Track and Systems Agreement No.: [●]

Part B-1: Functional and Technical Requirements

INDUSTRY DRAFT – May 9, 2019

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Definitions and Terminology

A	**Acceptance**	*The action of consenting to receive or undertake something offered*
	Alignment Design Speed	The speed for which the Track System shall be designed to be capable of safely operating within the infrastructure shown in the Base Design
	Approval	*The action of officially agreeing to something or accepting something as satisfactory*
	Asset	A physical object or tangible entity owned by the Authority throughout its lifecycle for the Authority, this is anything owned or leased by the Authority and requires management intervention in order to mitigate risk of failure: 1. Requires a preventive maintenance schedule 2. Needs to be inspected 3. Needs to be calibrated 4. Its location or attributes need to be tracked
	Asset Management	Asset Management is the coordinated activity of an organization to realize value from assets. It is a structured approach to managing fleet, facilities and infrastructure assets to provide safe, reliable and cost effective high-speed rail services. It includes all documentation, evidence, inspection, measurement, maintenance, overhaul and renewal of Rail Infrastructure System assets
B	**Base Design**	The design of the Civil Works
C	**Capable**	The functionality or capacity that may be required of the Rail Infrastructure System
	Central Valley Wye	This serves as the junction for the system to head west to the Bay Area, north to Merced and Sacramento, and south to Fresno
	CHSR System	The entire California High-Speed Rail System, comprising Rail Infrastructure System, Rolling Stocks, Stations and Service Operator and the work required for/by the high-speed System of any other Interfacing Parties as described in section 19.5
	Civil Works	All Civil Works on the Right-of-Way, completed by Interfacing Parties, upon which the Track and Systems infrastructure shall be constructed, or that is required to meet the Contract Requirements. This excludes non-rail infrastructure such as third-party structures, landscaping and non-Authority assets
	Rail Infrastructure System civil works	All civil works to be provided by the Contractor to support the Rail Infrastructure System in addition to the Civil Works provided by Interfacing Parties
	Commercial off-the-Shelf	A non-proprietary product, piece of equipment or software that is generally available and capable of achieving the requirements without modification
	Contract Duration	The Contract Duration is from Notice to Proceed (NTP) to 30 years after Final Acceptance or handback of the Rail Infrastructure System to the Authority, whichever is later

	Contract Requirements	All requirements described within the Track and Systems Contract
	Contractors Design Standard	The standard that is proposed by the Contractor and Accepted by the Authority as the standard to which the design shall be provided, implemented, validated and verified, entered into service, operated and maintained
D	**Degraded Mode**	Continued safe operation of Rolling Stocks in the event of a failure of the Rail Infrastructure System or Rolling Stocks
	Design Standard	The Contractor's proposed standard, process or procedure against which component systems, subsystems or elements shall be designed
	Dynamic Envelope	Also known as the dynamic gauge or kinematic envelope, this is a diagram showing the maximum area at a point in space within which the rolling stock is permitted to run. It is the outline of the space occupied by a rail vehicle when in motion, including the effects of sway, superelevation, body roll, movement from curving forces and vehicle tolerances.
E	**Endpoint**	Used when describing communications equipment to mean a network point where services shall be accessed
	Entry into Service	The undertaking of agreed activities that shall allow for the commencement of the Service Period
	Equivalent	Something that is different but, in all respects delivers the same overall performance as the original item.
F	**Fleeting**	A selectable feature that allows automatic generation of movement authority for successive trains travelling in the same direction whilst maintaining all relevant safety requirements.
G	**Gal**	Unit of measure for ground acceleration - 1 Gal is equal to 0.01 m/s²
	Geographical Limits	The boundaries within which the Contractor shall undertake the works
H	**Headway**	The minimum time between successive trains travelling at the Operating Speed as defined in Section 6.2.2
	Heavy Maintenance Facility	The Rolling Stock supplier's facility where their Rolling Stocks shall be assembled and maintained
I	**Independent Safety Assessor**	This entity is appointed by the Contractor and provides independent regulatory guidance. The ISA interfaces between the Contractor, regulatory bodies, the Authority and any other legislatorial organizations to ensure that the Contractor's submissions to the external parties are complete to allow the external parties to assess the submissions and provide informed assessment and authorization as legally required.
L	**Light Maintenance Facility (LMF)**	The Rolling Stock supplier's facility where their Rolling Stocks shall be cleaned and prepared for daily service.
	Local Control Centre (LCC)	These shall be secure facilities, located away from the OCC, that contain all facilities and amenities required for the continuing operation and management of the day to day operations of the System and service when the OCC is not available.

M	**Maintain**	Maintaining the performance of the asset by management, inspection, monitoring, intervention and repair or replacement.
	Maintenance Ratio	For the calculation of the mean time to restore service (MTTRS), this is the number of calendar hours of restoration time per hour of item operation
	May	Indicates a permissible course of action
	Mean Time to Restore Service	The mean time in hours to restore regularly scheduled service after a service interruption occurs. In service, it will include all time from the occurrence of a service interruption until all California High-Speed Rail operations are operating on schedule.
	Movement Authority	Permission for a train to move to a specific location with supervision of speed.
	MTTRS	The sum of all Service Interruption Mode Maintenance Ratios divided by the sum of all Service Interruption failure rates
N	**Network**	The geographical extent of the planned California High-Speed Rail infrastructure and operational limits
	Northbound Interface	An interface that allows a particular component of a network to communicate with a higher level component
	Notice to Proceed	As defined in the General Provisions
O	**Operate**	Perform the necessary day-to-day duties to allow the Network to function as planned
	Operating Speed	The maximum speed at which a Rolling Stock can safely operate within the track alignment at any given location
	Operations Control Center (OCC)	This is the secure facility that contains all facilities and amenities required for the continuing operation and management of the day to day operations of the System and service.
P	**Passing Tracks**	Tracks strategically located along the System that allow for Rolling Stocks or Railway Equipment to pass another Rolling Stocks or Railway Equipment.
	Performance Requirements	The daily output that the Rail Infrastructure System shall achieve.
	Personnel	Individuals in roles associated with delivery of this scope of work.
	Plain Line	All rail Infrastructure required as per Section 2.1.1.
	Platform	Is a level boarding area to allow passengers safe access to Rolling Stock.
	Provide	All services, labor, materials, equipment, facilities and other efforts required to achieve the ”operate and maintain” phase of the Rail Infrastructure System. This shall include, as a minimum, survey, design, procure, construct, integrate, test and commission and gaining all necessary acceptance, approvals and certification.
R	**Rail Infrastructure System**	The Rail Infrastructure System is the integrated infrastructure that results from the Track & Systems Work constructed onto the civil works provided by other HSR contractors.

	Railway Equipment	Any item of rail mounted plant or equipment (not Rolling Stocks) that may be required to operate on the Track system.
	Refuge Tracks	Tracks that are located at Stations where Rolling Stocks or Railway Equipment can be stored clear of the Mainline or Station Tracks.
	Renew	Wholesale replacement of the asset. May also include an element of asset improvement, for example, to increase capacity.
	Revenue Service Hours	The hours between which passenger Rolling Stock are operating on the Mainline Tracks in accordance with the Operational Plan. Nominally 0500-0000.
	Review	A submission made by the Contractor to the Authority for Statement of No Objection (SONO)
	Rolling Stock	A high-speed rail train procured by the Authority under the separate High-Speed Rail Rolling Stock contract
	Rolling Stock Maintenance Facilities	Facilities provided by the Rolling Stock supplier for the purposes of Rolling Stock maintenance activities
S	**Service Operator**	The contractor responsible for the operation of High-Speed Rail Trains and stations
	Shall	Indicates a mandatory requirement
	Spares	Equipment or tools to be used in the event of failures that, are provided by the Contractor in order to meet the Contract Requirements
	Special Trackwork	Any track and equipment that is provided to allow trains to change route, for example: turnouts, crossovers and any junction requirements
	Standard Gauge	This is the measurement between the running edge of the two rails and is 1435 mm (nominally 4’ 8.5”).
	Station Tracks	Tracks which diverge from the Mainline Tracks at stations to allow Rolling Stocks to stop at station platforms without blocking the Mainline Tracks.
	Structure Gauge	Also known as the construction gauge, the structure gauge is an outline drawing that identifies the minimum clearance to surrounding infrastructure based on the dynamic gauge of the Rolling Stocks.
	System Integrator	The System Integrator shall bring together component subsystems into a whole and ensure that those subsystems function together and deliver the Performance Requirements of the System.
	System Safety Case	Is the combination of the Design and Operation Safety Cases
T	**Technical Requirements**	The requirements determined by the Contractor and captured in the System Requirements Baseline that the Rail Infrastructure System component systems, subsystems, elements or components shall achieve for the Rail Infrastructure System to meet the Contract Requirements.

	Test Track Geographic Limits	The limits of the Test Track that shall allow for sufficient length of track to enable the System to be tested as if in full operation. Equivalent to CP1-4 geographic limits.
	Testing Speed	The Operating Speed plus 10 percent
	Third-Party Tracks	Tracks and all associated infrastructure operated and maintained by parties other than the Contractor, including freight tracks, tracks on other passenger railways, and tracks within rolling Stock maintenance facilities.
	Track Alignment	The designed and installed alignment that allows the Rolling Stock to achieve the Performance Requirements within the Right-of-Way.
	Track System	The support and guidance system on which the Rolling Stock will run.
	Trackway	The Civil Works on which the Rail Infrastructure System shall be constructed. This is also known as 'Guideway'.
	Transfer Point	The defined and agreed point at which operations and maintenance responsibility transfers from one party to another
	Transfer Tracks	The tracks that link the Mainline Tracks to Third-Party Tracks and maintenance facilities (excluding Station Tracks)
U	**Universal Console**	Used when describing operational equipment. Universal Consoles are operational consoles capable of integrating the display and operation of various Rail Infrastructure Systems.
V	**Validation and Verification Method**	The Contractor's proposed method for determining that a component system, subsystem, data, software, element or component provides the Contract Requirements.
W	**Workstation**	A workstation shall include all supporting furniture, chairs, equipment enclosures, equipment, cabling and cable management, power and power distribution and task lighting.

Acronyms / Abbreviations

A	**AD**	access deterring
	AFR	Accident Frequency Rate
	ANSI	American National Standards Institute
	API	application programming interface
	AR	access restricting
	ARS	automatic route setting
	AT	autotransformer
	ATCRS	automatic train control radio system
	ATP	automatic train protection
	ATR	automatic train regulation
B	**BICSI**	Building Industry Consulting Service International
	BMS	building management system
C	**CHSRA**	California High-Speed Rail Authority – the Authority
	CHSTP	California High-Speed Train Project
	CIS	customer information system
	COTS	commercial off-the-Shelf
	CP	Construction Package
	CPUC GO	California Public Utilities Commission General Order
	CSV	comma separated value
	CWDM	coarse wavelength division multiplexing
D	**DAQ**	delivered audio quality
	DBM	design build maintain
	DBOM	design build operate maintain
	DDM	digital diagnostic monitoring
	DTX	DownTown EXtension
	DOM	digital optical monitoring
	DWDM	dense wavelength division multiplexing
E	**EACS**	emergency access control system
	EEDS	earthquake early detection system
	EIA	Electronic Industries Alliance
	EVACS	emergency voice/alarm communication system
F	**FTA**	Federal Transit Administration
G	**GIS**	geographical information system
	GoA	grade of automation
	GP	general provisions

	GTFS	general transit feed system
H	**HAZID**	hazard identification
	HDEWS	hazard detection and early warning system
	HDRAR	hazard detection response analysis report
	HMF	heavy maintenance facility
	HV	high voltage
I	**IBM**	International Business Machines
	ICEA	Insulated Cable Engineers Association
	IDS	intrusion detection systems
	II	intelligent infrastructure
	IIMP	integrated information management platform
	INCOSE	international council on systems engineering
	IP	internet protocol
	ISA	independent safety assessor
	ISO	International Organization for Standardization
	ISP	internet service provider
	ITU-T	International Telecommunication Union – Telecommunication
L	**LA**	Los Angeles
	LCC	local control center
	LEED	Leadership in Energy and Environmental Design
	LMF	light maintenance facility
M	**MEF**	Metro Ethernet Forum
	MOIS	maintenance of infrastructure sidings
	MOS	mean opinion score
	MOU	memorandum of understanding
	MOWF	maintenance of way facility
	MOWS	maintenance of way sidings
	MSA	multi-source agreement
	MSE	mechanically stabilized earth
N	**NEC**	National Electrical Code
	NESC	National Electrical Safety Code
	NF	negative feeder
	NMS	network management system
	NOC	network operations centre
	NPSTC	National Public Safety Telecommunications Council
	NTP	notice to proceed

O	**ONVIF**	open network video interface forum
	ORS	operations radio system
P	**PACIS**	public address customer information system
	PDT	Pacific Daylight Time
	PE	Professional Engineer
	PESQ	perceptual evaluation of speech quality
	PG&E	Pacific Gas & Electric
	PM	post meridiem (afternoon)
	PSIMS	physical security information management system
	PST	Pacific Standard Time
	PSTN	public switched telephone network
	PSTTRS	public safety trench and tunnel radio system
	PVC	polyvinyl chloride
R	**RAS**	RAM accounting system
	RE	RAM estimate
	RIIM	rail infrastructure information management
	S.I.	Système International
S	**SCADA**	supervisory control and data acquisition
	SDK	software developers kit
	SDLC	system development life cycle
	SEMR	system engineering management requirements
	SFF	small form factor
	SNMP	simple network management protocol
	STI-PA	speech transmission index – public address
T	**TES**	traction electrification system
	TIA	telecommunications industry association
	TIS	telephone and intercom systems
	TpH	trains per hour
	TPRS	traction power return system
	TPSS	traction power supply system
	TSB	telecommunications systems bulletin
	TSR	temporary speed restriction
	TTC	Transbay Transit Centre
U	**USGS**	United States Geographic Survey
	UTC	Coordinated Universal Time
V	**VCA**	video content analysis

	VDC	volts direct current
	VMS	video management system
W	**WDM**	wavelength-division multiplexing

1.1 California High-Speed Rail Network – Silicon Valley to Central Valley

Segment 1: Madera Acres to Poplar

- This segment covers the CP1-4 area and will also be the test segment where all static and dynamic system proving, testing and certification (first in class testing) will take place.
- This segment also includes the Plain Line Segment, which shall be the highest priority work within this segment.
- This segment will be provided for dedicated high-speed operations.
- This segment shall be a fully operational self-contained system that can be independently operated to its full functionality to deliver the Performance Requirements.
- This segment shall include the OCC, located in Fresno, for the full phase one and phase two system.
- All Rail Infrastructure Systems provided will be expandable, without affecting the ability of the operational system to deliver the Performance Requirements during their implementation, so that subsequent operating segments, covered by subsequent NTPs, can be added to the system and become fully functional additional parts of the overall system.

Segment 2: Poplar to Bakersfield Station

- This segment will be constructed and added to the South of Segment 1.
- This segment will be provided for dedicated high-speed operations.
- This will extend the operational segment to provide a fully functional system to the south
- Extending all track and systems infrastructure to deliver the Performance Requirements.

Segment 3: Merced to Madera Acres and the Central Valley Wye

This segment will be constructed and added to the North Segment 1.

- This segment will be provided for dedicated high-speed operations.
- This will extend the fully functional system to the north extending all track and systems infrastructure to deliver the Performance Requirements.

<u>Future indicative segments;</u>

Segment [XX]: San Francisco to CP Lick

- High-speed trains will operate as a tenant on the Caltrain operated infrastructure in this corridor.
- High-speed trains will operate in this segment under the control of the Caltrain dispatcher (at Menlo Park).
- The high-speed rolling Stock engineer requires dedicated and secure safety-critical voice and data communications with the 'high-speed OCC' at Fresno.
- Stand-alone radio sites will be provided at the wayside.
- The stand-alone radio sites will be connected to the high-speed rail infrastructure system and on to the OCC.
- The stand-alone radio sites will provide dedicated and secure high-speed rolling Stock-to-wayside safety-critical voice and data communications throughout this segment.
- High-speed rolling Stock will be required to have compatible train-control system and safety-critical voice communication systems on board for operating on this corridor communicating and interacting with the host railroad systems safely and reliably.

Segment [XX]: CP Lick to Gilroy

- This segment will be upgraded to have two dedicated electrified (25kVAC 60Hz) passenger tracks and one non-electrified track.
- The middle (of 3) track will be provided to allow double stack freight trains (cleared for 'plate H') to operate when the non-electrified track is not available.
- This operation will be protected by temporal separation and will not be under the protection of a signalling system – other than only allowing one train in the segment at any one time.
- The electrified tracks will be provided with the HSR signalling system, HSR traction power and HSR communication system.
- The tracks will be installed and maintained to HSR standards.
- This segment will include the Gilroy Maintenance-of-Way facility and will include connection to the local non high-speed railroad network.

Segment [XX]: Gilroy to Central Valley Wye

- This segment includes tunnels through the Pacheco Mountains.
- As such this segment, as well as all directly rail related infrastructure systems, will include tunnels specific related systems such as ventilation, lighting and fire life safety systems.
- This segment will be required to allow seamless and uninterrupted passage of a high-speed train between the blended segment described in Segment XX, and this dedicated high-speed segment.

2 SCOPE OF WORK

2.1 Contractor's Work

2.1.1 Plain Line Segment

Contractor shall provide a rail infrastructure System from Madera to Poplar Avenue, (CP1-4 geographic limits) to allow temporary operations of one non-electric train-per-hour, per-direction in accordance with milestones in schedule 3.

Contractor shall Design, Procure, Build, Test, Commission, and Maintain in accordance with all other contract requirements:

1. Plain line track work means two mainline tracks from Madera to Poplar Avenue not including:
    - Any special trackwork (turnouts, crossovers)
    - Final track geometry adjustments
    - final rail grinding
2. All relevant Positive Train Control requirements as described in CFR 236 and compliant with the Rail Safety Improvement Act of 2008;
3. An FRA compliant broken rail detection system; and
4. A wayside communications system (excluding vehicle borne radios)

The system shall be designed and constructed in such a way that it can be upgraded to form the final, fully electrified, 12 trains-per-hour, per-direction, 250mph Design Speed, Rail Infrastructure System with minimal disruption.

2.1.2 Test Track

The Test Track shall be maintained to achieve the Performance Requirements at all times.

The Test Track will be used by the Rolling Stock supplier to certify the Rolling Stock meet all requirements of the High-Speed Rail Trains contract.

1. Contractor shall provide a Test Track extending to the limits of the CP1-4 geographic sections
2. The Test Track shall be a fully functional, complete and extendable high-speed railroad that archives the Performance Requirements.
3. The Test Track shall be maintained to achieve the Performance Requirements at all times.
4. Contractor shall work with the Rolling Stock supplier to allow access to the Test Track for High-Speed Rail Trains testing purposes.
5. The Test Track shall be used by the Contractor to system integrate the Rail Infrastructure System with the Rolling Stock.
6. Contractor shall provide a Test Track Operational Control facility within the OCC Building.
7. The Test Track shall comprise all elements of the functioning Rail Infrastructure System to allow Rolling Stock to safely reach the Testing Speed of 242mph and come to a safe stop within the Test Track Geographic Limits.
8. The Test Track shall include a Transfer Track from Mainline Tracks to the Rolling Stock Heavy Maintenance Facility.

2.1.3 Silicon Valley to Central Valley Line

1. Contractor shall undertake all works required to provide a Rail Infrastructure System that meets the Contract Requirements within the Geographical Limits for the Service Period.

2. On Blended sections of railroad, the Contractor shall provide data and information to host railroad information systems where CHSR services shall call so that service information is displayed within station facilities for the benefit of CHSR passengers at hosted stations.
3. On Blended Sections of railroad, the Contractor shall provide dedicated voice and data radio coverage to the same standards as for dedicated sections. Voice data from this system shall be directed to the OCC.
4. Contractor shall provide the Rail Infrastructure System so that modification and extension to include the section from Bakersfield, via Palmdale through the Tehachapi, San Gabriel and San Angeles mountains to Burbank, Los Angeles and Anaheim shall take place when this phase of the project proceeds.
5. Contractor shall be the Infrastructure Manager of the Rail Infrastructure System so that it meets the Contract Requirements within the Geographical Limits for the Service Period and shall:
    a. Allow the safe operation of multiple Rolling Stock;
    b. Allow the safe operation of all Railway Equipment;
    c. Achieve the Performance Requirements;
    d. Provide a Track System that safely supports and guides all Rolling Stock and Railway Equipment;
    e. Supply all Rolling Stock with electric traction power;
    f. Supply power to all Rail Infrastructure System assets requiring power;
    g. Enable communications between all Rolling Stock, operational control facilities, wayside infrastructure, operation and maintenance personnel and emergency services;
    h. Provide data on the status of the Network to inform the Service Operator;
    i. Provide full security to the Right-of-Way to prevent unauthorized access;
    j. Provide Platforms, canopies and vertical circulation and pedestrian bridges between platforms at each station location
    k. Provide Station Tracks serving Platforms at each station location;
    l. Provide Refuge Tracks;
    m. Include any infrastructure as required to mitigate the impact of any disruption events on the Contract Requirements;
    n. Include any work needed in addition to the Base Design as required to achieve the Contract Requirements;
    o. Comply with the scope and Technical Specification for each component system, sub system or element of the Rail Infrastructure System as defined within this specification; and
    p. Enable bi-directional operation on any line at any time including all operational crossovers.
6. Where Professional Engineer sealed design is provided by the Authority, the Contractor shall be responsible for ensuring that the work is implemented to the design provided and maintained according to the Asset Management System Asset Class Strategy.

2.1.4 Phase 1

1. Contractor shall design and provide capacity within the Rail Infrastructure System to accommodate the future requirements of the full Phase 1 without impacting the safe operation of the interim Rail Infrastructure System during future installation, testing and operation of any and all modifications.

2.1.5 Phase 2

1. Contractor shall consider future capacity requirements within the Rail Infrastructure System to allow for future expansion that may be required to include Phase 2, without impacting the operation of the Phase 1 Rail Infrastructure System.

2.2 System Integrator

1. Contractor shall undertake the role of System Integrator as described in Schedule 14.
2. As System Integrator, the Contractor shall be responsible for the coordination and integration of its own work with that of the Interfacing Parties and any other parties identified during the course of the Work.
3. Contractor shall be responsible for the testing, validation, verification and certification of the System.
4. Contractor shall cooperate with all other contractors to coordinate, integrate, validate, verify, test and certify all work and to prevent any delay or hindrance to their work.
5. Contractor shall be responsible for the interface between the CHSR System and the connected neighbor railroads and shall ensure:
    a. Interoperability of Rolling Stock and Railway Equipment when travelling between connected neighbor railroads at the Operating Speed; and
    b. Safe operation of the Rolling Stock and Railway Equipment across the boundary between the CHSR System and the Network.
6. Contractor shall be responsible for the interface between the Rolling Stock suppliers HMF and the Mainline Tracks.
7. Contractor shall ensure the System shall safely transfer Rolling Stock between the HMF and the Mainline Tracks to support the Contractors Integration, Verification and Static and Dynamic Testing activities.
8. Contractor shall ensure the System shall safely transfer Rolling Stock between the HMF and the Mainline Tracks to deliver the operation of the Network.
9. Contractor shall coordinate the preparation and submission of Emergency Response plans including requirements of Interfacing Parties and first responders. Emergency Response plans shall be submitted for Review as stated in Section 3.2.

