All aerodynamic effects (e.g., passing Trains and wind effects).

12.3.20 Horizontal Clearances

Refer to DCM Chapter 3.3.2 (Horizontal Clearances) for Trainset horizontal clearance requirements.

12.3.21 Vertical Clearances

Refer to DCM Chapter 3.3.1 (Vertical Clearances) for vertical clearance requirements.

12.3.22 Track Center Spacing

Refer to DCM Chapter 3.5 (Track Center Spacing) for track spacing requirements.

12.3.23 Platforms

Refer to DCM Chapter 14.3.2 (Platforms) for requirements of operating a Trainset at the station platform.

12.3.24 Tunnels

Authority tunnels will allow for Train Operations at speeds of up to 354 km/h (220 mph).

Refer to DCM Chapter 13.3.4 (Tunnel Configuration) for considered tunnel configurations.

Refer to DCM Chapter 13.3.5 (Clearances) and Chapter 13.3.6 (Walkways) for requirements of clearances and walkways installed in the tunnels.

Refer to DCM Chapter 13.3.12 (Aerodynamic Considerations) and Chapter 13.3.13 (Minimum Tunnel Cross-Sectional Areas) for requirements on aerodynamic considerations, minimum tunnel cross-sectional areas, and for additional information.

12.3.25 Highway-Rail Grade Crossings

There will be no public highway-rail grade crossings on alignment sections where speeds will be greater than 201 km/h (125 mph) . The dedicated right-of-way will also be fully access-controlled.

There will be no private highway-rail grade crossings on dedicated portions where speeds are greater than 201 km/h (125 mph). Private highway-rail grade crossings in the dedicated portion will be limited to Authority O&M personnel and will be controlled.

Level crossings will be encountered in shared territories where speed will be limited to a maximum of 201 km/h (125 mph). The Contractor shall demonstrate how the Trainset design will limit damage to the Trainset and provide for the Safety of the passengers and crew in the event of a collision with a highway Vehicle.

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12.3.27 Hazard Risk Assessment Criteria

The Contractor shall assess and resolve risk associated with Safety Hazards and Security Vulnerabilities in conformance with the Authority's Hazard Management Program found in Section 4 of the SSMP. The Authority's Hazard Management Program will be refined and developed as requirements mature. The Contractor shall review the amended documents and shall ensure that the Contractor's hazard assessments and resolutions are consistent

and in conformance with the latest version of the Authority's Hazard Management Program.

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12.3.29 Energy

The Trainset shall control the impact of its demand for power based on the quality of supply. The Trainset shall be provided with the required line filters, unity power factor Converter Equipment, and harmonic filters to maintain the quality of supply for other Trainsets, and railway vehicles in the section.

Trainset propulsion and auxiliary Equipment shall accommodate operation at the full range of OCS voltages, and with normal railway OCS traction harmonics, without damage, Failure of the Equipment to function, or reduction of required service life.

Carborne Equipment shall be protected against damage from shutdowns caused by random interruptions of the OCS power due to isolation gaps, pantograph bounce, or other conditions. Under these conditions, the Equipment shall recover automatically without delay to restart.

Trainset Equipment shall be protected from transient voltages or when the OCS is subjected to lightning strikes.

For operation under reduced voltage conditions, the Trainset shall provide reduced performance further limiting the Trainset maximum line current. The operation of this performance feature shall be automatic and controlled solely by the level of the line voltage at the Trainset. Refer to Section 12.3.30.

12.3.30 Traction Power Supply System

The TPS is described in DCM Chapter 20.

The Trainsets shall operate on the 25 kVAC OCS and function normally for the range of system voltages detailed in DCM Chapter 20.6.1 (System Voltage) and Chapter 20.6.2 (Voltage Related Requirements).

The Trainset shall function normally for the range of system frequencies detailed in DCM Chapter 20.6.3 (Frequency).

12.3.31 Train Power and Current Limitation

The Trainset shall conform to Train power and current limitations specified in DCM Chapter 29.4.3 (Train Power and Current Limitation).

For system voltages below 17.5 kV, auxiliary power shall be reduced linearly with OCS voltage below 17.5 kV, by reducing the APS output voltage and frequency. Load shedding shall occur to facilitate operation of emergency systems (e.g., lighting, communications, etc.). The low OCS voltage shutdown threshold of the APS shall be determined by the Contractor. The EMI characteristics of the APS variable voltage, variable frequency control shall be qualified in the Trainset EMC program.