3 PROJECT LIFECYCLE AND DELIVERABLES

3.1 Project Lifecycle

The Contract can be considered as 9 delivery phases (per Segment); the completion of each phase being certified by the Contractor as complete following the successful Approval and/or SONO for each Deliverable in section 3.2. The issuance of the relevant Certificates in GP Schedule 5 will demonstrate achievement of the milestones listed in GP Schedule 3.

3.1.1 Phase 0 Proposal Phase

During the Proposal Phase, the Contractor shall:

i. Define the safety, performance, technical and management principles that they propose to adopt to perform the Contract Scope during the Contract Duration as defined within the Request for Proposal;

ii. Define the technical solution they propose to provide, operate and maintain;

iii. Propose their RAMS estimate and program;

iv. Propose their Asset Management principles;

v. Propose their Performance Standards; and

vi. Propose their Contract Price and Schedule.

3.1.2 Phase I System Definition Phase

During the System Definition Phase, the Contractor shall:

i. Complete the preparation of plans, processes and procedures that the Contractor shall follow in the execution of the Contract;

ii. Undertake project risk analyses;

iii. Develop the system definition and requirements analysis and document these within the System Baseline and System Definition Document; and

iv. Submit the deliverables for Authority review as listed in Section 3.2.

The Contractor shall issue to the Authority for approval a System Definition Phase Certificate, confirming that this Phase is complete.

3.1.3 Phase II System Requirements Phase

During the System Requirements Phase, the Contractor activities shall include:

i. Complete the system definition and requirements analysis, including apportionment of system and RAM requirements and document these within the System Baseline and System Definition Document;

ii. Undertake and complete the High-Level System (Architecture) Design;

iii. Define the System Design and Acceptance criteria and document within the Performance Demonstration Plan;

iv. Establish the Systems Validation Plan;

v. Establish management, quality and organizational requirements as defined within the Contractors plans, processes and procedures;

vi. Appoint the Independent Safety Assessor;

vii. Maintain civil assets handed over from the Authority; and

viii. Prepare and submit the deliverables for Authority review as listed in Section 3.2.

The Contractor shall issue to the Authority for approval a System Requirements Phase Certificate, confirming that this Phase is complete.

3.1.4 Phase III Design and Demonstration Phase

During the Design and Demonstration Phase, Contractor activities shall include:

i. Perform all design, development and design analysis;

ii. Perform all data preparation activities;

iii. Perform all verification and validation activities;

iv. Plan all verification and validation activities for future phases including preparation of Inspection and Test Plans;

v. Submit all completed designs and data to Escrow;

vi. Input all design data into the Asset Management System;

vii. Issue the Timetable Planning Rules (Section 15.1);

viii. Issue the Periodic System Definition Report (Section 4.13);

ix. Plan construction, asset management, maintenance, competence and training activities;

x. Complete initial Asset Management Plans for each Asset Class;

xi. Commence training for construction and maintenance of Rail Infrastructure System assets;

xii. Perform early construction activities;

xiii. Construct demonstration phase assets and maintain any that may become assets of the Rail Infrastructure System;

xiv. Prepare and submit the deliverables for Authority review as listed in Section 3.2;

xv. Undertake demonstration and mock ups in accordance with the Contractors Performance Demonstration Plan; and

xvi. Provide the Authority with the results of the Contractors Performance Demonstration via the Performance Demonstration Report.

The Contractor shall issue to the Authority for approval a Design and Demonstration Phase Certificate, confirming that this Phase is complete.

3.1.5 Phase IV Construction Phase

During the Construction Phase, Contractor activities shall include;

i. Perform all procurement, manufacture, assembly, inspection and testing of all systems, sub systems, assemblies and components and provide verification and validation evidence of completion in conformance to the Contract Requirements in accordance with Contractors Inspection and Test Plans;

ii. Perform all construction and installation activities and provide verification and validation evidence in conformance to the Contract Requirements in accordance with Inspection and Test Plans;

iii. Issue the Periodic System Definition Report (Section 4.11);

iv. Input all data into the Asset Management System;

v. Maintain all built Rail Infrastructure System assets; and

vi. Submit the deliverables for Authority review as listed in Section 3.2;

The Contractor shall issue to the Authority for approval a Construction Phase Certificate, confirming that this Phase is complete.

The Construction Phase for each NTP section will be subject to separate site access dates, therefore separate Construction Phase Certificates shall be issued for each NTP section.

3.1.6 Phase V System Validation Phase

During the System Validation Phase, the Contractors activities shall include;

i. Undertake all Integration, Testing and Commissioning activities in accordance with their System Integration Management Plan and Systems Validation plan;

ii. Perform all training in accordance with Contractors Competence and Training Assurance Plan;

iii. Issue the Periodic System Definition Report (Section 4.11);

iv. Input all data into the Asset Management System; and

v. Submit the deliverables for Authority review as listed in Section 3.2.

The Contractor shall issue to the Authority for approval a System Validation Phase Certificate, confirming that this Phase is complete.

The System Validation Phase for each NTP section will be subject to separate site access dates, therefore separate System Validation Certificates shall be issued for each NTP section.

3.1.7 Phase VI System Acceptance Phase

During the System Acceptance Phase, the Contractor shall;

i. Perform all Validation activities in accordance with their Systems Validation Plan and System Safety Plan;

ii. Input all data and evidence into the Asset Management System;

iii. Issue the Periodic System Definition Report (Section 4.11);

iv. Prepare and submit for Approval the Contractors Technical Safety Report and the Safety Assessment Report;

v. Submit the deliverables for Authority review as listed in Section 3.2;

vi. Maintain the Rail Infrastructure system assets in accordance with their Maintenance Plan; and

vii. Provide an operational Rail Infrastructure system to support any trial running, system testing or mileage accumulation activities.

The Contractor shall issue to the Authority for approval a System Acceptance Phase Certificate, confirming that this Phase is complete.

3.1.8 Phase VII Trial Running Phase

During the Trial Running Phase, the Contractors activities shall include;

i. Infrastructure Manage the Rail Infrastructure system in accordance with the Trial Running Operational Plan, System Validation Plan and System Safety Plan;

ii. Issue the periodic System Definition Report (Section 4.11);

iii. Issue the periodic Infrastructure Performance Report;

iv. Input all data into the Asset Management System;

v. Submit the deliverables for Authority review as listed in Section 3.2; and

vi. Maintain the Rail Infrastructure system assets in accordance with their Maintenance Plan.

The Contractor shall issue to the Authority for approval a Trial Running Phase Certificate, confirming that this Phase is complete.

3.1.9 Phase VIII Service Period

During the Service Period, the Contractors activities shall include;

i. Operate the Rail Infrastructure System, including dispatch of trains;

ii. Monitoring, inspection and maintenance of the Rail Infrastructure System to enable continuous safe operation of the system within the Contract Requirements for the Contract Duration;

iii. Operation, Maintenance and Management of Railway Equipment;

iv. Issue Contractors Daily Mission Quality Report;

v. Issue the periodic Infrastructure Performance Report

vi. Issue the periodic Asset Condition Report; and

vii. Renewal of Rail Infrastructure System assets in accordance with criteria set out in the Asset Management Plan.

3.1.10 Phase IX Handback Phase

During the Handback Phase, the Contractor shall;

i. Handback of the Rail Infrastructure system at the end of the Contract Duration in a condition that is fit for continued operation by the Follow on Contractor in accordance with the Handback Requirements.

The completion of each Phase will be considered as a Milestone. The Contractor shall provide evidence of completion of each milestone through the submission of deliverables and progress reports as listed below.

3.2 Deliverables

The following deliverables shall be submitted as part of this Contract and shall be submitted as required by the Submittal and Design Review Program referenced in Article 4.1 of the General Provisions.

Document / Milestone	**Action**	***Section***	**Time after NTP**	**Milestone Number**
Phase I System Definition				
Asset Class Strategy	Review	16.3	6 months	1
Baseline Program	Review	5.5	60 days	1
Competence and Training Assurance Plan	Review	7.6	3 months	1
Contractors Design Standards and Equivalency Report	Review	7.1	3 months	1
Configuration Management Plan	Review	4.2	3 months	1
Maintenance Plan	Review	4.19	6 months	1
Measuring Reference Systems proposal	Review	7.3	3 months	1
Infrastructure Operations Plan	Review	4.18	6 months	1
Product Safety Plan	Review	4.5	6 months	1
Project Management Plan	Review	5.5	4 weeks	1
Performance Demonstration Plan	Review	4.12	3 months	1
Performance Standards Plan	Review	4.20	3 months	1
Quality Management Plan	Review	4.1	3 months	1
RAM Program Management Plan	Review	10.1	3 months	1
Risk Management Plan	Review	4.7	3 months	1
Safety Management Plan	Review	4.1	3 months	1
Construction Management Plan	Review	4.13	3 months	1
Safety and Security Management Plan	Review	4.3	3 months	1
Software Quality Assurance Plan	Review	4.6	3 months	1

Strategic Asset Management Plan	Review	4.1, 4.17, 16.3	3 months	1
Submittal and Design Review Program	Review	5.5	3 months	1
System Engineering Management Plan	Review	4.8	3 months	1
System Integration Management Plan	Review	4.14	3 months	1
System Preliminary Design	Review	4.2.3	6 months	1
System Safety Plan	Review	4.4	6 months	1
System Safety Case Plan	Review	4.4.1	6 months	1
Systems Validation Plan	Review	4.15	6 months	1
RAM Allocation Report	Review	9.7	6 months	1
Phase II System Requirements				
System Requirements Baseline	Approval	4.9	12 months	2
System Definition Document	Approval	4,10 4.11	12 months	2
Systems Validation Plan	Approval	4.15	12 months	2
Safety Assessment Plan	Review	4.4.2	12 months	2
Civil Infrastructure / Base Design Variance Report	Review	8.1.1	12 months	2
Phase III Design and Demonstration				
Competence and Training Assurance Plan	Update	7.6	13 months	3
Contractors Design Submission	Review	4.2.3	18 months	3
ATC System Safety Requirements (Signalling Principles)	Approval	9.4.1	14 months	3
ATC Transfer Track Interface Report	Review	9.4.2	14 months	3
Emergency Response Plans	Review	2.2	18 months	3
Operations Management Plan	Review	9.5.1.2	18 months	3
Hazard Detection and Response Analysis Report	Review	7.7	18 months	3
Alarms Management Plan	Review	7.9	18 months	3

Grounding and Bonding Plan	Review	7.10	18 months	3
Track layout and alignment	Review	10.1	14 months	3
Track Class Selection Report	Review	9.1	14 months	3
OCS Sectioning Design	Review	9.2.7	14 months	3
Timetable Planning Rules	Review	15.1	14 months	3
Testing and Commissioning Plan	Review	4.16	18 months	3
Verification and Validation Plan	Review	11	18 months	3
Maintenance Plans and Procedures	Review	18.2	18 months	3
Asset Management Plan	Review	16.3	24 months	3
Rail Infrastructure System Periodic System Definition Report	Review	4.13	Monthly	3
Electronic Access Control System Report	Review	9.6.3	24 months	3
Coordinated Interface Program and Report	Review	4.14	18 months	3
Performance Demonstration and Mock Ups Report	Review	4.12	24 months	3
Grade Crossing Operations Plan	Approval	9.4.7.2	24 months	3
Guard Rail Risk Assessment	Review	9.1.5.7	24 months	3
HMF Contingency Power Supply Capability Report	Review	9.2.5	24 months	3
Maintenance of Way Facilities and Sidings Plan	Review	9.9	24 months	3
Relay Protection Scheme	Review	9.2.1	24 months	3
TIS Capacity Report	Review	9.3.1.1	24 months	3
RAM Program Plan	Review	10.3	24 months	3
Asset Management Data	Review	14	24 months	3
Phase IV Construction				
Civil Infrastructure Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
Track and Drainage Certificate of Completion	Approval	4.15	*Contractor to confirm*	4

Traction Electrification System Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
Overhead Catenary System Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
Railway Systems Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
ATC System Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
Communications System Certificate of Completion	Approval	4.15	*Contractor to confirm*	4
Phase V System Validation				
Inspection and Test Certificates	Review	12.1.4	*Contractor to confirm*	5
Testing and Commissioning Report	Approval	12.2	*Contractor to confirm*	5
Verification and Validation Report	Review	11	*Contractor to confirm*	5
Asset Management Data	Review	14	*Contractor to confirm*	5
Periodic System Definition Report	Update	4.11	*Contractor to confirm*	5
Systems Requirements Baseline Report	Update	4.10	*Contractor to confirm*	5
Competence and Training Report	Review	7.8.7	*Contractor to confirm*	5
Phase VI System Acceptance				
Technical Safety Report	Approval	4.4.1	*Contractor to confirm*	6
Safety Assessment Report	Approval	4.4.1	*Contractor to confirm*	6
Asset Management Data	Approval	3.1.7	*Contractor to confirm*	6
Periodic System Definition Report	Approval	4.11	*Contractor to confirm*	6
Phase VII Trial Running				
Technical Safety Report	Approval	4.4.1	*Contractor to confirm*	7
Safety Assessment Report	Approval	4.4.1	*Contractor to confirm*	7
Asset Management Data	Review	3.1.8	*Contractor to confirm*	7
Periodic System Definition Report	Update	4.11	*Contractor to confirm*	7
Periodic Infrastructure Performance Report	Review	3.1.8	*Contractor to confirm*	7

Phase VIII Service Period				
Infrastructure Performance Report	Update	3.1.8	*Contractor to confirm*	Monthly
Mission Quality Report	Review	3.1.9	*Contractor to confirm*	Daily
Asset Condition Report	Review	16.2, 16.5, 17.4	*Contractor to confirm*	Monthly
Projected Asset Condition Score and Residual Life Report	Review	17.2	*Contractor to confirm*	Annual
Phase IX Handback				
Handback Plan	Review	4.20	*Contractor to confirm*	9
Asset Management Data	Audit	19.1	*Contractor to confirm*	9
Initial Asset Condition Handback Survey Report	Review	19.1	*Contractor to confirm*	9
Detailed Asset Condition Handback Survey Report	Review	19.1	*Contractor to confirm*	9
Final Asset Condition Handback Survey Report	Review	19.1	*Contractor to confirm*	9

4 PROJECT EXECUTION

4.1 Integrated Management System

1. Contractor shall develop an Integrated Management System that meets the requirements of both ISO-9001:2015 and ISO-55001:2014 to ensure both the assets and the organization practices are managed and assured throughout the contract duration.
2. Contractor shall produce a Quality Management Plan and shall submit for review as stated in section 3.2.
3. Contractor shall produce a Strategic Asset Management Plan and shall submit for review as stated in section 3.2.
4. Contractor shall produce a Safety Management Plan and shall submit for review as stated in section 3.2.

4.2 Configuration Management Plan

1. Contractor shall develop and implement a Configuration Management Plan that provides details of their Configuration Management system to be used for maintaining accurate, thorough and correct records of the configuration state of all elements of the Scope of Work for the Contact Duration. The Configuration Management Plan shall be submitted for Review, as stated in Section 3.2.

4.3 Safety and Security Management

1. Contractor shall provide their Contractor Safety and Security Management Plan (CSSMP) as defined in Section 3.2, that shall describe how they intend to deliver the requirements of the CHSR Safety and Security Management Plan
2. Contractor shall be responsible for the ongoing identification and mitigation of all hazards that have the potential to affect the safe operation, security, maintenance, and renewal of the System.

4.4 System Safety Management

1. Contractor shall implement a System Safety Management structure that complies with the requirements of:
    a. EN50126 - Railway Applications, the specification and demonstration of Reliability, Availability, Maintainability & Safety (RAMS);
    b. EN50128 - Railway Application - Communications, Signaling and Processing Systems - Software for Railway Control & Protection; and
    c. EN50129 - Railway Applications Communications, Signaling and Processing Systems - Safety related electronics for Signaling.
2. Contractor shall produce a System Safety Plan as detailed in EN50126 and shall submit for Review, as stated in Section 3.2.

4.4.1 System Safety Case

1. Contractor shall prepare and maintain, for the Contract Duration, a System Safety Case in accordance with EN50129, which demonstrates that the Rail Infrastructure System meets all applicable safety legislation, regulations, standards, codes and conforms to the safety requirements detailed within the Contractors System Baseline.
2. The Contractors System Safety Case shall include, as a minimum:
    a. Definition of System;
    b. Quality Management Report;
    c. Safety Management Report;
    d. Technical Safety Report;

e. Safety Assessment Report;

f. The Contractors Design, Safety and Operating Cases;

g. The Design Safety Case of Interfacing Parties; and

h. Conclusion

3. For the Contract Duration, the Contractor shall be responsible for the production, update, accuracy of the System Safety Case, preparing the application for the rule of particular applicability and supporting the Authority in gaining the operating certificate

4. Contractor shall gain the agreement of the Independent Safety Assessor that the Technical Safety Report meets all applicable safety legislation, regulations, standards, codes and conforms to the safety requirements detailed within the Contractors System Baseline.

5. Contractor shall submit for Review, as stated in Section 3.2, their System Safety Case Plan that details how the safety requirements shall be met.

6. The appropriate elements of the System Safety Case shall be submitted for review six months in advance of the following:

   a. Commencement of static testing;

   b. Commencement of dynamic testing;

   c. Commencement of trial running;

   d. Commencement of Service Operations;

   e. Annually during the Service Period'; and

   f. The renewal of any subsystem of the Rail Infrastructure System.

7. During the Contract Duration, change requests may be raised for a variety of reasons, not all of which will be safety-related. Each change request shall be assessed for its impact on safety, by reference to the relevant portion of the safety documentation. Where a change request results in a modification which could affect the safety of the Rail Infrastructure System, or associated systems, or the environment, the appropriate portion of the safety life-cycle shall be repeated to ensure that the implemented modification does not unacceptably reduce the level of safety.

8. Contractor shall be responsible for the collation and management of the System Safety Case which shall include relevant elements of the Rolling Stock and Operator Safety Cases that shall allow the ISA to assess the safety of the complete CHSR System.

4.4.2 Safety Assessment

The Safety Assessment shall be an investigation, to arrive at a judgement, based on evidence, and on the suitability of the Rail Infrastructure System and its constituent elements, that all the conditions for safety acceptance have been satisfied. The results of these activities shall be documented in the Safety Assessment Report.

1. Contractor shall provide for the role of Independent Safety Assessor (ISA), in accordance with the requirements of EN50129 as directed by the Authority.

2. Contractor shall submit for Approval its proposal for the appointment of an ISA within 4 weeks following NTP.

3. Contractor shall appoint the ISA on approval by the Authority no later than 12 weeks following NTP.

4. The ISA shall be provided by an organization independent from the Contractor, which shall conform to the requirements of EN ISO/IEC 17020 or equivalent.

5. The ISA shall undertake the role of independent third-party verification and validation in accordance with CFR236:1017 and CFR 236, Appendix E and F.

6. The ISA shall perform Safety Assessments throughout all lifecycle phases as defined by EN50129, including:
    a. Requirements definition;
    b. Apportionment of system requirements;
    c. Design and implementation;
    d. Manufacture;
    e. Installation;
    f. System validation;
    g. System acceptance;
    h. Operation and maintenance;
    i. Performance monitoring;
    j. Modification, retrofit and renewal;
    k. Decommissioning and disposal; and
    l. Handback.
7. The ISA shall prepare and submit a Safety Assessment Plan for Approval as defined in Section 3.2. The Safety Assessment Plan shall be approved by the Authority and the FRA.
8. The Safety Assessment Plan shall describe:
    a. Activities throughout the independent assessment process and their link to engineering activities;
    b. Documents to be taken into consideration;
    c. Statements on pass/fail criteria and how non-conformance cases shall be dealt with; and
    d. Requirements regarding content and form of the Safety Assessment Report.
9. The ISA shall have access to the development process and all project related documentation.
10. The ISA shall:
    a. Agree the scope and contents of the Quality Assurance plan, the Safety Plan and the Systems Validation Plan. This agreement shall also make a statement concerning the presence of the ISA during testing;
    b. May carry out audits and inspections (e.g. witnessing tests) throughout the entire development process. The ISA may ask for additional verification and validation work;
    c. Shall assess the quality management system and the evidences on its use and application;
    d. Shall assess if an appropriate development process and an appropriate set of techniques, which are suitable for the intended development, has been selected;
    e. Shall review the evidence of the competency of the staff and shall assess the organisation for the system development;
    f. Shall assess the adequacy and completeness of the safety cases;
    g. Shall assess that the safety analyses are complete and correct;
    h. Shall assess safety-related application conditions;
    i. Shall check for noted deviations, non-compliances to the requirements and recorded non-conformities if these have an impact on safety, and make a judgment whether the justification from the project is acceptable;
    j. Shall record their activities and evaluations in a Safety Assessment Report confirming that the Technical Safety Report demonstrates that the Contractor has followed the correct processes for their work and demonstrates that the Rail Infrastructure System delivers the required level of safety; and
    k. The Safety Assessment Report shall be submitted to the Authority for onward regulatory Approval.
11. Contractor shall submit the Safety Assessment Report for Approval at intervals as required by the Safety Assessment Plan.

4.5 Product Safety Plan

1. Contractor shall submit for Review, as stated in Section 3.2, a Product Safety Plan.

4.6 Software Quality Assurance Program

1. Contractor shall follow the requirements of EN50128 to ensure quality and safety of software is managed and assured throughout the Contract Duration.
2. Contractor shall produce a Software Quality Assurance Plan that shall describe how they intend to deliver the requirements of EN50128 - Railway Application - Communications, Signaling and Processing Systems - Software for Railway Control & Protection and shall submit for Review, as stated in Section 3.2.

4.7 Risk Assessment

1. Contractor shall implement a risk management process in accordance with ISO31000.
2. Contractor shall submit for Review, as stated in Section 3.2, a Risk Management Plan detailing its process for the management of safety, technical, infrastructure operations and maintenance risks and for undertaking, as a minimum, all risk assessments identified within this specification, all referenced standards, all other risk assessments required to achieve legal compliance and the Contract Requirements.

4.8 System Engineering

1. Contractor shall comply with the requirements of the 'Rail Infrastructure System - System Engineering Management Requirements' (SEMR).
2. Contractor shall develop and implement a complete systems development life cycle (SDLC) for this contract, following the general requirements of the latest version of the International Council on Systems Engineering (INCOSE) Systems Engineering Handbook "A Guide for System Life Cycle Processes and Activities", and ISO/IEC/IEEE 15288 "Systems and Software Engineering – System Life Cycle Processes."
3. Contractor shall document the planned SDLC approach in a Contractor Systems Engineering Management Plan (SEMP). The SEMP shall follow the structure of the Systems Engineering Management Requirements (SEMR) document, demonstrating how the Contractor shall address the individual technical management, systems engineering, cross-cutting systems engineering methods, specialty engineering integration, and life cycle stages, milestones, and submittal process requirements outlined.
4. Contractor shall submit the SEMP for Review, as stated in Section 3.2.
5. Contractor shall maintain and update the SEMP at intervals to be agreed with by the Authority, for the Contract Duration, and manage its implementation by all partners, subcontractors, and suppliers.

4.9 Requirements Management Process

1. Contractor shall develop and implement a requirements management process, utilizing a requirements management tool in accordance with the SEMR to create and manage a System Requirements Baseline. The System Requirements Baseline shall be submitted for Review as stated in Section 3.2.
2. Contractor shall be responsible for the update, accuracy, maintenance and security of the requirements management tool for the Contract Duration.
3. Contractor shall be responsible for all licenses, hardware, software, data and firmware and all updates for the requirements management tool for the Contract Duration.
4. The requirements management tool shall be capable of transferring and linking data with the Asset Management Tool.
5. Where risk assessment exercises identify mitigations that are not contained within the Contract Requirements, the Contractor shall produce a Risk Mitigation report detailing why the mitigation is not covered by the Contract Requirements and shall propose how the mitigation shall be delivered. The report shall be issued for Acceptance as an output of each risk assessment.

6. On Acceptance of the mitigations contained within the Risk Mitigation report, any changes to the Contractors scope of work will be considered by the Authority.
7. Work shall only commence on the mitigations outside of the Contract Requirements once instructed by the Authority.
8. The requirements tool, including all data entered throughout the Contract Duration, shall be accessible by the Authority as required.

4.10 System Requirements Baseline

1. For each Contract Requirement, the Contractor shall identify all technical, functional and non-functional requirements and submit entries in the System Requirements Baseline for each requirement that shall include the following information as a minimum:
    a. Unique reference number;
    b. Contract Requirement;
    c. Applicable Laws, Statute, Regulation or Standard;
    d. Version number; and
    e. Configuration management information.
2. Contractor shall produce the Systems Requirements Baseline and submit for Approval as stated in Section 3.2.
3. Approval of the Systems Requirements Baseline will only be issued if the Authority agrees that the Contractor has demonstrated how all the Contract Requirements shall be met and that the Contractor has demonstrated that all Contractors Technical Requirements are legally compliant, have an appropriate Design Standard, performance measure, and Validation and Verification method.
4. The Contractor shall submit a Systems Requirements Baseline Update Report for Review demonstrating any changes to the Systems Requirements Baseline every six months, or more frequently if changes are significant.

4.11 Rail Infrastructure System Definition Document

1. A Rail Infrastructure System Definition Document shall be produced which details:
    a. How the Rail Infrastructure System shall achieve the Contract Requirements:
        i. Contractor’s Design Standard;
        ii. Performance measure;
        iii. Contractor’s Validation and Verification method, including applicable Laws, Statute, Regulation or Standards; and
        iv. Contractor’s compliance evidence.
    b. How the Railway Infrastructure System shall achieve the safety requirements as defined within the Safety Principles – Section 5;
    c. How the function of the Rail Infrastructure System delivers the Operational Plan provided by the Operator;
    d. How the systems shall be installed;
    e. The configuration state of all systems, sub-systems, assembles, components, documents, data and designs;
    f. The performance levels to be achieved by each system and sub system as defined in the RAM Program Plan;

g. How the maintenance, renewal and overhaul work shall be undertaken, listing the activities, their duration and their frequency and how it conforms to the Operational Plan;

h. A detailed list of potential failures of the Rail Infrastructure System that may cause the temporary cessation of revenue paying services and proposed mitigations for these failures; and

i. Outlines how any unplanned failures or faults shall be managed so that the Contract Requirements are delivered.

2. The Rail Infrastructure System Definition Document shall include a Rail Infrastructure System Architecture and Interface schematic that includes all systems and sub systems.

3. The Rail Infrastructure System Definition Document shall be produced and shall be submitted for Review, as stated in Section 3.2. A SONO to the Rail Infrastructure System Definition Document will only be issued if the Authority deems that the Contractor has demonstrated how all the requirements shall be met and validated.

4. The Rail Infrastructure System Definition Document shall be updated to incorporate all changes that may arise during the Contract Duration and shall be submitted to the Authority for review if there is a material change to the System Requirements Baseline.

5. Contractor shall issue and certify a structured report, the Periodic System Definition Report, every 12 weeks, until approval of the Operating Safety Case, that details progress against their agreed plan and how the Contract Requirements are being met. The report is to include percentage complete for verification and validation of each item and configuration state details for all systems, sub-systems, assemblies, components, designs, documents and data. All changes, renewals, replacements and deletions to the Rail Infrastructure System shall be recorded.

4.12 Performance Demonstration and Mock Ups

1. Contractor shall produce a Performance Demonstration Plan which shall detail how the Contractor shall demonstrate that the Contract Requirements shall be achieved and submit it for Review as stated in Section 3.2.

2. The Performance Demonstration Plan shall include details of any technology that the Contractor proposes to use as their means to demonstrate System performance. Examples may include;

   a. Physical mock-ups;

   b. System models; and

   c. Virtual Reality.

3. The Performance Demonstration Plan shall include details of how the Contractor intends to use the proposed mock-ups for:

   a. Demonstration of achievement of the Contract Requirements;

   b. Demonstration of Rail Infrastructure System operations and maintainability;

   c. Demonstration of Rail Infrastructure System reliability;

   d. Demonstration of the performance of future modifications;

   e. For training and development purposes for operations and maintainability;

   f. For continual improvement development; and

   g. For safety improvements.

4. Prior to commencement of construction of the Plain Line track, the Contractor shall provide a mock-up of the proposed track system. The mock-up shall be located within a Maintenance of Way Facility (MOWF).

5. Prior to commencement of construction of the remainder of the Track and Systems work the Contractor shall provide a mock-up that shall comprise all elements of the final Rail Infrastructure

System, arranged to be representative of the entire System. The mock-up shall also be located within a Maintenance of Way Facility (MOWF).

6. Contractor shall provide mock-ups of all customer facing equipment including CIS screenshots and all platform equipment.
7. Contractor shall provide documentary evidence that the Rail Infrastructure System has been demonstrated to meet Contract Requirements and their Performance Demonstration and Mock Up Report shall be submitted for Review, as stated in Section 3.2.

4.13 Construction Management

1. Contractor shall develop and implement a Construction Management process.
2. Contractor shall prepare a Construction Management Plan which shall be submitted for Review, as stated in Section 3.2.
3. On completion of each stage of construction, the Contractor shall issue for approval the following Certificates of Completion:
    a. Civil Infrastructure Certificate of Completion;
    b. Track and Drainage Certificate of Completion;
    c. Traction Electrification System Certificate of Completion;
    d. Overhead Catenary System Certificate of Completion;
    e. Railway Systems Certificate of Completion;
    f. ATC System Certificate of Completion; and
    g. Communications System Certificate of Completion;

4.14 Interface Management

1. Contractor shall develop and implement a System Interface Management process as described in the General Provisions Schedule 14 Integration and Interface Requirements and the System Engineering Management Requirements.
2. Contractor shall prepare a System Integration Management Plan that shall detail:
    a. How the Contractor shall undertake the role of System Integrator (see section 2.2);
    b. Identification of stakeholder needs and requirements;
    c. How the system integration and interoperability concept shall be applied;
    d. Interfacing Parties and how these shall be managed; and
    e. Key exchange of information and documentation with Interfacing Parties and when these are required.

    The System Integration Management Plan shall be submitted for Review in accordance with the Systems Engineering Management Requirements as stated in Section 3.2.
3. Contractor shall provide a Coordinated Interface Program and a Coordinated Interface Report as defined in Article 4.7 of the General Provisions and schedule 14 – Integration and Interface Requirements and submit for review as stated in Section 3.2.

4.15 Verification and Validation Process

1. The Contractor shall develop and implement a Verification and Validation process as detailed in the System Engineering Management Requirements and as required by Section 11.
2. Contractor shall prepare a Systems Validation Plan and submit for Review, as stated in Section 3.2, which shall detail the process, methods and activities of how technical requirements, high-level and detailed designs are verified, validated, and certified throughout the systems development life cycle.

3. On completion of the Validation and Verification process, the Contractor shall submit for Approval, a Verification and Validation Report demonstrating how each requirement has been met. Approval of the Verification and Validation Report will only be issued by the Authority if it is deemed that the Contractor has demonstrated how all the requirements have been met.
4. Verification and validation data for each asset shall be recorded in the asset management tool.

4.16 Inspection and Test Management

1. Contractor shall develop and implement for each asset the following:
    a. Static testing verification and validation method;
    b. Integration verification and validation method; and
    c. Trial running verification and validation method.
2. Contractor shall prepare a Testing and Commissioning Plan that shall detail:
    a. The proposed processes for testing and commissioning to demonstrate compliance with this contract in accordance with the Systems Validation Plan;
    b. The proposed processes for achieving all federal and State safety compliance;
    c. Any interaction required with Interfacing Parties to deliver the testing and commissioning activities;
    d. The proposed evidence and certification to demonstrate the testing and commissioning compliance; and
    e. A schedule of the proposed activities.
3. The Testing and Commissioning Plan shall be submitted for Review, as stated in Section 3.2. SONO to the Testing and Commissioning Plan will only be granted if it contains evidence of how the process will be effectively undertaken.

4.17 Asset Management System

1. Within the Contractors overarching Management System, the Contractor shall implement an Asset Management System that delivers the requirements of ISO-55001:2014.
2. Contractor shall develop, document and further develop a Strategic Asset Management Plan that establishes the organization capabilities for managing the assets under its stewardship. The Strategic Asset Management Plan shall consider:
    a. The overall approach (sometimes referred to as a framework) to managing assets adopted by the Contractor;
    b. The Asset Management Objectives that shall be adopted at relevant functions and levels, as defined in the Rail Infrastructure System Baseline, that shall be used to monitor performance and progress of the asset management practices adopted by the Contractor; and
    c. Functional Strategies and specific processes for managing lifecycle activities.
3. The Strategic Asset Management Plan shall be submitted for Review as stated in Section 3.2.

4.18 Operations Plan

1. Contractor shall submit for review, as stated in Section 3.2, an Infrastructure Operations Plan that details how the Rail Infrastructure System shall function under various scenarios including normal, abnormal and failure conditions.

4.19 Maintenance Plan

1. Contractor shall submit for Review, as stated in Section 3.2, a Maintenance Plan that defines detailed maintenance and fault response procedures and describes how the Rail Infrastructure System and any other assets under the stewardship of the Contractor are to be maintained, repaired or replaced throughout the Service Period to achieve the Contract Requirements.

2. The Maintenance Plan shall include the Contractors maintenance, renewals and overhaul methodology and whole life cost analysis to meet asset management lifecycles and achieve residual life requirements as detailed in the Asset Management Plan work plans for each asset class as identified in Section 16.

4.20 Handback Plan

1. Contractor shall submit for Review, as stated in Section 3.2, a Handback Plan that defines how the Contractor will achieve the requirements for handback as detailed in Section 18 of this specification.

5 SAFETY PRINCIPLES

1. Contractor shall provide, operate and maintain a Rail Infrastructure System that:
    a. Eliminates or minimizes the risk to employees, passengers and members of the public from hazards when undertaking work, maintaining, operating, using or interfacing with the Rail Infrastructure System;
    b. Allows safe access for inspection, maintenance, operation and renewal of equipment to be undertaken at a location that is a safe distance from the Right-of-Way and eliminates the risk of being struck by a train;
    c. Provides within the Operations Control Center, Local Control Centers or other control facilities, a safe, ergonomically assessed and compliant working environment with workstations of a sufficient number to safely and efficiently control and operate the Network; and
    d. Complies with the SSMP in Part C.
2. The planning, design, construction, installation, acceptance, operation, maintenance, overhaul, renewal, modification and extension of the Rail Infrastructure System, including the development of hazard mitigation procedures, shall provide a quantitative level of safety such that any single incident, or any combination of incidents, with the potential of causing death or severe injury to passengers or staff shall not occur with a frequency greater than the Passenger Accident Frequency Rate of no greater than [one fatality or serious injury per 10 billion passenger kilometers] travelled.
3. Contractor shall achieve a Staff Accident Frequency Rate of no greater than [one fatality or serious injury per 10 million man] hours worked.
4. Contractor shall employ personnel that are competent in the roles for which they are employed.
5. Contractor shall safely control all movements of trains, on-track plant and machinery (Rail Equipment). This shall be under the protection of the train control system.
6. Contractor shall be responsible for all site safety, scheduling, planning, resourcing, risk assessment, and coordination of all construction, setting to work, testing, commissioning, maintenance and operational activities. This shall include all Contractor work and works by Interfacing Parties.
7. Contractor shall be responsible for ensuring all personnel (including those of Interfacing Parties):
    a. Have the necessary safety training;
    b. Wear personnel protective equipment as defined in the risk assessment for the work;
    c. Have security clearance; and
    d. Are trained and competent to undertake the work for which they are accessing the site.
8. Contractor shall provide all safety equipment as determined by their risk assessments for the undertaking of all works.
9. Contractor shall bring trains to a stop in a safe location when the Railway Infrastructure System is not fit for the safe passage of trains.
10. Contractor shall provide for the role of Independent Safety Assessor (ISA) as directed by the Authority.
11. Contractor shall provide all the documents to support the Authority in filing all petitions in accordance with all applicable regulatory requirements.
12. Contractor shall ensure that any failures of the Rail Infrastructure Systems shall not result in a dangerous operating state. This is generally known as “fail-safe”.
13. Where the Contractor is responsible for the planning, development, design, delivery, testing, commissioning, operation, maintenance and renewal and decommissioning of works, the Contractor shall undertake risk assessments to ensure that their works meets the Contract Requirements.

14. Where work is provided by the Authority, upon handover, the Contractor shall take the work into their Asset Management System and shall maintain it as required to achieve the Contract Requirements.
15. Contractor shall carry out an Adjacent Highway Hazard risk assessment to assess the hazards associated with highways directly adjacent to the System as shown in the Base Design.
16. Contractor shall implement all required mitigations for Adjacent Highway Hazards identified in their risk assessment required to achieve the Contract Requirements.

6 PERFORMANCE REQUIREMENTS

This section defines the minimum Performance Requirements that the Rail Infrastructure System shall continually achieve within the Geographical Limits for the Service Period.

These Performance Requirements shall apply to all systems, subsystems and elements that comprise the Rail Infrastructure System.

6.1 Operational Requirements

1. The Rail Infrastructure System shall:
    a. Safely control the operation of the System within the Geographical Limits;
    b. Manage the condition of the Rail Infrastructure System to meet the Contract Requirements;
    c. Deliver the requirements of the Operational Plan;
    d. Be able to make automatic scheduling and routing alterations as necessary to achieve the Operational Plan;
    e. Provide clear, concise operational management information to support effective decision-making where automation is not practicable;
    f. Continuously monitor and record the status of the Rail Infrastructure System and availability of Rolling Stock throughout the Network, with positive confirmation of the status of each element;
    g. Provide warnings where the Rail Infrastructure System or Rolling Stock approach or exceed their design parameters and understand the actions required based on warnings received. Where such actions are taken automatically by the System, the operator and maintainer shall be made aware in real-time;
    h. Allow sufficient numbers of Rolling Stock to be presented in full operational mode to deliver the Operational Plan set by the Service Operator;
    i. Allow Rolling Stock and Railway Equipment to normally operate on the right-hand Trackway when viewed from the normal direction of travel;
    j. Issue, amend or remove permission for trains to access, exit and traverse the available Network;
    k. Provide data pertaining to the precise location, unique identifier and permission for movement (if any) of all trains on the available Network;
    l. Have the capability to operate trains in both directions on all lines, at any time, under the protection of the appropriate train control system;
    m. Safely and easily reconfigure the areas of control for each dispatcher workstation to support the effective real-time management of the network;
    n. Control the traction power supply feeding arrangements to safely maintain supply to the System and, where required, to isolate sections of the System. Such sections shall be designed to support the continued safe operation of train services around the isolated sections;
    o. Sustain secure, stable communications throughout the Network as required for the safe and efficient operation of the available Network;
    p. Sustain secure, stable communications to external parties as required for the safe and efficient operation of the available Network;
    q. Record all voice, video and messaging communications between personnel, and be able to replay such recordings as required;
    r. Provide monitoring of railway infrastructure and systems at maintenance facilities that is configured to cover the area of responsibility for that facility;
    s. Be able to transfer control of the available system between OCC and LCC locations;

t. Provide appropriate open source data to enable customers to receive real-time information of the running of train services via the development of third-party software applications; and

u. The Rail Infrastructure System shall continue to achieve the Contract Requirements in the event of the failure of a single component, where safe to do so, unless otherwise stated.

6.2 System Performance Requirements

6.2.1 Line Speeds

1. The maximum Operating Speed shall be 354 km/h (220 mph).
2. The Testing Speed shall be the Operating Speed plus 10 percent.
3. The maximum Alignment Design Speed shall be 402 km/h (250 mph) where topographic, geometric, operational, and environmental conditions permit.

6.2.2 Headway

1. The Rail Infrastructure System shall be designed to achieve a Headway of no more than 2 minutes, 45 seconds.

6.2.3 Stations

1. Stations shall be located at:
   a. San Jose Diridon;
   b. Merced;
   c. Gilroy;
   d. Fresno;
   e. Kings/Tulare; and
   f. Bakersfield.
2. The Rail Infrastructure System shall permit Rolling Stock to stop at all stations without blocking the Mainline Tracks and to permit Rolling Stock to bypass those stations at Operating Speed.

6.3 System Testing Performance Requirements

1. The Rail Infrastructure System shall allow Rolling Stock to be tested safely at all line speeds up to the Testing Speed.

6.4 Mean Time Between Service Interruption

1. The Rail Infrastructure System shall achieve a Mean Time Between Service Interruptions (MTBSI) of [at least 547 Revenue Service Hours]:
   a. MTBSI is the mean time in Revenue Service Hours between failures causing a Service Interruption; and
   b. A Service Interruption is when a train either does not arrive, arrives more than 3 minutes late, or arrives in a state not compliant with the Contract Requirements, at any scheduled station stop. All station stops affected by a single failure count as Service Interruptions. For example, if a failure causes a train to arrive more than 3 minutes late at two stations, the failure causes two Service Interruptions.
2. In service, MTBSI is the number of Revenue Service Hours in each four-week measurement period divided by the number of Service Interruptions in the same measurement period.
3. In RAM calculations, MTBSI is the inverse of the sum of all Rail Infrastructure System Service Interruption modal failure rates in failures per Revenue Service Hour.

6.5 Mean Time to Restore Service

1. The Rail Infrastructure System shall achieve a Mean Time to Restore Service (MTTRS) of [no greater than 1.33 calendar hours].
    a. The MTTRS for each Service Interruption includes all time, in calendar hours, from the occurrence of the first Service Interruption to the restoration of regularly scheduled service, with all elements of the Rail Infrastructure System in a state compliant with the Contract Requirements; and
    b. MTTRS is the mean time to restore regularly scheduled service for all Service Interruptions.
2. In revenue service, MTTRS is the total time to restore regularly scheduled service for all Service Interruptions in each four-week measurement period divided by the number of Service Interruptions in the same measurement period.
3. In RAM calculations, MTTRS is the sum of all Rail Infrastructure System Service Interruption modal Maintenance Ratios divided by the sum of all Rail Infrastructure System Service Interruption modal failure rates in failures per Revenue Service Hour:
    a. Each Service Interruption modal Maintenance Ratio is the failure rate for that Service Interruption mode multiplied by the MTTRS for that mode; and
    b. The Maintenance Ratio is the number of calendar hours of restoration time per Revenue Service Hour.

6.6 Maintainability

1. Maintenance diagnostic functions shall be an integral part of the Rail Infrastructure System.
2. Personnel shall be able to access and display health status and diagnostic information of the complete Rail Infrastructure System via the RIIM and the IIMP along with local asset status information for the respective equipment.
3. The Railway Infrastructure System shall make data available to maintenance systems for the purposes of preventive maintenance and planning maintenance activity.
4. The Contractor shall design the Rail Infrastructure System for continued operation for the Service Period.” Continued Operation” shall include monitoring of the System availability to meet RAMS requirements.
5. To manage any safety and availability risks, the Contractor shall manage all risks associated with obsolescence of Commercial-off-the-Shelf (COTS) equipment.
6. Software updates shall be undertaken to include operating systems, database applications and any security requirements that evolve through the design life.

7 GENERAL REQUIREMENTS

This section defines the general requirements that the Contractor shall comply with for the Contract Duration.

7.1 Regulations and Standards

1. Contractor shall provide the Rail Infrastructure System suitable for its intended purpose (as set forth in the California Streets and Highways Code, chapter 20, Article 2, section 2704.09 except with Rolling Stock Operating Speeds of up to 354 km/h [220 mph]).
2. This specification also mandates conformance with specified international standards and standards defined under European Association for Railway Interoperability Technical Specifications for Interoperability (TSI) and offers other standards as advisory.
3. Contractor may be permitted to adopt other equivalent international standards, accepted as standards of the industry, provided the Contractor demonstrates that such standards are equivalent or superior to those stated within this document. The Contractor shall provide a Design Standards and Equivalency report containing evidence of equivalence for Review, as stated in Section 3.2.
4. Contractor shall be responsible for confirming the appropriate regulations and standards, and for submitting a proposal for Review, as stated in Section 3.2, of the regulations and standards on which the System provision, operation and maintenance will be based. These shall be documented in the System Requirements Baseline and Rail Infrastructure System Definition Report as per Sections 4.10 and 4.11.

7.2 Unit of Measure

1. The unit of measure for the rail infrastructure systems contract shall be the S.I. metric system.
2. Within this document, all units of measure are in metric, with the U.S. customary unit noted in brackets. The metric values are the values to be used as the basis of design, the figures in brackets are nominal conversions to US customary units for information only.

7.3 Stationing and Measurement

For the Rail Infrastructure System to perform as required, it is vitally important that an accurate, consistent and controlled method of measuring the location of assets is enforced.

1. Contractor shall develop, propose and implement a measuring reference system, for construction and operation and Asset Management of the Rail Infrastructure System. The proposal shall be submitted for Review, as stated in Section 3.2.
2. The measuring system shall be used for the purposes of defining, to a high degree of accuracy, the location of Rolling Stock travelling at the Operating Speeds. For this to be undertaken safely, a very high degree of accuracy is required as the vital processors within the ATC system shall use the location of trains and equipment information to issue Movement Authority.

7.4 Surveys

1. Contractor shall undertake all surveys to implement the scope of work in accordance with the requirements for Design Surveys and Mapping contained in Appendix 1 of this document.
2. Contractor shall use available system-wide survey control monuments to perform Rail Infrastructure System installation in accordance with the requirements for Design Surveys and Mapping contained in Appendix 1 of this document.
3. Contractor shall preserve and propagate existing monuments at risk of being damaged or destroyed by work.
4. All survey data shall be retained by the Contractor and used for the purposes of ongoing analysis and planning to deliver the Contract Requirements for the Contract Duration.

7.5 Network and Computer Security

1. Contractor shall comply with the requirements for Network and Computer Security contained in Appendix 2 of this document.