12.3.32 Regenerative Braking

The Trainset's Regenerative Braking shall be facilitated by the following:

- a) Transfer of braking energy back into the OCS for use by another Trainset that is drawing power from the OCS and is located in the same electrical section as the braking Train.
- b) Provision of a power management system onboard the Trainset to utilize, store and/or dissipate regenerated electrical energy.

Depending on the provisions on the wayside, Regenerative Braking may also be facilitated by the following:

- a) Transfer of braking energy back to the power supply utility company's network.

Refer to DCM Chapter 29.4.4 (Regenerative Braking) and DCM Chapter 20.4.7 (Regenerative Braking).

12.3.33 Power Factor

The Trainset shall conform to the power factor requirements specified in DCM Chapter 29.4.5 (Power Factor).

12.3.34 Electrical Protection Coordination

The Trainset shall conform to the electrical protection coordination requirements between Trainset and TPS specified in DCM Chapter 20.7.5 (Electrical Protection Coordination) and DCM Chapter 29.4.6 (Electrical Protection Coordination). The Contractor shall work with the interfacing contractor and/or the Authority to demonstrate that these requirements are met.

12.3.35 Overvoltages Generated by Harmonics

The Trainset shall conform to the harmonic distortion limits/overvoltages specified in DCM Chapter 20.7.7 (Harmonic Distortion Limits). The Contractor shall interface with the interfacing contractor and/or the Authority to demonstrate compliance with these requirements.

12.3.36 Overhead Contact System

The Trainset shall operate under the style and type of OCS Equipment detailed in DCM Chapter 21.

Refer to DCM Chapter 29.5 (Overhead Contact System Interfaces) for additional Trainset-to-OCS Interface criteria.

12.3.37 Phase Breaks

The Trainset shall operate with the design of the OCS phase breaks as detailed in DCM Chapter 21 and DCM Chapter 29.5 (Overhead Contact System Interfaces) for additional Trainset-to-OCS Interface criteria.

12.3.38 Pantograph-OCS Interaction

The Trainset and pantograph shall account for quality of current collection, mean contact force, and percentage of arc duration in coordination with the OCS. Refer to DCM Chapter 21 for the criteria for the dynamic interaction between the pantograph and the OCS. Refer to DCM Chapter 29.5 (Overhead Contact System Interfaces) for additional Trainset-to-OCS Interface criteria.

12.3.39 Signaling and Train Control Interfaces

The signaling, Train control, and PTC system, collectively known as the ATC system or ATC/PTC system, includes all of the Safety-critical and non-Safety-critical functions of a high speed rail Train control system, and will include PTC functions, as per 49CFR Part 236 Subpart I, as defined in DCM Chapter 24, Chapter 25, and Chapter 29.

The Trainset ATC Equipment is not included within the Contractor's scope. The Trainset ATC Equipment will be designed, implemented and integrated with the Trainset by an interfacing ATC contractor.

The Contractor shall provide the Trainsets with provision of physical space, mountings, and electrical, signal, Data, system and all other Interfaces and design provisions for ATC onboard Equipment, per DCM Chapters 24.3 (General Design Requirements), 24.3.6 (Environmental Conditions), 24.3.10 (Safe Braking), 24.3.11 (Speed Limits), 24.3.12 (Hardware Requirements), 24.5.1 (On-board Functions), and 24.7 (On-board Equipment); and Chapter 29.6 (Automatic Train Control Interfaces), so that the interfacing contractor can provide and integrate the onboard ATC system onto the Trainsets.

All Interfaces between the Trainset and the onboard ATC shall be open and standards-based, or otherwise fully documented.

12.3.40 Communications

The Trainset radio Equipment and Trainset GPS Network Timing System Equipment are not included within the Trainset Contractor's scope. These systems will be installed by an interfacing Contractor. However, the Trainset Contractor shall make spatial, mechanical, electrical and EMC provisions, and provide functional Interfaces and integration for these systems' Equipment that will be provided by separate Procurements.

To that end, the Trainset Interfaces and protocols shall be non-proprietary, utilize open standards and/or be documented such that the onboard radio systems and wayside communications systems can be provided by a separate, multiple-vendor Procurement. No onboard systems' Interfaces, protocols, features, hardware or software shall preclude any interfacing Contractor from interfacing to the onboard systems and providing end-to-end functionality and performance provided that the interfacing Contractor meets all requirements of the onboard interface.

The wayside communications systems provided by an interfacing contractor will consist of:

- a) Wide area network (WAN).
- b) Local area networks (LAN) (including Wireless Local Area Networks).
- c) Radio systems (including Operations radio system, broadband radio system, and public Safety trench and tunnel radio system).