7.6 Competency, Training and Qualifications

1. Contractor shall produce a Competence and Training Assurance Plan that documents the level of competency, qualifications and experience that personnel involved in the provision, operation and maintenance of the Rail Infrastructure System shall be required to hold to undertake their roles.
2. The Competence and Training Assurance Plan shall apply to all personnel who will work on the provision, operation and maintenance of the Rail Infrastructure System.
3. The Competence and Training Assurance Plan shall include methods for how competency shall be measured and the training that shall be provided by the Contractor to ensure its personnel maintain their competency.
4. Where qualifications are required to undertake roles or activities, the Contractor shall document these in the Competence and Training Assurance Plan and detail how its personnel shall achieve the required qualifications to undertake their roles or activities.
5. The Competence and Training Assurance Plan shall identify any training and development facilities the Contractor intends to provide and when they shall be available for use.
6. The Competence and Training Assurance Plan shall be submitted for Review as stated in Section 3.2.
7. Contractor shall provide a periodic Competence and Training Assurance Report detailing adherence to the Competence and Training Assurance Plan and shall submit for Review, as stated in Section 3.2.
8. Contractor shall always ensure that its personnel are trained and competent to undertake the roles on which they are employed.
9. For the Contact Duration, the Authority shall retain the right to engage in periodic audits of personnel to ensure that they are competent to undertake the roles for which they are employed.
10. Contractor shall demonstrate that personnel within key roles have relevant and suitable qualifications and competence to undertake the role.
11. As described within GP 21, key roles shall be occupied by Key Personnel and shall remain on the project as defined.
12. For non-vital Rail Infrastructure Systems, the Contractor shall comply with the requirements of the State Professional Engineers Act and all other laws and regulations.
13. Contractor shall provide evidence of competence of all personnel involved in the design, data preparation, manufacture, installation and testing of vital systems. The Contractor may provide evidence that the personnel employed on the provision of vital systems hold competence from internationally recognized relevant competence framework providers. An example of this, for signaling and telecommunications, may be the Institute of Railway Signal Engineers (IRSE).
14. Contractor shall provide evidence of competence of all personnel involved in the design, manufacture, installation and testing of the Track System.

7.7 Hazard Detection and Early Warning Systems

The Hazard Detection and Early Warning System (HDEWS) detects, reports, and where appropriate, autonomously intervenes and implements mitigation measures for events that may affect the safe passage of trains.

1. Contractor shall provide, operate and maintain a Hazard Detection and Early Warning System.

2. The HDEWS shall function to protect personnel and passengers from hazards caused by adverse physical or environmental conditions and intrusions, including but not limited to:
    a. Earthquakes (EEDS);
    b. Right-of-Way intrusion (earth slides, rock fall, falling objects, vehicles, large animals and other objects that present a danger to a train);
    c. Heavy rainfall and flooding;
    d. High wind;
    e. Rail defects and temperature;
    f. Derailment; and
    g. Subsidence.
3. For hazards that present imminent danger to the safe operation of the System, the System shall intervene to bring all affected trains to a stop. Hazards that present imminent danger to the safe operation of the System shall include;
    a. Earthquake (EEDS);
    b. Rockfall / mudslide;
    c. Rail vehicle incursion;
    d. Road vehicle incursion; and
    e. Large animal within the Right-of-Way.
4. Following the stopping of a train, the operator shall be able to allow the train to proceed using a degraded mode of operation. The actions of the operator shall be recorded by the System.
5. Where sensors, or their signals, that are provided to protect the System from imminent danger become unavailable, the System shall intervene to limit all affected trains to a safe speed.
6. For hazards that have the potential to cause danger to the safe operation of the System, the System shall provide a warning to the operator.
7. Hazards that have the potential to cause danger to the safe operation of the System shall include:
    a. Earthquake;
    b. Issues caused by water such as flooding or high flow rates;
    c. High winds;
    d. Subsidence; and
    e. High temperature.
8. Contractor shall provide earthquake early warning and detection system sensors which shall be located at all TPSS sites throughout the Network.
9. For all sensors, an authorized operator shall have remote access to the sensors, and their systems, to retrieve data regarding activations and to interrogate system health.
10. The System shall maintain continuous communication with sensors to monitor their availability and provide an alarm in the event on non-availability.
11. Contractor shall undertake a structured HAZID process to identify any hazards not mitigated by the System. The Contractor shall prepare a Hazard Detection and Response Analysis Report (HDRAR) and submit for Review as stated in Section 3.2, that includes:
    a. Each type of hazard to be detected, detection ranges and associated levels of alarms;
    b. Hazard detection (including data sources or sensor types and applicable thresholds);

c. Proposed locations and distribution plan for sensors;

d. System responses to each hazard including interventions to operations and alarms including whom and where they shall be routed;

e. Predicted effectiveness of hazard detections and responses;

f. Identification, analysis and sufficient mitigation of environmental hazard risks;

g. Established operational procedures for each type of hazard, for the on-board crew, operational staff at every facility (e.g. OCC, stations, maintenance facilities, sidings) and track maintainers; and

h. Analysis of initial and residual risk for every hazard mitigation.

12. Contractor shall be responsible for providing mitigations to risks identified in the HDRAR so that risks are mitigated to a tolerable level and achieve the Contract Requirements.

13. The HDEWS shall generate, distribute and direct alarms and notifications to warn appropriate systems, people and parties, as identified in the HDRAR Report and the Contractors Alarm Management Plan.

14. The HDEWS shall provide users the ability to acknowledge, silence, reset and cancel alarms. The alarms and operator actions shall be recorded.

15. The HDEWS shall have the ability to communicate/exchange and integrate relevant hazard detection and prediction information with/from external entities available (e.g., meteorological and geological data services, USGS, other railroads, UC Berkeley, CalOES, ShakeAlert, etc.).

16. The HDEWS alarms shall be routed through the Integrated Information Management Platform (Section 9.6.8).

7.8 Right-of-Way Safety and Security

1. From handover of the Civil Works or any other asset from the Authority to the Contractor for the Service Period, the Contractor shall ensure the entire boundary of the Right-of-Way, is secure to prevent access by all unauthorized persons, vehicles or animals.

2. Contractor shall provide Right-of-Way security fencing as defined in the Base Design.

3. From the start of the Construction Phase and for the Service Period, authorized access to the Right-of-Way shall only be permitted via an access control system.

4. Prior to handover of the Civil Works to the Contractor, the Contractor shall coordinate activities with the contractor responsible for the site to gain access to undertake inspection, surveys and works.

5. Contractor shall accurately and contemporaneously detect, log and record the presence and location of all personnel, plant, materials and equipment that enter or exit the area within the boundary fence protecting the Right-of-Way, which shall be available to the Authority on request.

7.9 Alarm Management

1. Contractor shall submit for Review as stated in Section 3.2 an Alarms Management Plan.

2. The Rail Infrastructure System shall issue, distribute, and direct alarms and notifications as defined in the Contractor’s Alarms Management Plan.

3. The Rail Infrastructure System shall detect and display an alarm whenever an alarm condition or state occurs. Alarm conditions shall include, but not limited to, the following:

a. Failures with a potential to affect the safe operation of the System;

b. Any failure, where a second failure in an associated system may cause a service interruption;

c. Un-commanded or unexpected changes of state of any monitored devices;

d. Loss of any communication channels;

e. Communication errors resulting in loss of data;

f. Predictive maintenance alarms; and

4. Alarms shall be integrated into the User Interface
5. Alarms shall be assigned to one of the following alarm priorities, but not limited to:
   a. Emergency;
   b. Urgent;
   c. Non-urgent; and
   d. Advisory/Notification.
6. Alarms shall be routed through the Integrated Information Management Platform to roles appropriate to manage the alarm, or Dispatchers as described in the Contractors Alarms Management Plan.

7.10 Grounding and Bonding

1. Contractor shall comply with EN50122 – Railway Applications – Fixed Installations – Electrical Safety, earthing and the return circuit.
2. Contractor, in undertaking the role of System Integrator as defined in Section 2.2, shall be the lead role in ensuring all elements of grounding and bonding are undertaken and integrated.
3. Contractor shall produce, and submit for Review as stated in Section 3.2, a Grounding and Bonding Plan that shall include:
   a. The Contractors work;
   b. The work of Interfacing Parties; and
   c. Any work associated with making neighbor systems and infrastructure safe and compatible with the Rail Infrastructure System.
4. Contractor shall provide the necessary grounding and bonding for the Rail Infrastructure System and assets within the Geographical Limits.
5. Grounding and bonding of Civil Works, stations (excluding platforms and associated equipment), Rolling Stock maintenance facilities, and adjacent railroads will be undertaken by Interfacing Parties. However, as System Integrator, the Contractor shall take the lead role in integrating the design and provision of grounding and bonding where this interfaces with the Rail Infrastructure System.
6. Contractor shall utilize ground rods and grounding plates where suitable, as provided by the Interfacing Parties within the Civil Works as detailed on typical section drawings included within the Base Design.
7. Electronic equipment shall be grounded and bonded to comply with the requirements of IEEE 1100-2005 – IEE Recommended Practice for Powering and Grounding Electronic Equipment.

7.11 Electromagnetic Compatibility

1. Contractor, in undertaking the role of System Integrator as defined in Section 2.2, shall be the lead role in ensuring all elements of Electromagnetic Compatibility are undertaken and integrated.
2. Contractor shall ensure that the combined characteristics of the Rail Infrastructure System, the received Civil Works, the Rolling Stock, and other Authority equipment achieve Electromagnetic Compatibility.
3. Contractor shall ensure that the combined characteristics of the Rail Infrastructure System and other Authority assets are Electromagnetically Compatible with equipment and facilities adjacent to Authority property.
4. Contractor shall comply with the requirements for Electromagnetic Compatibility and Interference as defined in Appendix 3 of this document.

7.12 Continuous Improvement

1. Contractor shall produce a report which identifies areas where there could be improvements to the Rail Infrastructure System beyond the Contract Requirements.
2. Contractor shall benchmark against international best practice to compare California High-Speed Rail performance and methodologies. The Contractor shall produce a Continuous Improvement Report that shall be submitted annually for Review.

8 CIVIL WORKS

8.1 Received Civil Works

Details of the Civils provided by the CPs is shown in the Base Design.

1. Contractor shall be responsible for operation, maintenance and inspection of the Civil Works provided by the Interfacing Parties.

8.1.1 Base Design

The Base Design consists of the anticipated completed Civil Works delivered by Interfacing Parties CP 1, CP 2-3 and CP 4 and future contracts. The Base Design is included in Part B-2 of this Contract.

1. Contractor shall design and construct the Rail Infrastructure System compatible with the Base Design.
2. The Rail Infrastructure System shall be designed, constructed and installed within the limits of the Civil Works and Right-of-Way that the Contractor will receive from the Authority as per the Base Design.
3. Contractor shall produce a report that details their analysis of any omissions, errors, variances or quality deficiencies within the Base Design against the Civil Works as provided. The Civils Infrastructure / Base Design Variance Report shall be submitted for Review as stated in Section 3.2.
4. Contractor shall be responsible for designing the Rail Infrastructure System without exceeding the capacity of the Base Design under any conditions.
5. Contractor shall be responsible for implementing any additional requirements or alterations to the Civil Works that are required to deliver the Contract Requirements.
6. Contractor shall be responsible for implementing any additional requirements or alterations to any structure or environmental feature required to deliver the Contract Requirements.
7. Contractor shall maintain the Civil Works from handover from the Authority to the end of the Service Period.

8.1.2 Bridge Safety Management Program

1. Contractor shall take over from the CP contractors and/or develop and implement a Bridge Safety Management Program as defined in 49 CFR Chapter II, Federal Railroad Administration, Department of Transportation, Part 237 – Bridge Safety Standards,
2. The Bridge Safety Management Program shall include all elevated trackways, culvert and wildlife crossings supporting the high-speed rail Track System.
3. The Bridge Safety Management Program shall include normally scheduled condition inspections and emergency condition inspection (such as post threshold earthquake events).

8.2 Civil Works– Sealed Design

The Authority has entered into Civil design contracts with Interfacing Parties. The Civil design contractors will deliver design for certain key elements.

1. The Authority will provide Professional Engineer of Record sealed design to the Contractor.
2. For the sealed design, the Contractor shall be responsible for the surveying, confirming suitability / applicability of design, completing / modifying designs, construction, operation, maintenance, inspection, renewal and overhaul to achieve the Contract Requirement.
3. The PE sealed design provided by the Authority may include:
    a. Acoustic mitigation / noise barriers;
    b. Light pollution mitigations;
    c. Drainage;

d. Mechanical and Electrical systems;

e. Road and Rail vehicle incursion barriers; and

f. Intrusion barriers and fences.

8.3 Rail Infrastructure System Civils

8.3.1 Rail Infrastructure System civil works

1. The Rail Infrastructure System civil works to be undertaken by the Contractor shall be all Rail Infrastructure System civil works required to provide, maintain and operate the Rail Infrastructure System to meet the Contract Requirements.
2. All Rail Infrastructure System civil works provided by the Contractor shall be undertaken to achieve the Contract Requirements.
3. Contractor shall be responsible for ensuring that all Rail Infrastructure System civil works achieves the requirements of its intended purpose as part of the Rail Infrastructure System and that it complies with all relevant requirements, codes, regulations and laws.
4. All Rail Infrastructure System civil works shall be recorded in the Asset Management tool.
5. Contractor shall be responsible for the inspection, operation, maintenance, overhaul and renewal of Rail Infrastructure System civil works assets and the associated updates to the Asset Management tool data.

8.3.2 Cable Trough

1. Contractor shall design the cable routes so that there is capacity to carry all Rail Infrastructure System cable requirements, and any Authority directed use, for the Contract Duration.
2. Contractor shall design the cable route so that any separation of cables required shall be achieved, as required by the cable function, so that the Contract Requirements are achieved.
3. All cable route shall have at least two diverse physical routes connecting to the Rail Infrastructure System facilities.
4. Contractor shall design and construct Cable Trough in accordance with the requirements for Cable Trough.
5. Contractor shall carry out a risk assessment that details how cable route diversity shall be achieved using the proposed number of cable routes into and between each Rail Infrastructure System facility.

8.3.2.1 Embedded Conduit - PVC pipes in underground guideway

1. Contractor shall design and construct embedded conduits as required to achieve the Contract Requirements.

8.3.2.2 At-Grade Guideways

1. Contractor shall design and construct accessible cable trough along and outside each Mainline Track, adjacent to and outside of permanent drainage.
2. Cable trough may be an integral part of an emergency walkway if designed and constructed to requirements.
3. The cable trough shall be constructed to allow effective drainage.
4. The cable trough, including lid, shall be capable of supporting an emergency walkway and anticipated maintenance workloads.

8.3.2.3 Aerial Guideways

1. Contractor shall design and construct accessible cable trough to form an integral emergency walkway using the space between available guideway parapet wall and trackside derailment wall.

2. The cable trough, including lid, shall be capable of supporting an emergency walkway and anticipated maintenance workloads.
3. The cable trough shall be constructed to allow effective drainage.

8.3.2.4 Underground Guideways

1. Contractor shall design and construct accessible cable trough along and outside each mainline track.
2. The cable trough, including lid, shall be capable of supporting emergency walkway and anticipated maintenance workloads.
3. The cable trough shall be constructed to allow effective drainage.

8.3.2.5 Cable Route Tie-Ins

1. Contractor shall design and construct all cable trough transitions, cable trough from manhole to systems sites, cable troughing and protection for all tail cables.

8.3.3 Fences and Gates

1. Contractor shall design and install access deterring and/or access restriction fences and gates, including grounding and bonding:
    a. along the Right-of-Way;
    b. at emergency exit staircases;
    c. at Rail Infrastructure System facilities;
    d. at Maintenance of Way sites;
    e. at tunnel portal sites;
    f. at tunnel ventilation shaft building sites; and
    g. At other locations as required.

8.3.4 Stations

1. Contractor shall design and construct all passenger station platforms, canopies and supporting walls for those stations listed in 6.2.3 Stations.
2. The station platform shall be required to support structures and other vertical circulation equipment.
3. Contractor shall design and provide platforms that include the following:
    a. Pedestrian bridges;
    b. Elevator pits;
    c. Elevators;
    d. Escalator landings;
    e. Escalators; and
    f. All services and utilities required for the above.
4. All facilities and equipment on Station Platforms provided by the Contractor shall be fully compliant with the requirements of the Americans with Disabilities Act.
5. Where the main station building will not be provided prior to the operation of the platform, the Contractor shall provide safe, accessible and compliant means of access and egress for passengers.
6. Where a sealed PE design is provided it shall be implemented by the Contractor.

8.3.5 OCS Support System

8.3.5.1 At-Grade Guideway

1. Contractor shall design and construct OCS pole support foundation.

8.3.5.2 Aerial Guideway

1. Contractor shall verify available preset pole support structural capacity per OCS design requirements.
2. Contractor shall remove protective cap and clean inserts, if necessary, to receive OCS pole foundation anchoring assembly.

8.3.5.3 Underground Guideway with Secant Pile Wall (Fresno Trench)

1. Contractor may opt to design and construct the OCS assembly to attach to the wall using the attachment points provided, the Contractor shall verify the capacity of attachment points before use.
2. Contractor may opt to design and construct the anchor for the OCS pole in the invert slab, the Contractor shall first verify the capacity of the invert slab and support wall and the concrete rebar location.

8.3.5.4 Underground Guideway (Cut and Cover)

1. Contractor shall verify the concrete rebar location on side walls and ceiling soffits.
2. Contractor shall design and construct OCS support connection and provide any work required to complete OCS assembly connection.

8.3.5.5 Underground Guideway (Tunnels) with Precast Lining

1. Contractor shall verify available preset OCS connection capacity per OCS design requirements, remove protective cap and clean inserts, if necessary, to receive OCS assembly and provide any other work required to complete OCS assembly connection.
2. Where OCS fixings have not been provided, the Contractor shall design and construct OCS support connection and provide any work required to complete OCS assembly connection.

8.3.6 Track Bed

8.3.6.1 At-Grade Guideway including cut and fill

1. Contractor shall remove protective layer; re-grade to design elevations as required, particularly in areas where ground condition is being monitored; re-compact subgrade prior to sub-ballast or direct fixation sub-layer installation and design and construct track bed to requirements.

8.3.6.2 Aerial Guideway

1. Contractor shall verify concrete rebar location on deck slabs where non-ballasted tracks are required and coordinate work with the trackway, drainage and bonding requirements in accordance with track types.
2. Contractor shall design and construct track bed to requirements.

8.3.6.3 Underground Guideway: Trench and Cut-and-Cover Tunnels

1. Contractor shall verify concrete rebar location on invert slabs to facilitate non-ballasted track construction.
2. Contractor shall place second pour concrete on invert slab and coordinate associated track form work with the trackway, drainage, bonding and emergency walkway/cable trough requirements.
3. Contractor shall complete track bed design and construction to requirements.

8.3.6.4 Underground Guideway: Bored/Mined Tunnels

1. Contractor shall place second pour concrete on invert slab and coordinate work with the trackway, drainage, bonding and emergency walkway / cable trough requirements.

8.3.7 Tunnels

8.3.7.1 Civils Works in Tunnels

1. Contractor shall provide Civil Works in tunnels to achieve the Contract Requirements.
2. Contractor work in tunnels shall include:
    a. Independent track slab;
    b. Walkways and safety handrails;
    c. All cable trough, embedded conduits and other cable retention devices;
    d. Tunnel drainage;
    e. All lighting;
    f. Fire doors and walls;
    g. Ventilation buildings;
    h. Train evacuation and control zone;
    i. Emergency command post and rescue/passenger assembly area;
    j. All tunnel signage;
    k. Site drainage;
    l. Water tank and water supply facilities;
    m. Sound walls;
    n. Access restriction fencing;
    o. Access control system; and
    p. Fixings for all Rail Infrastructure System equipment located within tunnels.

8.3.7.2 Tunnel Cross Passage: Fire Doors, Separation Walls, Vent Louvers, ADA Refuge Spaces

1. Contractor shall design and construct civils works within available tunnel cross passages as needed for the Contractor's systems design and construction.
2. Contractor shall install fire doors and separation walls at every interface point with emergency walkways.
3. Contractor shall place second pour concrete on invert slab and coordinate work with trackway drainage requirements and emergency walkway / cable trough requirements.

8.3.7.3 Tunnel Ventilation

1. Contractor shall provide all ventilation requirements

8.3.7.4 Underground Paralleling Stations

Space within tunnels will be provided for the provision of Underground Paralleling Stations by others.

1. Contractor shall provide details to the Authority for the location, spatial capacity and access requirements for underground paralleling stations within tunnels.
2. Contractor shall provide any additional fire doors and protection as required.

3. Contractor shall design and construct second pour concrete, separation walls and conduits.

8.3.7.5 Tunnel Portal Facilities

1. Contractor shall provide all Rail Infrastructure Systems works including:
    a. Drainage;
    b. Rescue assembly areas;
    c. Tunnel firefighting water reservoir and waste treatment facilities;
    d. Cable conduits; and
    e. Tunnel mechanical and electrical equipment in accordance with Authority provided sealed design.
2. Portal hood structures, provided to mitigate aerodynamic and acoustic impacts around tunnel portals, will be provided by others.

8.3.8 Duct Banks

1. Contractor shall provide all duct banks where required by the Rail Infrastructure System, including connection to manholes and cable troughs, but excluding those provided by the Interfacing Parties as detailed in the Base Design.
2. Any duct banks or buried duct banks provided by Interfacing Parties shall be tied into the Contractors system by the Contractor.
3. Any duct banks or buried duct banks provided by the Authority that are not required by the contractor shall be managed to prevent future performance impacts (maintenance or removal/backfilling).

9 RAIL INFRASTRUCTURE SYSTEM SCOPE AND TECHNICAL SPECIFICATION

This section details the Contractors scope and specifies the minimum technical requirements that the Rail Infrastructure System and each component system, subsystem or element shall comply with.

9.1 Track System

The Track System is the support and guidance system on which the Rolling Stock will run.

1. The Track System shall be from the top of the prepared sub-grade, top of structural concrete for aerial structures or top of base slab for trenches and tunnels to the top of rail.
2. The extent of the Track System shall be as follows:
    a. Mainline Tracks;
    b. Station Tracks;
    c. Refuge Tracks;
    d. Special Trackwork;
    e. Maintenance of Way Facilities;
    f. Maintenance of Way Sidings;
    g. Transfer Tracks;
    h. Passing Tracks;
    i. Connections from freight railroad to Maintenance Facilities (clear of the foul point); and
    j. Derailment Protection.

The Track System excludes track within Rolling Stock Maintenance Facilities beyond the Transfer Point on the Transfer Tracks.

3. Contractor shall provide and maintain the Track System.
4. Contractor shall design the Track System in line with EN standards and the requirements of this Technical Specification, in accordance with the Base Design.
5. Contractor shall maintain the Track System up to an agreed point on the Transfer Track between the Mainline Tracks and the Third-Party Track to allow the interface between the Mainline Tracks and the Third-Party Track to be maintained to the required standards.
6. Contractor shall define track characteristics to accommodate ATC and Traction Electrification System requirements as necessary.
7. The Track System shall incorporate assets and materials designed to accommodate a maximum prescribed axle load of 17 metric tons at the Design Speed.
8. Where the Contractors provides Railway Equipment that exceeds the maximum prescribed axle load, the Contractor shall carry out a risk assessment to define how the Railway Equipment shall be operated so as to not impact the safety and availability of the System.
9. The Track System shall incorporate assets designed to accommodate Railway Equipment for infrastructure operations and maintenance. These loads shall be determined by the Contractor.
10. Contractor shall produce a Track Class Selection Report that describes the appropriate Track Class for the design, installation and maintenance of the Track System appropriate for the local alignment to achieve the Contract Requirements and submit for Review as stated in Section 3.2. This report shall include:
    a. The installation and maintenance dimensions and tolerances for all track components;
    b. Maintenance intervention limits for the agreed Track Class.