- d) Cable infrastructure.
- e) Antennas
- f) Integrated information management platform.
- g) GPS network timing system,
- h) Fire alarm system.
- i) Public address and customer information sign system.
- j) Telephone and intercom system.
- k) Intrusion detection system.
- l) Electronic access control system.

Refer to DCM Chapter 28.1 (Scope) for additional information on the wayside communications systems.

Trainset onboard systems provided by the Trainset Contractor that shall have an Interface to and/or shall be integrated with the wayside communications systems to provide seamless functionality include, at a minimum:

- a) ICP.
- b) PA/IC system.
- c) Passenger information system.
- d) Passenger alarm system.
- e) Fire alarm system.
- f) Passenger emergency intercom.
- g) Internal and external video cameras.
- h) Internal and external electronic displays.
- i) TCMS/OBC system.
- j) Analog trainline network.
- k) Digital trainline network.

Refer to DCM Chapter 29.7 (Communications Interfaces) for detailed design criteria for the Trainset communications system Interfaces.

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12.3.46 Maintenance Management Information System (MMIS)

The Contractor shall provide an integrated MMIS that facilitates Trainset-pertinent inspections, preventative maintenance, corrective maintenance, and asset management. At a minimum, the MMIS shall comprise of an asset register, a planning system, and a data and analysis system:

- a) Asset register: the purpose of the asset register is to have a current record of all assets of the Trainset and the modification and maintenance status of each

significant item, component, or system. The Contractor shall provide asset register information as specific assets become identifiable.

- b) Planning system: at a minimum, the planning system shall:
 - a. Devise Trainset rosters;
 - b. Devise staff rosters;
 - c. Plan Train paths, including special Trains and station stops;
 - d. Plan technical incident control;
 - e. Plan maintenance activities including:
 - i. System configuration tracking;
 - ii. Maintenance and new work planning, scheduling and control;
 - iii. Resource management;
 - iv. Materials management;
 - v. Cost and budgetary control.
- c) Data and analysis system: the data and analysis system shall be available to provide statistical information over different user-defined timeframes concerning, but not limited to:
 - a. Numbers of Trains running daily;
 - b. Total daily mileage of each Trainset;
 - c. Availability of Trainsets.

The MMIS shall permit the following tasks to be performed:

- a) Financial control, through proper knowledge of costs and use of resources, informing trade off decisions;
- b) Status of Authority-owned spares, Contractor provided spares, consumable spares
- c) Technical results, through efficient tracking of technical information;
- d) Efficient scheduling and organization of activities;
- e) Recording of all maintenance undertaken and scheduling of maintenance due on the Trainset;
- f) Quality through compliance with ISO traceability requirements and delivery of current technical information to maintenance personnel;
- g) Improvement results through proper global indicators allowing detection of trends and continuously improving maintenance performance;
- h) Identification of endemic design or manufacturing defects;
- i) Equipment availability and reliability improvement.

Details of the MMIS shall be included in the Contractor-developed Maintenance Program, and shall address the following, at a minimum:

- a) Information in the Trainset history books;
- b) Information and details for the asset register, planning system, and data and analysis system;
- c) Configuration management information;
- d) Software;
- e) Interface with the TCMS/OBC and response to faults and alarms;
- f) Interface with Trainset communications for the relay of pertinent data/information to wayside facilities, including interface with the Authority's Enterprise Asset Management (EAM) system;

- g) Generation of service requests from faults and alarms;
- h) Management procedures for the receipt and processing of information relative to the operational integrity of the Trainset including operational and/or maintenance incidents with a potential to affect the safety integrity of the Trainset;
- i) Operational duty profiles of the Trainset (including but not limited to total mi (km) traveled);
- j) Security management processes for the protection and validation of the information systems.

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12.3.49 Vehicle/Track Analytical Simulation

As part of final design, the Contractor shall complete Table 12-1 with information from the proposal and final Trainset design. Columns (2), (4), and (5) shall be completed with relevant information from the preliminary Trainset design parameters previously submitted with the proposal. Column (6) shall be completed for each parameter requested using the final Trainset design. Final Trainset design parameters shall be within the specified tolerances for final design submitted in the proposal.