11. The Track System shall be designed, installed and maintained to the approved Track Class.
12. The Track System shall be maintained in accordance with the Asset Management Policy.
13. The Track System shall be provided so that Reliability Centered Maintenance techniques and tools can be used as described in Section 17.3.
14. The Track System shall be designed and constructed in the limits of the Civil Works that the Contractor will receive from the Authority. The track geometry may be adapted within these limits to achieve the Contract Requirements.

9.1.1 Track System Safety Requirements

1. Contractor shall provide a risk assessment that identifies risks associated with rail vehicle operation on the Track System. The output of the risk assessment shall be mitigations for identified risks such as the risk of derailment.
2. Mitigations identified in the risk assessment shall become Contract Requirements.
3. Contractor shall provide passing clearances between trains and structures in accordance with the requirements for Trackway Clearances as defined in the Base Design.

9.1.2 Track System General Requirements

1. Contractor shall provide a Track System that meets the following design requirements and constraints:
    a. The track gauge shall be Standard Gauge;
    b. The track horizontal alignment shall meet the requirements of UIC code 703R and EN 13803 with a maximum value of non-compensated transverse acceleration in the track plane (a_q) of 0.5 m/s^2 and a maximum quasi-static lateral acceleration (a_i) considered acceptable not to be outside the 1.0 to 1.5m/s^2 range;
    c. A maximum superelevation of 150 mm (nominally 6 inches) with a maximum unbalanced superelevation of 75 mm (nominally 3 inches);
    d. The design speed for a curve shall be the same throughout the entire length of the curve between tangent points;
    e. Maximum vertical acceleration of 0.27m/s^2 (0.9 ft/s^2) due to the effect of vertical curvature;
    f. Vertical curves shall not overlap horizontal transitions;
    g. The length of a vertical curve and the length between two vertical curves shall not be less than Lm = V/2.5, where Lm = minimum length of curve in meters and V is velocity in mph. The minimum length of curve shall be 100 m (nominally 328 ft);
    h. The speed of turnouts on the through Mainline Tracks shall be at least 129 km/h (80 mph). High-speed turnouts and crossovers shall only be installed on tangent track sections and on constant gradients;
    i. Turnouts connecting the Station Track with the Mainline Track shall permit an operating speed of 96km/h (60 mph) or faster;
    j. Contractor shall not use adjustment switches due to difficulties with their maintenance. The Contractor shall provide solutions for the management of rail movement caused by changes in stress and thermal variance in the rail while optimizing safety in the operation of the railway;
    k. Universal crossovers between Mainline Tracks shall be located no farther than one mile from the Station Track entry and exit turnouts at each end of the Station Tracks.
    l. Universal crossovers shall be capable of handling diverging moves at speeds of 129 km/h (80 mph);

m. Crossovers shall be located on the Mainline Tracks no farther than 0.8 km (0.5 mile) from the Mainline Track turnouts at each end of the MOWF or MOWS;

n. Switch plates in turnouts shall be non-lubricated and shall enable friction free movement of the switch blade;

o. Turnouts shall be located so that the point of switch on one end of the turnout and/or the point of frog on the other end is/are a minimum of 50 m (150 ft) from any grade separated structure passing over the high-speed rail tracks; and

p. Bumping posts shall be installed at the end of track carrying revenue trains and end of track in yards and shops and at the end of refuge tracks.

9.1.3 Track System Performance Requirements

1. The Track System shall achieve an availability of 99.994% of Revenue Service Hours per annum. Availability in the context of this requirement means, the ability to operate a train over the Track System at the Operating Speed.
2. Where ballasted track is used, the Track System shall be designed to achieve a resultant track modulus with concrete ties located on earthworks within a range of 27.6 to 41.4 MPa (4000 to 6000 lb/in^2).
3. The transition from track modulus of direct-fixation track, ballasted decks or open deck bridges to ballasted track on earthworks shall be accommodated by a smooth transition. The maximum differential settlement shall be not greater than 3 mm (⅛-inch) on non-ballasted track or 5 mm (¼-inch) on ballasted track over a 20 m length.
4. Contractor shall carry out a design risk assessment for areas where there is a transition between trackforms. The risk assessment shall identify mitigations for the risks associated with the transition.
5. All mitigations from the risk assessment shall become Contract Requirements.
6. Homogeneity in track type is recommended. Frequent changes in trackform shall be avoided. The continuous minimum length of any trackform shall not be less than the minimum length of alignment segment for a run time of 1.8 seconds at the design speed of the segment.
7. Where non-ballasted track is proposed, the Contractor shall take account of the requirement to minimize noise and vibration with consideration given to the following:
   a. Wheel-rail interface and corrugation development (see Section 9.1.4.1);
   b. Minimization of rail roughness and noise and vibration levels;
   c. Accessibility to and inspection/maintenance of track components including resilient elements;
   d. The transition between ballasted and non-ballasted track forms; and
   e. Optimization of track noise and vibration isolation design to ensure compatibility with the Rolling Stock proposed to operate on the System.

9.1.4 Track System Interface Requirements

1. The Track System interface items below shall undergo interface hazard analysis to determine the impact of Track System assets and components in relation to the overall System operation.
2. Contractor shall detail clear boundaries between interfaces and limits of control, responsibility and accountability for each discipline and align to asset class:
   a. Structures and earthworks;
   b. Drainage and formation;
   c. Wheel rail interface;
   d. Rolling Stock; and

e. Transfer Tracks.

3. Non-ballasted track shall be used in station areas.
4. In addition, non-ballasted track shall be used for all tracks adjacent to and for a minimum distance of 23 m (75 ft) beyond the end of station platforms.
5. Where platforms are located adjacent to special trackwork (turnouts and crossovers) the non-ballasted track form shall be extended to include the special trackwork.

9.1.4.1 Wheel Rail Interface

1. As System Integrator, the Contractor shall be responsible for agreeing the wheel/rail interface criteria (rail profile, back-to-back dimensions etc.) with the Rolling Stock supplier to provide smooth and safe movement of the Rolling Stock at all specified speeds and track conditions.
2. Equivalent conicity shall be 0.10 in accordance with TSI standards.
3. The design of the rail head profile and rail inclination shall be selected by the Contractor and matched with the track gauge to ensure that the equivalent conicity value is not exceeded.
4. Contactor shall be responsible for the management of fatigue and defect propagation within the Track System.

9.1.5 Track System Components Requirements

9.1.5.1 Rails

1. The selection of rail section and steel grade to be used for high-speed track installation shall be determined from assessment of the axle load in order to provide a rail with acceptable beam strength to support the load on standard ties at the appropriate spacing and a reliability in accordance with the Contract Requirements.
2. Rail shall be continuously welded and shall have a minimum weight of 60 kg/m (nominally 121 lb/yd).
3. Rails shall be installed so as to be free of longitudinal stress.
4. Rails shall be certified as required by the Contractor's Design Standards. as stated in Section **Error! Reference source not found.**.

9.1.5.2 Ties (where used)

1. Ties shall be of concrete with a minimum mass of 220 Kgs (nominally 485 lbs) and minimum length of 2.25 m (nominally 7.38 ft).
2. Hardness of concrete shall be compatible with hardness of the support to avoid attrition of ties.
3. Ties shall be certified as required by the Contractors Design Standards.

9.1.5.3 Fastening System

1. Contractor shall certify conformity of the fastening system with EN 13481 and EN with a minimum toe load of 9 kN (2023 lb) per fastening

9.1.5.4 Turnouts and Other Special Trackwork Components

1. Switch rails shall be asymmetric with forged transitions.
2. Movable point frogs, also called swing nose frogs or swing nose crossings, shall be used in turnouts where the design speed of either track is above 100 km/h (60 mph).
3. Movable point frogs shall be equipped with anti-lifting devices and the design of the switches shall be compatible with the use of eddy current braking.

9.1.5.5 Ballast

1. Where ballasted track is used:

a. Ballast shall be certified as required by the Contractors Design Standard;

b. The ballast shall meet the requirements of EN 13450;

c. As a minimum, ballast shall be crushed igneous rock; and

d. Contractor shall state the minimum ballast thickness in the Contractors Design Standard.

9.1.5.6 Special Considerations in Seismically Active and other Unstable Areas

1. Contractor shall undertake an assessment of track-structure interaction, with particular attention paid to seismically active and unstable areas, and the interface between the rail and the structure.
2. The rails and fastening system shall be modeled to consider fastener slippage and rail stiffness with the requirements for fastener non-linear longitudinal restraint, transverse stiffness, and uplift capacity accounted for in the analysis.
3. In areas subject to ground movement from seismic activity, the non-ballasted trackform shall be designed to accommodate potential movements. The dynamic requirements of each rail fastener/clip in its final assembly position shall be that the maximum deflection shall be 3 mm (⅛ inch).
4. For non-ballasted track, the design shall accommodate the following “maximum movement” and “design movement” due to construction, expansion, and earthquake loading:
    a. Lateral Horizontal: 6mm (¼ inch) max / 4 mm (⅛ inch) design;
    b. Vertical absolute: 10mm (½ inch) max / 8mm (3/8 inch) design;
    c. Longitudinal: 20mm max (3/4 inch / 18mm (11/16 inch) design; and
    d. Angular displacement: 1 in 1000 max .
5. Contractor shall allow for movement of ±50 mm (2 inches) on elevated structures, tunnels and earthworks.

9.1.5.7 Guard Rails

1. The Contractor shall carry out a Guard Rail Risk Assessment to determine the location and extent of guard rail installation. The Contractor shall provide a report for Review as stated in Section 3.2.
2. Guard rails shall be installed where determined by Contractor risk assessment.

9.1.5.8 Rail Welding

1. The number of welds shall be limited to:
    a. An average of 4.4 per km and per stretches in average on 100 km length of track; and
    b. Maximum of six welds per km and per stretches.

9.2 Traction Electrification System

The Traction Electrification System (TES) comprises:

a. Traction Power Supply System (TPSS);

b. Overhead Contact System (OCS);

c. Traction Power Return System (TPRS); and

d. All associated subsystems, including:

i. TPSS Supervisory Control and Data Acquisition (SCADA) system; and

ii. Any TES-derived low voltage power supplies for the Rail Infrastructure System, excluding any requirements for low voltage supplies in tunnels, stations, depots and other non-critical systems.

9.2.1 Traction Electrification System General Requirements

1. Contractor shall provide, operate and maintain a complete Traction Electrification System on all Mainline Tracks, Station Tracks, Refuge Tracks, Transfer Tracks up to the Transfer Point, special trackwork, infrastructure maintenance facilities and sidings, but excluding track within Rolling Stock maintenance facilities beyond the Transfer Point.
2. Contractor shall provide all inboard infrastructure from the point of common coupling and facilitate the interconnections. The high voltage utilities connections are excluded as detailed in Section 19.5.
3. Contractor shall identify all failure modes to the train operations and any resulting operational constraints under degraded operations, and the recovery steps from degraded to normal operation.
4. Contractor shall lead the integration between the Caltrain network and Rolling Stock facilities to provide the safe operation of any interconnection of the TES and SCADA control system.
5. Contractor shall provide a Relay Protection Scheme which coordinates between Pacific Gas & Electric (PG&E), TES, Rolling Stock, Rolling Stock Maintenance Facilities and any other electrified sidings and facilities, and shall submit for Review and PG&E agreement as stated in Section 3.2.
6. Contractor shall lead and coordinate with the Rolling Stock supplier to ensure that the harmonic distortion limits of voltage and current at the point of common coupling with the power supply utility network (PG&E) are in accordance with IEEE Standard 519: 2014 and the Energy TSI.
7. Contractor shall integrate with the Rolling Stock supplier to ensure:
    a. Rolling Stock power demand modelling is compatible with the TES and meets the Contract Requirements; and
    b. The dynamic performance of the OCS/pantograph interface is compliant with the Energy TSI.
8. The TES will connect to the PG&E network (at the point of common coupling) at locations as defined in the Base Design.
9. Contractor shall be responsible for the coordination with the Authority and PG&E for all connection and verification and validation requirements and document these within the Systems Validation Plan.
10. Contractor shall provide a minimum of 600 mm (nominally 24 inches) electrical clearances from all energized OCS conductors to any grounded element.
11. Contractor shall provide metering equipment that conforms to the requirements of PG&E on the primary side of the high voltage transformers, AT, and on each individual catenary and NF circuit.

9.2.2 Traction Electrification System Safety Requirements

1. The TES shall comply with the safety requirements of EN 50122-1:2011 and IEEE80.

9.2.3 Traction Electrification System Performance Requirements

1. The TES shall enable the Rolling Stock to achieve the Operating Speed and Headways under normal and single electrical contingency conditions, with or without regenerative braking being utilized, in accordance with the Operational Plan and degraded modes of operation.
2. The TES shall be a 2x25 kV, 60 Hz, AC autotransformer system with a short circuit fault current of 15 kA.
3. The TES shall not damage the integrity of the Rail Infrastructure System or Rolling Stock under fault conditions.

9.2.4 Traction Electrification System Operational Requirements

1. Contractor shall provide, operate and maintain a TES SCADA system that shall deliver all necessary control, alarms, alarm management and display information required to operate the TES in accordance with the Contract Requirements.
2. The TES SCADA system shall be a safety critical system in accordance with EN50126.

3. For any OCS feed section, the TES shall enable full service operation under the following single electrical contingency conditions (failures / planned outages):
    a. Loss of any one incoming HV supply circuit;
    b. Loss of any one main transformer in a substation;
    c. Loss of any one autotransformer in a paralleling station/switching station; and
    d. Loss of any one negative feeder (NF).
4. For a double electrical contingency condition in any OCS feed section, the TES shall enable degraded service, to include as a minimum:
    a. The recovery of all Rolling Stock to destination stations.
    b. The movement of all Rolling Stock from the degraded OCS feed section within 30 minutes.
5. The TES shall be automatically reconfigurable to accommodate all scenarios above and Contract Requirements shall not be affected by the reconfiguration to accommodate the single contingency conditions identified.
6. Auto reclose shall only be allowed once after three seconds in the event of a single section tripping.
7. Information generated by the TES SCADA system may be routed through the Integrated Information Management Platform

9.2.5 Traction Electrification System Interface Requirements

1. The OCS shall be designed, installed and maintained to be compatible with the following adjacent OCS systems:
    a. Caltrain – the demarcation point between California High-Speed Rail and the Caltrain network to be identified by the Authority; and
    b. Rolling Stock Maintenance Facilities (HMF and LMFs) – the demarcation between the Mainline Tracks and the rolling Stock maintenance facilities will be the Transfer Point on the Transfer Track and is to be managed by the Contractor.
2. The TES shall be able to feed the HMF in situations where the dedicated independent HMF traction power supply is not available:
    a. This shall facilitate as a minimum the movement of Rolling Stock on and off the Network but not be required to back feed the Mainline Tracks from the HMF; and
    b. The Contractor shall identify what electrical loads can be supported in this scenario, and provide a HMF Contingency Power Supply Capability Report for Review as stated in Section 3.2.
3. The TES shall be interconnected with the Caltrain TES to provide a traction power supply between systems under double contingency conditions.

9.2.6 Traction Electrification System Technical Requirements

1. The TES system shall as a minimum comply with CPUC GO 176.
2. The TES system shall comply with the technical requirements of the current Energy TSI including the following European Standards:
    a. EN 50119;
    b. EN 50122-1:2011;
    c. EN 50149;
    d. EN 50163;
    e. EN 50206-1;
    f. EN 50317;

g. EN 50318;

h. EN 50367;

i. EN 50388;

j. EN 50463-5;

k. EN 50124-1;

l. EN 50124-2;

m. EN 50152; and

n. EN 50329.

3. The TES system shall comply with the following sections of these related TSIs:

   a. Locomotive and Passenger Stock TSI – Section 4.3.1;

   b. Command, Control and Signaling TSI – Section 4.3.4;

   c. Operation and Traffic Management TSI – Section 4.3.4; and

   d. Safety in Tunnels TSI – Section 4.2.2.

4. Contractor shall undertake modeling of the Traction Electrification System based on alignment, gradient, proposed rolling Stock and service patterns demonstrating that the Contract Requirements can be achieved within the constraints of the provided feeder locations.

9.2.7 Overhead Contact System Technical Requirements

1. The OCS shall meet the current collection criteria in accordance with the Energy TSI and EN 50367, including all discrete components.
2. To allow bi-directional working enabling trains to continue operation under emergency conditions and to facilitate routine maintenance of the Rail Infrastructure System, the OCS shall be divided into electrical sections and sub-sections.
3. To facilitate operations and maintenance activities, the OCS shall be equipped with non-load break motor operated disconnect switches at feeding points which can be operated both locally onsite and remotely through a SCADA system.
4. The switches shall be fitted with OCS voltage detection circuitry that will provide for remote monitoring of the system.
5. Motorized switches/isolators shall also be provided to facilitate standard maintenance activities.
6. Any electric trains shall pass through each phase break arrangement without establishing an electrical connection between the successive electrical sections which are fed from different phases. This shall be achieved at the Operating Speed with the train pantographs raised and in contact with overhead contact wire, but with the pantograph circuit breakers open.
7. Contractor shall submit their OCS Sectioning Design for Review as stated in Section 3.2, taking into account the requirements for isolation to facilitate operation and maintenance activities.
8. Back-to-back cantilevers, supported on single poles centered between tracks shall not be used on the Mainline Tracks.
9. The OCS shall be free running under all overhead structures.
10. In tunnels, the Contractor shall be required to provide all fixings for OCS to the tunnel lining.
11. The contact wire shall be installed and maintained at a nominal constant height of 5.3 meters (nominally 17 ft 5 inches) at the supports.

12. The design of the OCS phase breaks shall permit approved trains to move at all speeds up to the Operating Speed from one electrical section to an adjacent electrical section without bridging between two electrical phases or two separate utility supply systems.
13. The OCS shall not use section insulators on the mainline.
14. Contractor shall coordinate the sectioning of the power supply system in each tunnel with the pertinent agency that will be responsible for development of the Tunnel Emergency Evacuation Plan. The sectioning shall be designed to support the overall strategy for evacuation from the tunnel.
15. Headspan OCS shall not be permitted above the Mainline Tracks.
16. In general, OCS poles in station areas shall be located between mainline and station tracks. For situations where OCS poles must be located on station platforms, they shall be placed in a manner that minimizes the visual impact and obstruction to passengers, and shall be integrated with the platform architecture and design. The minimum distance from platform edge to face of poles shall be 2.13 meters (nominally 7 ft).
17. For OCS poles on aerial structures the Contractor shall refer to the Base Design for the embedded anchor bolt sleeve detail.
18. Unused sleeves/OCS bolts on aerial structures shall be filled/capped/removed by the Contractor once it has been determined that they are not required by any other discipline, to avoid a safety risk and to prevent deterioration of the integrity of the structure.
19. For OCS poles on retained fill, mechanically stabilized earth (MSE) wall structures, provisions will be made by the civils contractor for the future installation of the OCS foundations. The Contractor shall refer to the Base Design for construction and space allocation details.
20. In addition to the load conditions indicated in NESC, a 160 km/h (nominally 100 mph wind) plus 10 percent gust allowance shall be evaluated to prove no failure.
21. Contractor shall evaluate the local extreme climatic conditions and adjust the load combinations for worst case loads, including the effects of wind pressure on OCS poles due to slipstream effects.
22. All structures, poles, brackets, foundations and anchors shall:
    a. Handle construction loads imposed during erection and during catenary assembly and wire installation;
    b. Withstand a broken-wire failure, including breakage of both the static wire and parallel feeder conductor in any one span, without exhibiting major, catastrophic damage; and
    c. Support structures shall also handle loads due to breakage of other parts of the OCS.
23. The foundation and pole, or vertical members of the support structure, shall be designed to enable the pole to be raked during installation. This rake shall allow for the static dead loads that are imposed on the structure by the cantilevers, equipment and along-track conductors. Rake installation shall provide for a visually plumb and vertical pole after application of the full static loading. This position shall serve as the design reference datum for the calculation of the live-load operating deflection. All OCS alignment and wire layout designs shall utilize this static, plumb, dead load position as the true pole-face reference datum.
24. The OCS support locations shall be individually numbered for ease of identification on site.
25. Structure number plates shall be fitted to the structure at a height of 2 meters (nominally 6 ft 6 inches) above rail level. For supports located in tunnels, the number plate shall be attached to the wall using suitable fixings.
26. Poles shall be designed as free-standing structures, except for poles carrying wire terminations, which shall be down-guyed, typically in the ‘along track’ direction.

27. The lateral offset from centerline of tangent track to centerline of pole shall be nominally 3.25 meters (nominally 10 ft, 8 inches). Offsets shall be increased as needed to satisfy curved track situations and/or sighting requirements.
28. The OCS foundations shall be capable of meeting the structural loading requirements, and shall be designed for each individual location.

9.3 Communications Systems

The Communications Systems include:

- Communications network (which provides connectivity between systems that require it).
- Radio systems (for communications to the Rolling Stock and track workers on the Right-of-Way).
- Telephone and intercom systems (for operational voice, video and text-based communications).

Communications Systems carry voice and data for the operation of the Network. The Communication system also includes facilities and infrastructure to enable the provision of non-California High-Speed Rail data services along the Network.

The Communications Systems include management systems to facilitate operations, administration and maintenance functions for all systems functionality.

1. Contractor shall provide, operate and maintain the communications systems.
2. The architecture and design of the communications systems shall promote secure design consistency, uniformity of structure, network scalability and extensibility, fault resilience, network path diversity and cost-effective deployment of different types of communications equipment.
3. Contractor shall provide the communications between Rolling Stock and Rail Infrastructure for each Rolling Stock.
4. Contractor shall coordinate and integrate with the Rolling Stock supplier to agree the space requirements, location, power supply and interconnection details for all communications equipment it requires on the Rolling Stock.

9.3.1 Telephone and Intercom Systems

Telephone and Intercom Systems (TIS) are the electronic systems that support operational voice, video and messaging communications within the Network, which broadly fall under the following categories:

1. Operational communications – directly associated with the operation of the Rail Infrastructure System, trains and safe movement of passengers
2. Safety and security communications – associated with the safety and security of passengers, personnel and the System

9.3.1.1 Telephone and Intercom Systems General Requirements

1. TIS shall be provided for both operational personnel and for safety and security purposes.
2. TIS components shall communicate using the Internet Protocol.
3. The TIS shall be transported by California High-Speed Rail's Communications Network.
4. All in-use features of TIS shall be user configurable without restriction.
5. TIS shall provide geographic redundancy.
6. TIS audio communications shall be full-duplex.
7. The TIS shall be designed with the specific chain of custody demands in accordance with the requirements for System Safety and Security Management PLan

8. As a minimum, the system shall meet chain of custody requirements for both the State and federal requirements.
9. Stored TIS communications shall include a means of ensuring no tampering of each audio stream has taken place in a manner suitable for evidence in a court of law.
10. TIS communications shall be automatically timestamped, recorded and stored for a minimum of 90 days suitable for evidentiary purposes.
11. TIS shall provide authorized users with a means to play back previously recorded and stored TIS communications either local to the stored communications or remotely via a secure gateway.
12. TIS shall have direct dial access to and from the Public Switched Telephone Network (PSTN) for voice calls.
13. TIS shall support Direct Inward Dialing permitting the routing of incoming calls from an incoming PSTN trunk directly to the called party without attendant intervention.
14. TIS shall support Direct Outward Dialing allowing users, based on class of service, to obtain access to the PSTN without attendant assistance.
15. The capacity of the connection from the TIS to the PSTN and to other external systems shall be determined based on anticipated usage, both inbound and outbound, using standard traffic engineering principles. A TIS Capacity Report shall be submitted for Review as stated in Section 3.2.
16. Government Emergency Telecommunications Service access shall be provided via the TIS.
17. 911 calls originating from the TIS shall automatically be routed to the appropriate Public Safety Answering Point and shall automatically transmit the caller's phone number and location information.
18. TIS shall support the prioritization of incoming and outgoing numbers so that lower-priority calls that are offered, or are in progress, do not impede higher-priority calls.
19. TIS shall support direct connections via open standard interfaces to the phone systems of external organizations.
20. TIS shall support open protocols for all signaling and data transmission.
21. TIS audio quality of live calls and recorded calls that are replayed shall have a Mean Opinion Score (MOS) of 3.9 or greater as defined in ITU-T Recommendation P.800.
22. TIS shall not block or drop calls under normal TIS system and communications network conditions.
23. TIS shall present dial tone, where dial tone is to be presented, within two seconds.
24. TIS shall signal internal calls within five seconds of dialing/auto-dialing.
25. TIS system shall include the hardware, software and licensing for the complete Phase 1 system with 25 percent additional capacity for endpoints of all types being used.
26. The TIS shall comprise system management functionality that includes the self-diagnosis and notification of faults, errors and performance problems.
27. The TIS management system shall provide a freely-configurable 'northbound interface,' which shall pass selected alarms in an open, non-proprietary, and documented data format to other alarm management systems as may be required by other Rail Infrastructure System requirements.