Table 12-1: Final Trainset Design Compliance Check

| Parameter | Notation | PRELIM. TRAINSET DESIGN | | Tolerance for Final Design At Proposal (%) ² | | FINAL TRAINSET DESIGN | |
|---|------------------------|--------------------------------|------------------------|---|---|------------------------------------|------------------------|
| | | Value At Proposal ¹ | Units | + | - | Value At Final Design ³ | Units |
| | | | | | | | |
| Length Dimensions | | | | | | | |
| end of carbody to centerline truck | L_1 | | ft | | | | ft |
| centerline truck to centerline car | L_2 | | ft | | | | ft |
| wheel spacing | L_3 | | ft | | | | ft |
| Height Dimensions | | | | | | | |
| c.g. lateral secondary to c.g. car body | h_3 | | ft | | | | ft |
| c.g. truck to c.g. lateral secondary | h_2 | | ft | | | | ft |
| c.g. lateral primary to c.g. truck | h_1 | | ft | | | | ft |
| Nominal Radius of Wheel | r_o | | ft | | | | ft |
| Width Dimensions | | | | | | | |
| centerline truck to vertical primary | d_p | | ft | | | | ft |
| centerline truck to vertical secondary | d_s | | ft | | | | ft |
| Masses | | | | | | | |
| Mass of Car Body | m_{cb} | | lbf*s ² /ft | | | | lbf*s ² /ft |
| Mass of Truck | m_t | | lbf*s ² /ft | | | | lbf*s ² /ft |
| Mass of Wheelset (including axle) | m_w | | lbf*s ² /ft | | | | lbf*s ² /ft |
| Mass Moments of Inertia (MMI) | | | | | | | |
| MMI of car body about x axis | I_{cbx} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of car body about y axis | I_{cby} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of car body about z axis | I_{cbz} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of truck about x axis | I_{tx} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of truck about y axis | I_{ty} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of truck about z axis | I_{tz} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| MMI of wheelset about x axis | I_{wx} | | lbf*s ² *ft | | | | lbf*s ² *ft |
| Stiffnesses³ | | | | | | | |
| Stiffness of Vertical Primary Suspension System | k_{z1}^p (Typ. of 4) | | lbf/ft | | | | lbf/ft |
| Stiffness of Vertical Secondary Suspension System | k_{z1}^s (Typ. of 2) | | lbf/ft | | | | lbf/ft |
| Stiffness of Lateral Primary Suspension System | k_{y1}^p (Typ. of 4) | | lbf/ft | | | | lbf/ft |
| Stiffness of Lateral Secondary Suspension System | k_{y1}^s (Typ. of 2) | | lbf/ft | | | | lbf/ft |
| Damping³ | | | | | | | |
| Damping of Vertical Primary Suspension System | c_{z1}^p (Typ. of 4) | | lbf*s/ft | | | | lbf*s/ft |
| Damping of Vertical Secondary Suspension System | c_{z1}^s (Typ. of 2) | | lbf*s/ft | | | | lbf*s/ft |
| Damping of Lateral Primary Suspension System | c_{y1}^p (Typ. of 4) | | lbf*s/ft | | | | lbf*s/ft |
| Damping of Lateral Secondary Suspension System | c_{y1}^s (Typ. of 2) | | lbf*s/ft | | | | lbf*s/ft |

Notes:

- 1) Trainset 1, 2, or 3 from the preliminary Trainset design parameters submitted with the proposal.
- 2) Values from the preliminary Trainset design parameters submitted with the proposal.
- 3) Equivalent linear stiffness and damping characteristics across multiple components and complex behavior are acceptable. Detailed supplements shall be provided to justify selection/comparison of parameters to compare with preliminary Trainset design.

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12.7 THIS SECTION INTENTIONALLY LEFT BLANK

13 ATTACHMENTS

13.1 THIS SECTION INTENTIONALLY LEFT BLANK

13.2 AUTHORITY ATTACHMENTS

The following documents are attached to this Specification.

- a. Authority's San Jose-LA Union Station Alignment (*note the alignment information provided in these files are subject to change)
 - 2.San Jose – Merced (w tunnel lengths).xls
 - 3.Merced to Fresno.xlsx
 - 4.Fresno – Bakersfield.xls
 - 5.Bakersfield – Palmdale (w tunnel lengths).xls
 - 6.Palmdale – Los Angeles (w tunnel lengths).xlsx
 - Representative CHSRA Alignment 20140122.doc
- b. Authority's Design Criteria Manual
 - DCM for RS Procurement (CP2-3 Rev 2).pdf
- c. Authority's Safety and Security Management Plan
 - SSMP Rev0.2 130408 No Signatures.pdf
- d. Authority's Verification and Validation Management Plan
 - TM 1600.01 VVMP R0 130617 no sigs.pdf
- e. Authority's Implementation Stage EMC Program Plan
 - Proj_Guidelines_TM300_10R0.pdf