9.3.1.2 Operational Communications: Auto-Dial System

Auto-dial endpoints, also known as blue light stations, are endpoints which, upon activation, are automatically directed to one or more appropriate workstation phone consoles at the OCC.

Auto-dial endpoints are typically located along the Right-of-Way and provide direct communications to and from the relevant train dispatcher at the OCC for an adjacent section of track.

Auto-dial endpoints are used for operational and maintenance purposes as well as for emergency purposes.

Workstations at the OCC and elsewhere are to be provided with a phone console endpoint which can handle calls to and from multiple auto-dial endpoints. Depending on a login, the phone console assumes a particular workstation 'role' and handles calls to and from a particular set of the auto-dial endpoints. However, the arrangement may not necessarily be a one-to-many arrangement because auto-dial endpoints often need to be handled by more than one phone console role (for example, there may be different roles for dayshifts and nightshifts). Phone console roles have access to and from the manual-dial operational communications systems and the PSTN.

9.3.1.3 Auto Dial Endpoints

1. The operational communications system shall provide working and tested auto-dial endpoints, which upon activation (e.g. lifting a handset) are automatically directed to one or more appropriate endpoints, often a phone console endpoint which is configured for a particular workstation role – see "Phone Console Endpoints" description below (Section 9.3.1.5).
2. Calls to auto-dial endpoints shall only be permitted from the appropriate workstation role(s).
3. Auto-dial endpoint locations shall be marked by a blue light above the endpoint device.
4. Auto-dial endpoints shall be vandal resistant and weather proof.
5. Auto-dial endpoints shall be available for use, as required, without the need for access keys.
6. Signage shall be provided every 10 meters in tunnels to indicate the distance to the location of the nearest auto-dial endpoint blue light station in each direction.
7. Auto-dial endpoints shall, at a minimum, be provided:
    a. At each radio tower and communications facilities;
    b. On both sides of the track at every tunnel portal;
    c. In every tunnel cross-passageway;
    d. At emergency access points and emergency egress locations;
    e. In safety refuges;
    f. On station platforms at the middle and ends of the length of each station platform;
    g. At traction power substations;
    h. Within every station control room or other station operations room; and
    i. Within all elevators.
8. The location and operational use of all auto-dial endpoint telephones shall be assessed to ensure that, once installed, any users shall not be exposed to any safety risks because of using the auto-dial endpoint telephone.
9. Endpoints shall be able to function normally even when the power and/or communications links are severed in one direction.
10. Auto-dial endpoints shall perform a remote audio path (i.e. earpiece to mouthpiece) self-test at least once per day.
11. Every auto-dial endpoint shall always report faults to and be remotely monitored by the (Communications) Network Operations Center.

9.3.1.4 Public use Auto Dial Endpoints – Help Points

1. Auto dial end points, sometimes known as "help points", shall be provided for passenger use on all platforms and shall connect the caller to an appropriate member of staff at the OCC or station control room.

2. The location and operational use of all auto-dial endpoint telephones shall be assessed to ensure that, once installed, any users shall not be exposed to any safety risks as a result of using the auto-dial endpoint telephone.

9.3.1.5 Phone Console Endpoints

1. Workstations at the OCC and elsewhere shall be provided with a phone console endpoint for the primary purpose of receiving calls from the auto-dial endpoints.
2. It shall be possible to use a phone console endpoint to make or receive calls at any location that is designated as a location to operate the Rail Infrastructure System.
3. The following phone console variants shall exist which have identical functionality and graphical user interface (GUI):
    a. Standalone, desk-mounted;
    b. Standalone, wall-mounted; and
    c. Integrated into the Universal Console.
4. Phone console endpoints shall:
    a. Have a uniform software build to be interchangeable with other phone consoles and spare phone consoles without any requirement for configuration so as to be rapidly replaceable in the event of failure; and
    b. Be configured for different workstation roles, which are accessible via separate logins.
5. Workstation roles shall:
    a. Have incoming access to a predetermined subset of endpoints and outgoing access to a predetermined subset of endpoints. Subsets may overlap;
    b. Allow calls to be made to endpoints by pressing a single ‘speed dial’ button. Multiple screens of buttons are acceptable;
    c. Allow calls to be received, indicated by the flashing of the appropriate speed dial button and an audible alert;
    d. Allow different audible alerts to be associated with different incoming calls to provide a means of alerting the operator to different priority calls;
    e. Have touchscreen speed dial buttons that are configurable;
    f. Have a touchscreen keypad to provide a means by which to dial numbers not configured as speed dial buttons; and
    g. Have access to endpoints within:
        i. The Public Switched Telephone Network;
        ii. The Operational Manual-Dial Communications system within Network; and
        iii. The phone systems of external organizations, where direct connections have been provided.

9.3.1.6 Operational Communications: Manual-Dial

The manual-dial endpoints used in operational communications provide modern private branch exchange functionality, as per the minimum set of features described below, allowing employees to conduct day-to-day operational functions.

1. Operational manual-dial communications endpoints shall be provided within all California High-Speed Rail facilities provided by the Contractor including buildings, stores, security offices, conference rooms and equipment shelters.

2. Operational Manual-Dial Communications shall be provided for all operational personnel and maintenance personnel.
3. Operational Manual-Dial Communications shall provide the following features:
    a. Automatic Redial – allows a previously busy or unanswered extension to be automatically redialed;
    b. Caller ID – permits a user to see who and where a call is from before it is answered;
    c. Dialed Number ID – permits a user to see who they have dialed, including a list of at least the last 10 previously dialed numbers;
    d. Call Forwarding All Calls - temporarily forwards calls to another extension or to an outside number;
    e. Follow-Me – a feature that allows calls to reach a user on a selected endpoint no matter where the user is currently located within the System;
    f. Call Waiting – this feature sends a distinctive tone to a user that is busy on a call that another incoming call waiting to be answered. The waiting call can be picked up and the existing call can be put on hold or completed;
    g. Conference – permits three or more parties to connect together, including the ability to spontaneously include another party in a call;
    h. Directory – allows the look up of a user by entering the letters of the person's name or role that has been stored in the systems directory database;
    i. Hold – puts a call on hold, allowing another call to be placed, a waiting call to be answered or another task to be completed;
    j. Redial – (Last Number Dialed) allows the manual redialing of the last extension or outside number; and
    k. Voicemail – allowing users to leave and retrieve audio messages, which shall include the following features:
        i. Ability to access voicemail via the internal user communications systems and from the PSTN;
        ii. Ability for the user to provide a greeting;
        iii. Ability for the caller to check and edit their message;
        iv. Message Check/Save/Skip/Delete capability;
        v. User access codes for security and privacy;
        vi. An indication that a message is waiting on the endpoint;
        vii. Time and Date Stamp provided with messages; and
        viii. Voicemail transcription to e-mail.
    l. Video-capable – All endpoints shall have the in-built facility to record and display video calls;
    m. Simultaneous ring selectable by either the end user or system administrator;
    n. Transfer – allows a call to be transferred to another extension or outside number;
    o. Call monitor – permits an authorized user to listen in to existing calls;
    p. Barge-In – permits an authorized user to join an existing call;
    q. Speed-dial – permits fast dialing of user-specified numbers;
    r. Hunt groups – permits incoming calls to be presented to multiple endpoints either simultaneously, randomly, to an idle endpoint or in a particular order;

s. Call Priority – alerts users about high-priority incoming calls;

t. Auto-dial endpoint – whereby activation of the endpoint (e.g. by lifting a handset) causes the dialing of a predetermined number; and

u. Comfort noise generation.

9.3.2 Radio System

The radio system provides secure voice and data communications to mobile systems, equipment, and users along the entire length and breadth of the Network, including tunnels and trenches. The Radio System is described in terms of three different radio subsystems which are for different purposes:

1. Operations Radio System (ORS);
2. Public Safety Trench and Tunnel Radio System (PSTTRS); and
3. Automatic Train Control Radio System (ATCRS);

The functions of individual radio subsystems may be combined where feasible and desirable.

9.3.2.1 Radio System General Requirements

1. The radio systems shall carry train control system data, remote condition monitoring data, security data and voice communication for the Network.
2. Contractor shall coordinate with the Rolling Stock supplier to ensure that the radio equipment in the Rolling Stock is properly installed, configured, integrated and working successfully at up to the Testing Speed.
3. Contractor shall provide to the Rolling Stock contractors all radio system On-board equipment.
4. The Rolling Stock contractor will install all radio system equipment on the Rolling Stock.
5. Contractor shall design and deploy the radio system so that it scales to meet the requirements of Phase 1 of the Network, supporting sufficient numbers of Rolling Stock in normal operational mode to meet the planned schedules, without upgrade or modification or reconfiguration to the existing radio system.
6. Contractor shall deploy the radio system as though the Contractor were deploying the final system, and that every specification that applies in the final built-out system must be met as soon as the first piece of the built-out system is in-place and operating.
7. Contractor shall use the Upper 700 A Band (757-758 MHz paired with 787-788 MHz) RF spectrum acquired by the Authority.
8. Additional RF spectrum acquisition and any associated costs shall be the responsibility of the Contractor.
9. Contractor shall test and commission, operate, inspect, maintain, overhaul and renew all On-board radio system equipment to achieve the Contract Requirements.

9.3.2.2 Operations Radio System Requirements

1. The Operations Radio System (ORS) shall service the voice and data requirements of the number of radio users (i.e., Rolling Stock cab radios, mobile radios, and portable radio/handsets) that may be located or stabled in one location at any time, including Rolling Stock maintenance depots.
2. The ORS shall support voice and data, including alarm and event notification, on-board public address and passenger information signs, T-coil transmitter, and other on-board communications subsystems meeting the Contract Requirements of the applications.
3. The ORS shall support multiple user groups. Those groups may have different operations centers at different locations, all of which shall be provided as part of the ORS.
4. The ORS shall provide a mechanism to record all voice, video and messaging communications between personnel and actions.

5. The ORS shall provide the ability to replay recordings as required.
6. All recordings made shall be at physically separated and secure primary and secondary sites.
7. The ORS shall provide a mechanism to record, at physically separated and secure primary and secondary sites, all voice and text communications that take place using the ORS as required to deliver.
8. The ORS shall provide operational-only connectivity to tablets and other graphic-oriented devices for personnel to interact with back-office systems for applications including asset management and track warrant request and delivery.
9. The ORS shall provide operational voice and data radio communications between on-board equipment, mobile and portable users and fixed users and systems.
10. ORS voice and data shall be encrypted over the air interface.
11. Voice communications within 1600 meters (nominally one mile) on either side of the Right-of-Way, including trenches and within tunnels, shall be first-responder grade/public safety-grade as defined by NPSTC Defining Public Safety Grade Systems and Facilities, May 22, 2014.
12. Voice communication coverage requirements may be waived, at the Authority's convenience, with exceptions documented.
13. ORS coverage shall include all Authority-owned and Authority-used tunnels and trenches along the Right-of-Way, and all places in those areas on or adjacent to the Right-of-Way where personnel can move or congregate.
14. ORS voice communications shall provide clear a delivered audio quality (DAQ) of DAQ level 4.0 or better for voice communications over the entire extent of coverage, and in all situations and locations, as defined in multiple paragraphs above.
15. Voice quality, as mentioned in the previous paragraph, shall be measured either by the DAQ/MOS methods in TIA TSB-88 or by the PESQ method specified in ITU-T Recommendation P.862, and operations and technical representatives from the Authority shall be included as judges in the evaluation method employed.
16. A sufficient number of portable radio handsets, to meet the Contract Requirements of the system and operator, shall be provided by the Contractor for use by track workers with the following secured communications features:
    a. Push-to-talk functionality shall be built in for all portable radio handsets on the ORS supporting voice;
    b. All radios shall include a red "emergency button" with the same function as the locomotive engineer's "emergency button" defined in the ATC section 9.4.2; and
    c. Operation of the emergency button (on a Rolling Stock radio, mobile or portable radio handset) shall cause an audible alarm on all radios, including a vibration alarm in portable radio handsets area where the movements of trains shall be affected by the alarm.
17. Dispatch consoles and end-user radios shall be able to make calls to and receive calls from other radios on an individual basis throughout the Network.
18. Dispatch consoles and end user radios shall be able to make calls to and receive calls from other radios on pre-defined group basis.
19. Users employing a variety of computing devices as part of their work shall be able to contact users, optionally and securely, on the ORS whether those users and their devices are connected via the California High-Speed Rail radio network or commercial cellular network.
20. The ORS shall provide a data transport service that permits an authorized person to select and view the images in real-time from at least one CCTV camera on board any Rolling Stock that is in revenue service.

21. The quality of the video stream shall be sufficient to provide identification, as defined in the APTA document APTA-IT-CCTV-RP-001-11, of an individual oriented face-on and line-of-sight to the camera, at any distance within a vehicle in which the camera is located.
22. No single point of failure of the ORS equipment, RF coverage deficiency or external RF interference, shall reduce the capability of the ORS to provide coverage and connectivity for the continuous operation of supported systems.
23. ORS voice and data communications shall not be simultaneously unavailable due to radio system failures.
24. Voice and data shall be carried by the IP protocol while in transit within the communications Network.

9.3.2.3 Public Safety Trench and Tunnel Radio System

1. Public safety/first responder systems included in the Public Safety Trench and Tunnel Radio System (PSTTRS) shall be identified through a signed memorandum of agreement between that entity and the Authority, which will be made available to the Contractor.
2. The PSTTRS shall extend coverage of public safety/first responder radio systems into the trenches and tunnels to allow such first responders to access their respective radio systems as they normally do immediately adjacent to, or within, such areas.
3. The PSTTRS shall not degrade any existing public safety/first responder systems below their existing performance levels.
4. The PSTTRS shall maintain continuous radio coverage despite a single site failure.

9.3.2.4 Automatic Train Control Radio System

1. The Automatic Train Control Radio System (ATCRS) shall provide data with coverage meeting service and Performance Requirements for train control purposes between on-board ATC equipment and systems, and wayside ATC equipment and systems at speeds up to the Testing Speed.
2. Continuous radio coverage shall be maintained despite a single site failure.
3. At all times, except during planned non-operational maintenance periods, the ATCRS shall provide coverage that has no adverse impact on the Performance Requirements.

9.3.3 Communications Network

The Communications Network provides data transport services between systems.

The Communications Network comprises an architecture of networking devices, cabling and other associated, supporting infrastructure located along the wayside and in buildings, equipment shelters/huts, and wayside cabinets.

Note: The hosts and servers of applications and systems that are supported by the Communications Network are not considered to be part of the Communications Network but are defined in their respective sections of this specification.

9.3.3.1 Communications Network General Requirements

1. The Communications Network shall provide data transport services between systems.
2. The Communications Network shall interface with other networks such as an Internet Service Provider (ISP) network, other Transit Agency networks, First Responder Networks, and Utility Company networks as necessary to meet the Contract Requirements.
3. The Communications Network shall be sourced from manufacturers having provided equivalent service-provider backbone network product families and materials for at least the previous ten years.
4. The Communications Network shall include independent and scalable capacity for very high bandwidth, large capacity, non-CHSR data services.

9.3.3.2 Data Transport Service Requirements

1. The Communications Network shall support the data transport service needs of the Network.
2. The Communications Network shall be capable of being configured to transport data traffic associated with different systems or applications in a manner so that the hosts of these different systems shall not be able to communicate with each other via the Communications Network.
3. The Communications Network shall support point-to-point, point to multi-point and multi-point to multi-point data transport services.
4. The Communications Network shall support, at a minimum, the following virtual private network services:
    a. Layer 2 (Ethernet) pseudo-wire and virtual private LAN as defined in the Metro Ethernet Forum (MEF) Technical Specification 6.2; and
    b. Layer 3 (Internet Protocol Version 4 and Internet Protocol version 6) virtual private network and multicast virtual private networks.
5. End-to-end provisioning of data transport services shall be done from one management application.

9.3.3.3 Communications Network Architecture

1. The Communications Network shall be based on the packet-switched service-provider technologies prevalent at the time of NTP.
2. The Communications Network shall provide a converged infrastructure capable of handling all of the different data transport requirements of the Network.
3. The Communications Network shall not rely upon proprietary protocols.
4. The Communications Network design shall minimize the different types of networking protocols and technologies while meeting the data transport services required in the Contract Requirements.
5. The Communications Network design shall minimize the different types of network equipment manufacturers and models.
6. A Communications Network point-of-presence shall be provided at every building and equipment shelter that is capable of providing the minimum data transport services defined above.
7. The Communications Network shall be based on an architecture and topology that allows the Network to scale and extend as additional communications sites are added along the Network without impact to the existing communication network services.

9.3.3.4 Traffic Engineering and Communications Network Survivability Requirements

1. Traffic-engineered data transport services shall be supported between all buildings and equipment shelter/hut locations as a single provisioning activity.
2. The communications network shall support the following traffic-engineering capabilities/features:
    a. Strict hop-by-hop explicit path definition;
    b. Loose / partially-specified explicit path definition;
    c. Exclusion of hops in an explicit path definition; and
    d. Shortest, dynamic path allocation;
3. The Communications Network shall support the following network survivability capabilities/features:
    a. Configuration of zero or more protecting paths;
    b. Automatic selection and establishment of an alternative path upon failure of an existing path through the Communications Network; and

c. Deterministic rerouting of a path upon Communications Network failure in the lower of either 100 milliseconds or the most stringent application requirement.

9.3.3.5 Quality of Service Requirements

1. The Communications Network shall support and implement the following hardware-based Quality-of-Service capabilities/features:
    a. Classification, marking, policing, shaping and queuing of data traffic;
    b. Relative prioritization of data traffic into different queues;
    c. Permit the reservation of bandwidth capacity for selected classes of data traffic;
    d. Ensure the flow of important operational data traffic through the Communications Network remains within the service-level parameters and bounds at all times; and
    e. Permit the flow of high priority data traffic through the Communications Network without data loss and with the minimum possible network latency, regardless of the amount of lower-priority data traffic present in the Communications Network.

9.3.3.6 Communications Network Synchronization Requirements

1. The Communications Network shall be capable of a means of synchronization per both following standards:
    a. IEEE 1588-2008 Precision Time Protocol version 2; and
    b. ITU-T G.871 Synchronous Ethernet.

9.3.3.7 Communications Network Cabling

1. The outside plant cabling system shall:
    a. Meet industry guidelines for designing, installing, maintaining, and restoring outside plant cabling infrastructure (e.g., BICSI, NEC, ITU-T);
    b. Support substantial scaling capability without the need to lay additional cable or duct;
    c. Avoid the likelihood of micro-bends and cracking at the time of installation;
    d. Minimize the requirement for optical fiber splices; and
    e. Allow for the installation of additional cable or cable duct for the provision of non CHSR services.
2. All outside plant cabling system shall be designed and installed to provide a service life of not less than 40 years.
3. Interconnections between Communications Network devices shall be of optical fiber.
4. Non-optical fiber interconnections shall:
    a. Only be used to connect end-user devices to the Communications Network;
    b. Only be used where the distance to the end-user device is shorter than 100 meters;
    c. Use Category 5e or higher twisted-pair cable; and
    d. Have 8P8C male connectors terminated as per T568A pinout (TIA/EIA-568 standard) in the straight-through configuration.
5. The optical fiber shall be single-mode optical fiber.
6. The maximum optical fiber splice loss shall be measured to be 0.10dB.
7. At least one meter of fiber for each jointed fiber shall be stored without twists or kinks within optical fiber splice organizers.

8. The optical fiber splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification without damage to the cable or splices.
9. The optical fiber cable system shall be suitable for CWDM, DWDM and non-WDM applications.
10. The optical fiber cable system shall be approved by the manufacturer for transmission in all DWDM bands, O through L.
11. Optical transceivers shall support diagnostic measurements, commonly known as digital diagnostic monitoring (DDM) or digital optical monitoring (DOM), according to the industry standard MSA (Multi-Source Agreement) SFF-8472.
12. Optical transceivers shall support, at a minimum, the following diagnostic measurements:
    a. Average optical transmit power;
    b. Average optical receive power;
    c. Laser bias current;
    d. Transceiver temperature; and
    e. Transceiver supply voltage.
13. The diagnostic measurements from the optical transceivers, listed above, shall be monitored by the Network Management System (NMS) so that degradation in optical fiber links can be identified.
14. Outside plant communications infrastructure shall comply with the most recent edition of the ANSI/ICEA Standard for Optical Fiber Outside Plant Communications Cable (ICEA-S-87-640) or its successors.

9.3.3.8 Communications Network Physical Architecture

1. The Communications Network shall consist of an architecture that provides design consistency, uniformity of structure, scalability and extensibility, fault resilience, path diversity and cost-effective deployment of different types of communications equipment.
2. The physical architecture may comprise optical fiber installed on both sides of the entire length of the Right-of-Way.
3. All Communications Network devices shall have at least two diverse physical routes connecting them to the rest of the Communications Network.
4. Diverse physical routes are those for which the physical media shall not come within 0.5 meters of each other at any point.
5. Diverse physical routes shall not share a common conduit, duct, or cable trough.
6. There shall be at least two physically diverse routes into each building, shelter/hut or wayside cabinet. The Contractor shall carry out a risk assessment that details how diversity shall be achieved using the proposed number of routes into each facility.
7. Within the Communications Network it shall be possible to provide two physically and logically separate end-to-end data paths from any place to any other place which are not susceptible to the same single failure.
8. The backbone physical topology of the Communications Network shall be able to survive at least two independent and simultaneous network-network link failures without the Communications Network becoming partitioned.

9.3.3.9 Communications Networking Devices

1. The Communications Network devices shall be designed and installed to provide a service life of not less than 15 years.
2. Communications Network devices forming the network backbone shall be powered using standard -48 VDC from circuit breakers in the rack in which they are installed.

3. Communications Network devices shall provide a visible indication that the device is fault-free.
4. Communications Network devices shall provide a visible indication that the device is experiencing fault conditions.
5. Communications Network devices shall provide a visible indication of fault severity on the rack front side, for example by means of colored status lights.

9.3.3.10 Network Management System

1. The users of the Network Management System (NMS) shall be the network operations personnel who are responsible for communications network management aspects such as network planning, monitoring network faults and performance, and remote configurations of network equipment.
2. The Network operators shall be situated at the Network Operations Center.
3. The location of the Network Operations Center shall be at the Operations Control Center.
4. The Network Management System shall provide the following minimum operational functionality:
    a. Auto-discovery of the Communications Network and its configuration for all NMS functionality, including Communications Network devices, links, topology and data transport services;
    b. System backup and restore functions for all configured Network Management System capabilities;
    c. A graphical user interface and dashboard that displays in real-time a visual snapshot of the state of health of the Communications Network in terms of capacity bottlenecks, faults and errors;
    d. A graphical user interface with Communications Network and data transport services schematics allowing the administrator to:
        i. View Communications Network inventory.
        ii. View the physical and logical Communications Network connectivity at all layers.
        iii. Troubleshoot, monitor and manage Communications Network devices, including command line access.
        iv. View up-to-date Communications Network maps showing Communications Network device connections, data transport services and traffic flows.
        v. Automatically discover new equipment connected to the Communications Network and add such new equipment to its database without user intervention, besides possibly initiating the start of the automatic discovery process via the click of an icon/button on a Graphical User Interface; and
        vi. Automatically discover the physical and logical Communications Network connectivity at all layers without user intervention, besides possibly initiating the start of the automatic discovery process via the click of an icon/button on a Graphical User Interface
    e. Fault management capabilities through:
        i. Event collection and logging;
        ii. Identification of alarms;
        iii. Alarm summarization;
        iv. Alarm correlation;
        v. Root-cause analysis;
        vi. Alarm prioritization;
        vii. Alarm archiving;

viii. Alarm retrieval; and

ix. Issue, display and distribute trouble tickets for Communications Network faults which may affect data transport services.

f. Provide logging and archiving of all alarms, events, trouble-tickets for a period of time to be agreed upon with the Authority;

g. Provide a severity level for each event and correlated group of events and trouble-ticket, ideally represented by a suitable color;

h. User-programmable and configurable so as to provide third-party vendor device alarm management;

i. Automatically discover and maintain an inventory of all Communications Network hardware and software, including name, unique serial numbers and version numbers;

j. Allow the provisioning of data transport services across the Communications Network, including traffic-engineered paths and associated survivability features;

k. Provide configuration management capabilities that allow the administrator to control and track changes that are made to a device configuration, including archiving whenever a change is detected, as well as periodic archiving;

l. Provide configuration management capabilities that allow the administrator to control and track software upgrades to Communications Network devices;

m. Internet Protocol address management;

n. Collect performance measurements from the Communications Network and provide the necessary analysis, display and report generating tools in order to:

i. Report to what extent service level parameters are being met for configured data transport services;

ii. Provide detailed statistical trend graphs and data tables for the throughput, errors and availability status of Communications Network links;

iii. Provide statistical trend graphs and data tables of the load on Central Processor Unit performance of Communications Network devices;

iv. Provide accurate details of the different traffic flows on the Communications Network including source and destination, traffic type, and throughput;

v. Monitor bandwidth utilization and alert when a Communications Network resource exceeds preset utilization thresholds; and

vi. Display above items averaged over five minute, hour, day, week, month and annual timescales.

o. Cable management which:

i. Holds in a computer database format, at all times, accurate details of the cable plant infrastructure (including cables, joints, terminations and related physical infrastructure) in sufficient detail that the cable plant infrastructure could be reconstructed from the data; and

ii. Stores the topology of the cable infrastructure.

p. Allows all stored data to be freely exportable retaining all data, meta-data, data structures and fields in the proper places; and

q. The Network Management System shall be routed through the Integrated Information Management Platform (Section 9.6.8).

9.3.3.11 Communications Network Spare Capacity

1. When there are no Communications Network failures in progress, Communications Network devices and links shall have a traffic throughput no more than one tenth of their maximum capability as currently configured and equipped.
2. The number of fibers in fiber bundles between shelters shall have at least 300 percent spare capacity.
3. The number of spare fiber optic cable ducts in a pathway shall have at least 300 percent spare capacity.
4. The network management system shall be able to scale to at least 300 percent spare capacity in terms of total communications network devices required to operate the entire communications network specified in the scope of works.
5. The full Phase 1 and 2 Communications Network shall be designed in segments across multiple contracts. Segment design shall allow for subsequent additions to the Communications Network that shall be compatible and interoperable with the previous segments.
6. The initial communications network segments shall be designed to support the traffic capacity of currently planned applications and subsystems of the full build out of the Network that utilize the data transport services of the Communications Network.
7. As new segments are installed and brought on-line there shall not be any need to increase the capacity of links or equipment installed in previous segments.

9.4 Automatic Train Control System

Automatic Train Control (ATC) is the signaling system that governs the safe and efficient movement of trains. The Automatic Train Control System includes the following key functional areas:

1. Automatic Train Operation (ATO);
2. Automatic Train Supervision (ATS);
    a. Automatic Route Setting (ARS);
    b. Automatic Train Regulation (ATR);
3. Automatic Train Protection (ATP);
4. Positive Train Control (PTC);
5. Hazard Detection and Early Warning System (HDEWS);
6. Earthquake Early Detection System (EEDS); and
7. ATC Control Center Equipment.

9.4.1 ATC System General Requirements

1. The Contractor shall provide an Automatic Train Control System for all Mainline Tracks, Station Tracks, Refuge Tracks, Transfer Tracks, Special Trackwork and sidings, but excluding track on Transfer Tracks beyond the Transfer Point.
2. The ATC System shall be a vital system.
3. The ATC System shall:
    a. Calculate and provide positive and continuous enforcement of Movement Authority to include:
        i. Dynamic speed-distance profiles;
        ii. Braking curves (emergency and service);
        iii. Not-to-exceed speed limits; and
        iv. Current train location.

b. Provide route setting and locking by means of interlocking functions;

c. Provide broken rail detection;

d. Provide train detection;

e. Provide confirmation of rail vehicle integrity;

f. Safeguard against unintended train entrance into work zones and unintended train movement into restricted areas;

g. Display of train location;

h. Determination and display of train speed;

i. Determination and display of train direction of travel;

j. Display of current movement authority for every train;

k. Provide automatic route setting as per the schedule;

l. Provide saved contingency plans for use during degraded mode operations;

m. Allow manual implementation of Temporary Speed Restrictions;

n. Provide integration of wayside defect, event, incident detectors and HDEWS Sensors; and

o. Integration with Rolling Stock defect detectors, as described in Authority Tier III Rolling Stock Performance Specification.

4. Contractor shall submit for Approval their ATC System Safety Requirements, as stated in Section 3.2 for Approval.

5. The ATC System Safety Principles document shall provide a complete and comprehensive description of how the Contractor intends to implement:

   a. Compliance with the Positive Train Control (PTC) requirements of the Rail Safety Improvement Act of 2008 and other associated FRA Regulations; and

   b. Interlocking rules;

6. All the 49 CFR Part 236 Subpart I rule-mandated documents shall be submitted and approved by FRA before the start of revenue service. The Contractor shall establish a schedule for these submittals as detailed in Section 4.4.2. The Authority will be responsible for all submittals and interactions with the FRA. The Contractor shall provide the Authority with all required support in preparing submittals for, and during FRA interactions.

7. The ATC System shall be able to command a variety of braking rates in order to meet different speed distance profiles required to meet the Performance Requirements.

8. The ATC System shall allow a call-on function (allow a train in rear to pass its limit of movement authority) to be safely performed in the event of an operational need. Call-on shall be performed in restricted manual mode.

9. Where call-ons are allowed and the field conditions support it, the ATC System shall provide controls and indications for call-on selection.

10. The ATC System shall allow for fleeting mode of operations in normal and bi-directional working.

11. The ATC System shall allow for any combination of stopping and non-stopping train services.

12. The Contractor shall coordinate ATC system design with the traction power and OCS designs to ensure that trains are not normally stopped or slowed by the ATC System on approach to or within a phase break section.

13. ATC System design shall utilize, to the extent possible, Rail Infrastructure System Sites and undertrack conduits detailed within the Base Design.

9.4.1.1 Interlockings

1. Processor based interlockings, as defined in 49 CFR Part 236, shall be used.
2. Their use shall be verified in compliance with IEEE 1483 - Standard for Verification of Vital Functions in Processor-Based Systems Used in Rail Transit Control and other applicable regulatory requirements.

9.4.1.2 Switch Machines

1. Power operated switch machines shall be provided on all switches and moveable point frogs on all tracks of sufficient power to reliably operate each switch type.
2. The ATC System shall include switch detection mechanisms that provide a positive confirmation that a switch is in continuous correspondence and mechanically locked.
3. For any switch-out-of-correspondence, the ATC System shall:
    a. Notify the responsible Dispatcher; and
    b. Stop train movement through this switch until the switch is locked in the position corresponding to its interlocking device.

9.4.2 ATC System Safety Requirements

1. The ATC System shall provide a quantitative level of safety such that any single, independent hardware, software or communication failure, or any combination of such failures with the potential of causing death or severe injury to passengers or staff, shall not exceed the Tolerable Hazard Rate for a Safety Integrity Level 4 System as defined in EN50129.
2. The ATC System shall be in compliance with the following standards:
    a. EN 50126 – Part 1, Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 1: Basic requirements and generic process;
    b. EN 50128 – Railway applications – Communications, signaling and processing systems. Software for railway control and protection system;
    c. EN 50129 – Railway applications – Communication, signaling and processing systems. Safety related electronic systems for signaling;
    d. EN 50159 – Railway applications – Communication, signaling and processing systems – Safety–related communication in transmission systems;
    e. IEC 61508 – Functional Safety of Electrical / Electronic / Programmable Electronic Safety-related Systems;
    f. IEEE-1483 Standard for Verification of Vital Functions in Processor-Based Systems Used in Rail Transit Control;
    g. AREMA Standards, Chapter 17 – High-Speed Rail Systems; and
    h. CFR49 – 236 – Appendix C.
3. The ATC System shall be developed under a comprehensive program that ensures that safety-related maintainable hardware will be delivered and meets the system availability requirements. The program shall be a documented and certified SIL 4 as defined in EN50126 for vital system hardware.
4. ATC Software (including firmware and databases, if any) shall be developed under a comprehensive program that ensures that safety-critical, maintainable software will be delivered. The program shall be a documented and certified SIL 4 as defined in EN50126 for vital system software.
5. ATC Software for non-safety critical (non-vital) subsystems shall be documented and certified to the appropriate SIL level as defined in EN50126, approved and in compliance with the above said standards.

6. ATC Software shall be structured, to the greatest extent possible, such that system extensions and track configuration changes do not require complete verification and validation of the ATC System and shall be limited to the data portions.
7. For tunnels and trenches (and other high-risk areas), the ATC System shall include a wayside protection device for the safety of railroad workers, which on activation shall prevent the routing of trains into these areas. These wayside activation devices shall be secured and protected from unauthorized/malicious activation or deactivation.
8. The on-board ATC System shall allow the locomotive engineer to issue emergency alarms to the Rail Infrastructure System. The alarms shall be initiated by the press of respective hard physical buttons, protected from accidental activation, located in the driving cab of the train. The ATC system shall intervene within 500 milliseconds to implement emergency braking on the Rolling Stock and issue an intervention to all trains in the affected control zone.
9. The ATC System shall issue emergency alarms to the Rail Infrastructure System initiated by the press of 'soft' buttons in the relevant area of the ATS screens. The ATC System shall intervene within 500 milliseconds to implement emergency braking for all the trains in the affected control zone.
10. Each control action initiated by the ATS to the field shall be confirmed back to the ATS, by the system, that the request has been implemented safely and positively.
11. The ATC System shall prevent the routing of an electrically powered train into a section of railroad where the OCS is isolated/de-energized or not installed.
12. The ATC system shall allow the dispatcher to update/modify/amend Movement Authority at any time.
13. The Speed reductions initiated by the locomotive engineer shall not be overruled by the ATC System. Resumption of permissible speed shall be confirmed by locomotive engineer.
14. For a work zone area, the ATC System shall allow the dispatcher to authorize and implement work zone speeds.
15. The ATC System shall allow taking planned possession of any section(s) of track within five minutes.
16. The ATC System shall include integrated train approach warning systems – one for station operational staff and one for passengers on platforms.
17. The ATC System shall provide safe operation of all Rolling Stock and Railway Equipment movements between the Mainline Tracks and Transfer Tracks. An ATC Transfer Track Interface Report shall be submitted for Review as stated in Section 3.2.
18. The transition from Transfer Tracks to Mainline Tracks shall be protected by a fail-safe derailing mechanism to protect unauthorized or unintended train movements to the Mainline Tracks integrated into the ATC System. The Contractor shall ensure that the area where the unintended movement is designed to derail is clear of any infrastructure and equipment and derailment presents no hazards to Mainline Tracks or Station Track operations.
19. In areas where a derailing device is not permitted or possible, a fail-safe means of preventing any train from entering the Mainline Tracks or Station Tracks, shall be provided.
20. The ATC System shall have a functional interface with HDEWS sensor systems along the route as detailed in Section 7.7.
21. An ATC System cut out switch, protected from accidental activation, shall be provided in the Rolling Stock cab for use by the locomotive engineer in the event that the ATC System needs to be deactivated in emergency situations.

9.4.3 ATC Communications

1. The safety and integrity of vital messages between elements of the ATC System shall be managed by the ATC System.

2. The ATC System shall not rely on the communications network to ensure the safety and integrity of ATC System messages of a vital or non-vital nature.

9.4.4 ATC Safe Braking Distance

1. The ATC System shall implement a Safe Braking Design for each type of train that can operate on the Network that is equipped with an on-board ATC subsystem and is subject to ATC enforcement. Along with applicable regulatory requirements, the safe braking principles of train separation shall also comply with IEEE 1698 – IEEE Guide for the Calculation of Braking Distances for Rail Transit Vehicles.
2. The ATC System requires guaranteed train braking performance that includes an Assured Emergency Brake Rate, with a specified level of worst-case wheel-rail adhesion and failure conditions. The Contractor shall coordinate with the Rolling Stock supplier to confirm the braking performance of passenger vehicles including brake rates, build up times, variation in rate application versus time and train speed, spin-slide control parameters, rolling Stock modeling parameters, IEEE 1698 modeling parameters and an agreed level of degradation of braking effort due to failure(s) within the braking system.
3. The Contractor shall confirm the braking performance of maintenance (non-passenger) rolling stock with respect to the parameters above.

9.4.5 Earthquake Early Detection System (EEDS)

The EEDS is a part of the HDEWS (Section 7.7 refers).

1. EEDS shall be a dedicated and self-sufficient earthquake detection system designed for early detection of earth movement and shocks (earthquakes) across the Network.
2. Contractor shall provide an array of EEDS sensors at all TPSS Sites.
3. Contractor shall ensure that the EEDS sensor array is protected such that environmental impacts, such as thermal instability, is mitigated.
4. Contractor shall ensure that the EEDS sensor array, data loggers and data transmission systems shall not be affected by any electro-magnetic interference.
5. In their role as System Integrator, the Contractor shall ensure that the vaults where the EEDS sensor array is located provide the required levels of physical stability and isolation to ensure the EEDS system delivers the Contract Requirements.
6. The EEDS sensors shall detect ‘p’ waves (preliminary tremors) and ‘s’ waves.
7. Contractor shall provide a EEDS system that uses data from the sensor array, in real time, to identify:
    a. That an earthquake is occurring; and
    b. The areas where impact upon the Rail Infrastructure System is likely.
8. EEDS system shall direct an intervention to the ATC System to initiate a train stop command to the Rolling Stock when earth movement or shocks are detected based on the magnitude of the earthquake.
9. On detection of p-waves above 40 gal, the EEDS System shall:
    a. Perform an automatic intervention with the ATC System within 500 milliseconds to initiate an emergency brake application to all the trains in the earthquake zone;
    b. Transmit an automatic emergency alarm to the OCC to inform the operators; and
    c. Transmit a message via the ATC system to Trains approaching the affected area to stop. Trains shall stop at Stations where possible.
10. The EEDS shall allow for Authority authorized reconfiguration of the p-wave sensitivity, within safe limits, of the ground motion detection by any competent and approved supplier.

9.4.6 ATC System Technical Requirements

9.4.6.1 ATC Stopping Accuracy

1. The ATC System shall command the Rolling Stock to stop at the required stations with an accuracy of +/-150 mm (nominal +/- 6”).
2. The on-board ATC shall cause the service brakes to be applied automatically, as required to bring the train to a stop at a programmed station stop in the required location.

9.4.6.2 Onboard Rolling Stock ATC Functionality

1. Automatic Train Operation shall be provided to comply with the requirements of Grade of Automation Level 2 (GoA2) and shall demonstrate an upgrade path to GoA3.
2. The on-board ATC shall perform the following functions, as a minimum:
    a. Real-time communication of information to the locomotive engineer of ATC System commands, status and alarms;
    b. Correct selection and implementation of the ATC mode of operation;
    c. Ensure safe speed enforcement over the complete train length including allowance for position uncertainty;
    d. Train speed shall be displayed to the locomotive engineer rounded up to the nearest integer;
    e. There shall be no discrepancy between the speed shown to the locomotive engineer and the speed used for supervision of Movement Authority and speed limits functions;
    f. Allow safe Rolling Stock door operation;
    g. Ensure the on-board databases are correct and up-to-date – correct modification with temporary limits transmitted from the wayside, and update the on-board database when permanent updates are transmitted from the wayside;
    h. Monitor ATC and train equipment health status and report to OCC/LCCs as needed; including interfacing to on-board non-ATC subsystems to transmit health data to the wayside and OCC/LCCs;
    i. Provide degraded mode of operations when selected by external input;
    j. Record data for regulatory purposes; and
    k. The ATC System shall not allow the Train to roll back by more than 2 m (6.6 ft) in all ATC supervision modes.
3. Operating Modes – A minimum of four operating modes shall be provided:
    a. ATC Mode:
        i. Power and brake commands are provided by the locomotive engineer; and
        ii. Movement Authority with continuous overspeed supervision enforced.
    b. ATC-ATO Mode:
        i. Power and brake commands are transmitted to the train subsystems by the on-board ATC System;
        ii. Movement Authority with continuous overspeed supervision enforced;
        iii. Acceleration from station stops when requested by the locomotive engineer and in ATO mode; and
        iv. Cruise at safe speeds determined by the Movement Authority.
    c. Restricted Manual Mode:

i. Power and brake commands are operated by the locomotive engineer but with a continuous maximum speed limit (restricted speed as mandated by FRA), enforced by onboard ATC System.

d. Yard Mode:

i. Yard Mode will be provided by Rolling Stock supplier. Power and brake commands are operated by the locomotive engineer but with a continuous maximum yard speed limit as determined and enforced by Rolling Stock supplier.

4. Changes to the operating modes or additional operating modes shall be agreed with the Authority, Rolling Stock and Service Operator contractors.

9.4.6.3 Command and Control Functions

1. Automatic Train Supervision shall provide centralized and resilient command and control functionality to the operator to deliver the schedule.
2. Dispatching shall be achieved by the issuing of Movement Authorities.
3. The ATS shall store multiple versions of the Operational Plan and allow real-time editing by dispatchers and operating supervisors to cancel, add, or adjust trip information for individual and groups of trains.
4. The ATR shall automatically regulate trains in accordance with the following criteria:
   a) Schedule;
   b) First come, first served; and
   c) Train run ID.
5. The ATR shall allow the Operator to develop their own criteria for train regulation and to allow them to be added to the selection available to the operator.
6. The operator shall be able to select which of the ATR criteria the system uses for train regulation.
7. Temporary Speed Restrictions (TSR) and work zones shall be entered through the ATS subsystem.
8. All control, supervision, and monitoring functions shall be possible from any ATC workstation within the OCC or local control centers, once authorized with the protected configuration setting functions and comply with the requirements for Network and Computer Security contained in Appendix 2 of this document.
9. Servers and other processors shall be distributed such that the loss of any and all equipment at the OCC shall not prevent the LCCs from supervising and controlling any part of their respective territories.
10. The ATC System shall positively confirm that the control and indication system is operable and the displayed information accurately depicts the real time status of the Rail Infrastructure System.

9.4.6.4 Event Recording

1. The central, wayside, and on-board ATC subsystems shall record all changes of state for diagnostic, record keeping and maintenance purposes.
2. The on-board event recorder shall interface to the Rolling Stock on-board data and event recorders.

9.4.6.5 Maintenance and Diagnostic Functions

1. All ATC equipment shall be designed with built-in diagnostics and health monitoring functionality.
2. Equipment shall be monitored such that degrading performance can be identified and indicated as an alarm through the ATS component of the Supervisory Control and Data Acquisition (SCADA) subsystem and locally in the equipment houses and cases.
3. Where practicable, alerts and warnings shall be given prior to the loss of function of the equipment.

4. An alarm shall be given on loss of function of the equipment.
5. ATC equipment status shall be indicated through the ATS subsystem and locally in the equipment houses and cases.
6. The mode and status of each interlocking shall be continuously displayed to the dispatcher's console.

9.4.7 ATC System Operational Requirements

9.4.7.1 Blended Sections

1. The ATC System shall have a functional and operational interface with railroad systems on blended sections to allow uninterrupted transition of Train Operations and Control responsibility between adjacent train control systems.
2. On blended sections, the control systems shall transition to a ready and operational state without affecting the Contract Requirements.
3. When transitioning between railroad properties, Rolling Stock shall always be under the control of a train control system following make-before-break methodology.

9.4.7.2 Grade Crossings

1. The blended alignment between CP Lick and Gilroy will require the use of grade crossings. The Contractor shall provide grade crossings protected by quad gates that fully close off the vehicle roadway from the railroad tracks at required crossing-points and satisfy all regulatory requirements.
2. At each grade crossing, the Contractor shall provide channelization on the vehicle roadways to deter road vehicles from swerving around closing barriers.
3. At each grade crossing, the Contractor shall provide an electronic means of detecting if a grade crossing is clear of obstruction once the barriers are down and prior to a train being granted movement authority to pass through the grade crossing.
4. The ATC System shall provide integrated crossing activation.
5. Crossing warning and gate systems shall be activated automatically in response to approaching trains based on actual train speed and the train's capability to accelerate, providing reliable and consistent advanced warning time for all types of trains travelling at any speeds.
6. A detailed Grade Crossing Operation Plan shall be submitted for Review as stated in Section 3.2
7. The ATC System shall allow train movement over the grade crossing only after a "crossing clear" signal is received from the grade crossing.

9.4.7.3 Third Party Scheduling Package

1. The ATC System shall provide an interface to allow authorized alternative third party train scheduling packages to be used to adjust the planned schedule or to allow for the creation of new train schedules within the Timetable Planning Rules.

9.4.7.4 ATC Control - Reconfiguration

1. The ATC System shall allow secure reconfiguration of the areas of control between workstations within the OCC Control room during planned (night work, reduced workload) and unplanned (infrastructure/train failure) events.
2. The ATC System shall enable the transfer of defined areas of control to remote locations (outside of the OCC Control room).
3. At all times, when areas of control are amended, all areas of the ATC System shall remain under the supervision of a dispatcher, including during transition.

9.4.7.5 ATC System - Degraded Mode

1. Any degraded mode speed restriction imposed by the ATC system shall only be lifted by a manual intervention by the dispatcher.
2. In the event of a total ATC System failure, the ATC System shall restart to an operationally ready state. Service operation shall only recommence with the manual intervention by the dispatcher.
3. In the event of failure of ATC operating mode, there shall be a graceful degradation, which shall optimize service capacity while maintaining safety.
4. In the event of a complete ATC failure, the train shall be restricted to a maximum speed as defined in CFRs or as prescribed by the Authority.
5. An independent speed governor device (provided by Rolling Stock supplier) will interface with the Rolling Stock subsystems to restrict the Rolling Stock speed to a defined limit in the degraded mode. The ATC System shall have a continual interface with speed governor.
6. Upon activation of the ATC System cutout switch in the cab, the train's emergency brakes shall be applied and the train shall come to a complete stop. Alarms shall be issued to the dispatchers at the OCC and LCCs, and shall be logged.
7. The ATC System shall include protection so that if an unauthorized person attempts to start/restart the Rolling Stock, no train movement shall be permitted.

9.4.7.6 ATC Facilities

1. Facilities shall be provided in the OCC to allow for playback and related analysis of events following incidents and emergencies using ATS recorded data. The system may also be used for training and evaluation purposes.
2. Facilities shall be provided to enable construction and evaluation by simulation of new schedules including supplements to existing schedules and for minor and major editing of existing schedules. The evaluations shall output details of any conflicts or inefficiencies in the amended schedule.
3. Facilities shall be provided for training of dispatchers and managers a minimum six months prior to commissioning. The training facility shall:
    a. Allow the creation of scenarios both from scratch and from recorded data by a trainer; and
    b. Allow the trainee to manage the scenario through to a conclusion.
4. A separate set of workstations shall be provided for training purposes. Student and instructor workstations shall be provided.
5. Facilities shall also be available for playback of events and incidents, and shall be subject to the same configuration management and update requirements as the live ATC System.
6. The ATC System shall provide the ability to integrate imported data and historical from all railroad-logging systems such that an integrated, detailed and synchronized playback of an event can be constructed and played back for investigation and training purposes. It shall allow for viewing how railroad systems exchange messages, data, voice communications, event logs and fault logs. The playback shall be in a graphical and audio format.
7. The Contractor shall interface with the Rolling Stock supplier to provide a cab-training and driving simulator capable of being configured with the various scenarios and train performance models employed in ATC service.
8. The ATC Driving Simulator shall enable the instructor to trigger scenarios such as (but not limited to):
    a. Train over-speed;
    b. ATC System failures;
    c. Disabled trains;
    d. Train uncoupled;

e. ATC mode changes;

f. Signal/Section overrun;

g. Service blockages;

h. System failures; and

i. Failed field devices.

9. The system shall have the flexibility to allow the recreation of unforeseen events that may arise through the life of the system.

10. The Instructor shall have the ability to see all actions performed by the student and introduce ad-hoc events at any time during the training session as described above.

11. The student actions shall be logged, recorded and maintained for their competence records.

9.4.7.7 Interoperability

1. As part of the Performance Demonstration and Mock Up described in section 4.12, the Contractor shall demonstrate how their proposed Rolling Stock mounted ATC and PTC systems shall be implemented to operate on the Network and blended section (neighbor) railroads and be compliant with regulations and requirements at all times.

2. The Contractor shall supply and install any equipment to enable a seamless transition of trains between connected neighbor railroads at the limits of the shared tracks within shared corridors.

1.1.1 ATC System Interfaces

9.4.7.8 Railway Systems

1. The ATC system shall provide appropriate train data information including real-time train status (train delays, routed platform. etc.) and schedule adherence data, to allow Public Address and Customer Information Systems (PACIS) to operate throughout the Network and to other parties in General Transit Feed Specification (GTFS) format or other open formats on agreement with the Authority.

9.4.7.9 Rolling Stock

1. The Contractor shall interface and coordinate with the Rolling Stock supplier to define and implement:

   a. All ATC Rolling Stock interfaces;

   b. Provide to the Rolling Stock contractors all ATC On-board equipment; and

   c. Provide all necessary support to the Rolling Stock Contractor for installation and integration to achieve a functional ATC on-board equipment package.

2. The Contractor shall test and commission, inspect, maintain, overhaul and renew all ATC onboard equipment to achieve the Contract Requirements.

3. The Contractor shall be responsible for providing all software and data updates required for the ATC onboard equipment for the Contract Duration to deliver the Contract Requirements.

9.4.7.10 Rolling Stock Facilities

1. At the HMF and other Rolling Stock facilities, the Contractor shall coordinate interfaces between ATC system and Yard Control System (provided by Rolling Stock supplier).

2. The Contractor shall be responsible for integration of all operations between Transfer Tracks and the Rolling Stock facilities.

3. The ATC system shall have a functional and operational interface with any yard / depot signaling systems provided by the Rolling Stock supplier.

9.5 Operations Control Facilities

Operations Control Facilities are self-contained and secure locations designed to facilitate all aspects of train dispatch, management and oversight of the Network.

The Operation Control Center (OCC) will be the primary location where all operationally critical command and control activities shall take place.

Additional redundant capability shall be provided to allow operational services to be continued in the event of the OCC being rendered in-operational.

The Contractor's command and control organization is the Contractor's organization that has overall day-to-day operations responsibility for the System and operational interfaces with blended railroads. It may include dispatchers, Operations Control, OCS, Fault Management, Communications Network Operations Center (NOC), Trains and Train Crew Management.

9.5.1 Operational Control Center Facility

The OCC facility will be protected and resilient to the effects of external influences and factors.

The OCC facility will have suitable and sufficient facilities for the Contractors command and control organization.

9.5.1.1 OCC Building

The OCC Building will:

1. Be in buildings provided by the Authority at Fresno;
2. Be a stand-alone building;
3. Be a resilient facility that will be designed to mitigate:
    a. Earthquake;
    b. Bomb attack;
    c. Hostile vehicle attack;
    d. Trespass and intrusion;
    e. Fire; and
    f. Flood.
4. Be electrically and mechanically resilient to failures at the supply level.
5. Have mechanical and electrical systems with the required capacity to support the design loads.
6. Have redundant, at the point of supply, mechanical and electrical systems that are fault tolerant.
7. Be sized to accommodate the Contractors' and the Service Operators' organization required to be located within the OCC.
8. Be sized to accommodate equipment required by the Rail Infrastructure System to be located at the OCC.
9. Have welfare facilities to deliver the requirements of the organization located at the OCC.
10. Have an OCC Building Management System (BMS) that will inform the Contractor of the status of any plant or electrical systems to a centralized location within the OCC and provide alarms to the Contractor in the event of failures.
11. The BMS will support remote access.
12. Have rooms that will be provided for specific purposes as defined by the Contractor.

9.5.1.2 Operational Control Center

The Operational Control Center is the Operational Control Center building.

1. The Operational Control Center shall be compliant with the requirements of ISO 11064.
2. The Contractor shall:
    a. Locate their operational command and control organization at the OCC;
    b. Submit details of their proposed OCC based command and control organization to the Authority within the Operations Management Plan. The Operations Management Plan shall be submitted for Review as stated in Section 3.2;
    c. Provide all Rail Infrastructure System equipment required to be located within the OCC;
    d. Provide workstations that are ergonomically designed for dispatcher safety, comfort and efficient operator use and shall be compliant with ISO 9241;
    e. Undertake all ongoing management, maintenance and security operations associated with the day to day, safe, resilient and secure operations of the OCC for the Service Period.

9.6 Rail Systems and Subsystems

1. The Rail Infrastructure System includes the following component rail systems and subsystems which function across all elements of the Rail Infrastructure System:
    a. Physical Security Information Management System (PSIMS);
    b. Closed Circuit Television (CCTV) systems;
    c. Electronic Access Control Systems (EACS);
    d. Intrusion Detection Systems (IDS);
    e. Fire Detection Systems;
    f. Rail Infrastructure Information Management (RIIM);
    g. Public Address and Customer Information Sign (PACIS) systems;
    h. Universal consoles;
    i. Integrated Information Management Platform (IIMP); and
    j. Network timing systems.
2. All Rail Infrastructure Systems which generate or process information which may have a bearing on the immediate or impending ability to operate to the Operational Plan shall be able to generate or pass on information via a northbound interface to an Integrated Information Management Platform (IIMP).

9.6.1 Physical Security Information Management System Specification

The Physical Security Information Management System is a middleware platform designed to integrate multiple unconnected security applications and devices and control them through one encompassing user interface. It collects and correlates events from disparate security devices and information systems to empower personnel to identify and proactively resolve situations. PSIMS integration provides increased control, improved situational awareness and management reporting.

The PSIMS integrates a number of sub systems, including:

1. Closed Circuit Television (CCTV) systems;
2. Electronic Access Control Systems (EACS);
3. Intrusion Detection Systems (IDS);
4. Fire Detection Systems; and
5. Hazard Detection and Early Warning System (HDEWS).

These sub systems are described or referenced elsewhere in these specifications.

9.6.1.1 General Requirements

1. The PSIMS shall interface with and integrate with multiple subtending security and safety systems from various manufacturers.
2. The PSIMS shall interface with and integrate with different versions of a manufacturer's security or safety system.
3. The PSIMS shall exchange data with other systems in an open standard, non-proprietary, documented interface.
4. The PSIMS shall, at minimum, interface and integrate the following subtending security and safety systems:
    a. Closed Circuit Television (CCTV) systems;
    b. Electronic Access Control Systems (EACS);
    c. Intrusion Detection Systems (IDS);
    d. Fire Detection System [only to receive alarms];
    e. Hazard Detection and Early Warning Systems (HDEWS) [only to receive alarms]; and
    f. Any other systems required to comply with the security policies and standard operating procedures of the Authority.
5. The PSIMS shall be capable of being interfaced with and exchange data with other PSIM type systems from other transit agencies or first responder agencies. Whether an interface is required and the type of data exchanged across the interface is dependent on memorandum of understanding (MOU) agreements between the CHSR and these third parties.
6. Alarms shall be routed through the Integrated Information Management Platform (Section 9.6.8).

9.6.1.2 Data Collection

1. The PSIMS shall collect any data (e.g. events, alarms) that is made available by the subtending security or safety system's Software Developers Kit (SDK) or Application Programming Interface (API).
2. The Contractor shall be responsible for providing subtending security and safety systems that provide SDKs/APIs that allow access to all required data necessary to comply with the security policies and standard operating procedures of the Authority.

9.6.1.3 Data Correlation & Automated Integrated Functionality

1. The PSIMS shall provide customizable correlation of the collected data (e.g. events, alarms) from multiple subtending systems to raise alarms based upon such correlated data.
2. The PSIMS shall provide customizable automated integrated functionality between subtending systems, where the PSIMS may initiate actions within one or more subtending systems based upon the correlated data collected. For example, the system may be configured to request the display of live video from the CCTV system based upon correlated event data collected from the Access Control System and Intrusion Detection Systems.

9.6.1.4 Graphical User Interfaces

1. The PSIMS shall provide configurable Graphical User Interface (GUI) screens that are customized to display and allow control of only the relevant information based upon a user's role and responsibilities.
2. The PSIMS GUI shall support multiple windows providing video, text, dialog boxes, maps, and menus required by users to perform their daily functions.

3. The PSIMS GUI shall provide a uniform manner for users to perform common monitoring and control functions across the subtending systems.
4. The PSIMS GUI shall run on workstation computers as well as portable devices including tablets and smart phones.
5. The PSIMS GUI shall display real-time events and alarm data on a graphical map-based display with simultaneous display of alarm lists, response plans, and video tiles for monitoring live and recorded video associated with events across multiple computer monitors.
6. The PSIMS GUI shall display three-dimensional models of buildings and stations.
7. The PSIMS GUI shall overlay icons representing assets on three-dimensional models and two-dimensional maps based upon Geographic Information System (GIS) coordinates of the asset such that the icon's location on the model/map accurately represents the physical location of the asset it represents.
8. The PSIMS shall support multi-level drill down/up between map views.
9. The PSIMS shall automatically bring up map views of locations most relevant to an incident based on external trigger inputs associated with the incident.

9.6.1.5 Reports

1. The PSIMS shall generate reports, automatically and on-demand.
2. The PSIMS shall generate incident reports that include incident summary, all the tasks associated with the incident, sensor related activities, relevant snap shots of video, and maps.
3. The PSIMS shall generate System maintenance reports including System failures and performance data.
4. The PSIMS shall generate alarm log reports, including alarm details, such as the date and time the alarm originated, was acknowledged, was closed, and the user that handled the alarm.
5. The PSIMS shall generate user reports, detailing the data monitored and control actions taken by specific users during a specified period.

9.6.1.6 Information Storage, Retrieval and Playback

1. The PSIMS shall collect and store historical data on all user activity with the system, including login/logout activity, opening displays, control of devices, generation of reports, and information displayed to the user such as events and alarms.
2. The PSIMS shall collect and store historical data on all monitored device states and alarm conditions.
3. The PSIMS shall allow selective retrieval and evaluation of the data logged by authorized users based upon criteria such as date/time, workstation, user, event-type, and/or device.
4. The PSIMS shall utilize the stored historical data to recreate and playback incidents and system conditions/behaviors.

9.6.1.7 Training & Simulation

1. The PSIMS shall simulate the operation of the PSIMS software in such a way as to provide the capability for training users in an offline environment running operational scenarios and for testing updates to the PSIMS software.

9.6.1.8 Scalability

1. The PSIMS shall be scalable to interface with and integrate all security and safety systems along the Right-of-Way, facilities, and stations in support of all phases of the Network
2. The PSIMS shall be deployed in a distributed manner with remote instances of the PSIMS (e.g., at stations), which are can operate independently as well as in federation with a central PSIMS (e.g., at the OCC).

9.6.1.9 Reliability Availability and Maintainability

1. The PSIMS shall be deployed in a redundant architecture with geographically diverse servers supporting automatic synchronization and failover between the redundant servers.

9.6.2 Closed Circuit Television

9.6.2.1 General Requirements

1. Contractor shall provide, operate and maintain a Closed-Circuit Television (CCTV) system in certain key safety areas, such as station platforms, tunnel portals, and emergency egress areas, among others.
2. CCTV systems within stations, excluding platforms, will be supplied by others as defined in the Interfacing Parties section 19.5.
3. Contractor shall undertake a risk assessment, in co-operation with the Authority, to determine the appropriate location and functionality of all CCTV cameras in accordance with the requirements for System Safety and Security Management Plan.

9.6.2.2 Cameras

1. The CCTV system shall provide audio and visual monitoring of locations along the Authority's right-of-way.
2. As a minimum, visually monitored locations shall include:
    a. All passenger platform areas;
    b. All entrances to and within secure areas such as the Operations Control Center;
    c. Transfer Tracks;
    d. All tunnel portals;
    e. All tunnel egress points;
    f. All tunnel cross-passageways;
    g. An interface with Rolling Stock CCTV camera systems; and
    h. Other areas identified in the Contractors risk assessment.
3. Cameras shall be chosen in accordance with the latest version of the APTA IP camera and VCA Addendum.
4. The required number of pixels on target shall be as defined in APTA IT-CCTV-RP-001-11 IP Camera and VCA Addendum (or later).
5. Minimum CCTV frame rates and resolution shall be as defined in APTA IT-RP-001-11 IP Camera and VCA Addendum (or later).
6. CCTV cameras shall use either open standard or non-proprietary protocols for communicating with the CCTV and video management systems such as the Open Network Video Interface Forum (ONVIF) Profile S.
7. Configurations for the CCTV equipment shall be stored off the device for rapid restoration of replacement equipment and managed by the CCTV management system.
8. Cameras shall be installed in enclosures appropriate for their location from an environmental and security perspective.

9.6.2.3 Camera Lighting Requirements

1. The CCTV system shall be installed with supplemental lighting where required and determined by the Contractor for proper functioning of the cameras.

2. Cameras shall support day and night vision, thermal vision and infrared illumination as required on a per site basis and as determined by the Contractor.
3. Supplemental lighting for night use shall not be detectable by unaided human eyesight.

9.6.2.4 Rolling Stock CCTV

The Rolling Stock will have their own CCTV System supplied by the Rolling Stock supplier.

1. The OCC and LCCs shall be able to select and view on-board camera images.

9.6.2.5 CCTV for First Responders

1. OCC security personnel shall be able to authorize both real time and stored video and audio streams for remote viewing by first responders.
2. Video and audio streams for viewing by first responders shall be available remotely on devices of their choosing in a secure fashion in accordance with the requirements for Network and Computer Security contained in Appendix 2 of this document.
3. The quality of the video stream for fixed cameras shall be sufficient to provide identification, as defined in the recommended practice APTA-IT-CCTV-RP-001-11, of an individual oriented face-on and line of sight to the camera, at any distance within a vehicle in which the camera is located.

9.6.2.6 CCTV Video Management System

1. The CCTV Video Management System (VMS) shall be integrated and coordinated with the Physical Security and Information Management System.
2. The VMS shall provide a centralized event, end-user rights, and video recording and distribution management.
3. The VMS shall be capable of remotely managing and configuring cameras and devices directly associated with the CCTV system from multiple vendors using open source and nonproprietary protocols such as the Open Network Video Interface Form profile S.
4. Interoperability between the central and local video management systems shall be done through an open source and nonproprietary protocol such as those from Open Network Video Interface Forum.
5. The system may be configurable for showing live video from a camera based on an alarm input from another sub-system within the Geographic Limits. This may be achieved through the PSIMS defined above.
6. The CCTV system shall be able to show live video from any location to users at the OCC and other designated locations in accordance with the requirements for System Safety and Security Management Plan
7. The CCTV System shall retrieve and display stored video images with timestamps to authorized personnel at full captured resolution and frame rate.

9.6.2.7 Video Recordings

1. All camera recordings shall be stored for a minimum of 90 days unless specified otherwise.
2. All camera recordings shall be done at their design resolution.
3. Failure of a VMS shall generate an alarm and video and audio recorded by the failed VMS shall be recorded by a geographically separated backup VMS.
4. Camera recordings shall include a means of ensuring that each video frame is free of tampering in a manner suitable for evidence in a court of law.
5. All stored video images shall be automatically timestamped on a per frame basis suitable for evidentiary purposes.

6. The CCTV system shall be designed for meeting the specific chain of custody demands in accordance with the requirements for System Safety and Security Management Plan. As a minimum, the system shall meet chain of custody requirements for both federal and State requirements.
7. Recordings from fixed cameras along the wayside, stations and other Authority owned facilities shall be accessible via the PSIMS as defined above.
8. The central CCTV system shall be able to show, store and analyze video feeds from CCTV systems at all other locations along the Right-of-Way such as stations and maintenance facilities.

9.6.2.8 Video Analytics

1. The CCTV system shall provide a variety of automatic analytics options for detection of anomalous events in locations as determined by the Contractor via a risk assessment process in conjunction with Security and Operations and Maintenance personnel.
2. Video analytics available for use shall be at a minimum, as described APTA Video Content Analytics (VCA) Recommended Practice Transit Applications Draft (www.tswg.org) as issued at the time of NTP.
3. The alarm rules and parameter configurations listed in section 4.2.3 in the APTA Video Content Analytics (VCA) Recommended Practice Transit Applications Draft, as issued at the time of NTP, are the minimum the CCTV system shall provide.

9.6.2.9 Network Interface

1. The Contractor shall assure use of the CCTV system shall not adversely affect performance of the network.
2. The CCTV system transmission protocols shall ensure transfer of all video frames through an open-standard error checking and retransmission protocol.

9.6.2.10 Testing

1. CCTV camera fields of view shall be tested in the field to demonstrate that the live and recorded images meet the intended function.

9.6.3 Electronic Access Control Systems

1. All Pedestrian and vehicular access gates along the Right-of-Way and at Rail Infrastructure System sites shall be locked and controlled via an electronic access control system.
2. An Access Control System shall be provided at all authorized points of entry to the Right-of-Way, shelters, houses and other facilities, to allow for authorized access for routine and emergency purposes.
3. The Contractor shall undertake an Electronic Access Control System risk assessment to identify areas where the access control system shall be installed and what level of protection shall be provided based on local circumstances, hazards and the level of risk. The risk assessment, as a minimum shall assess:
    a. Wayside access;
    b. Access to structures;
    c. Maintenance of Way Facilities and Sidings;
    d. Operations Control Facilities;
    e. Station Platforms;
    f. Cabinets and Shelters;
    g. Vehicle access;
    h. Pedestrian Access;

i. Rolling Stock maintenance facilities; and

j. Access from neighbor, connected railroads and facilities.

4. The Contractor's Electronic Access Control System risk assessment report shall be submitted for Review as stated in Section 3.2.
5. Wayside shelters and houses shall be protected by gates and security doors locked and protected by the electronic access control system.
6. Any System assets that are located away from the Right-of-Way shall be protected by an electronic Access Control System and secured fences and gates as defined by the Contractor's risk assessment.
7. The Access Control System shall allow authorized users to identify themselves and be confirmed as authorized to access prior to granting access.
8. It shall be possible for remote access to be granted to individual controlled access points remotely by an authorized operator.
9. The Access Control System shall provide alarms to the operator when there is evidence of misuse or vandalism.
10. The Access Control System shall provide alarms to the operator if a gate is left open for a length of time more than a defined period.
11. The Access Control System shall interface with locks, CCTV systems, power operated gates, the TIS and any other systems that are required to provide secured access to the System.
12. Access Control Systems shall be provided in accordance with the requirements for Network and Computer Security contained in Appendix 2 of this document.

9.6.4 Fire Detection Systems and Protection

1. Fire detection and protection systems shall be provided in accordance with NFPA 72.
2. All local fire alarm panels in Authority-owned facilities shall report fire alarms to a common fire alarm display at the OCC.
3. Failure of connections between fire detection equipment and local fire alarm panels shall be sent to OCC operators.

9.6.5 Rail Infrastructure Information Management

The Rail Infrastructure Information Management (RIIM) system facilitates remote condition monitoring of the Rail Infrastructure System to enable rapid-response to failures and a predict-and-prevent maintenance regime whose aim is to avoid failures where possible. This requires instrumentation of the rail infrastructure, a means of communicating the gathered data, and a software platform that integrates and analyzes the data feeds, and provides monitoring and control through a uniform user interface.

9.6.5.1 General Requirements

1. Contractor shall provide, operate and maintain a Rail Infrastructure Information Management (RIIM) system to integrate remote condition monitoring data for all Rail Infrastructure System assets and other systems critical to the operation of train movements or required to comply with the Contractor's Asset Management Plans.
2. The Contractor shall risk assess all assets to identify their criticality to delivering the Contract Requirements and establish the monitoring methodology and alarm / intervention limits for each asset.
3. Rail Infrastructure System assets that may have remote condition monitoring applied shall include, but not be limited to:

   a. Environmental sensors (including temperature, humidity, water levels);

b. Shelter and wayside cabinet monitoring – alarms from shelters and wayside cabinets shall be as defined in the NPSTC PSGSF;

c. All power supplies (including monitoring for heartbeats, power outages, circuit breaker trips, frequency and phase, earth leakage and battery condition notifications);

d. Switch current during switch operation;

e. Heating, Ventilation and Air Conditioning (HVAC) equipment;

f. Electrical distribution systems;

g. Critical drainage systems including tunnels and trenches;

h. Movement and settlement of earthworks; and

i. Any other systems critical to the operation of train movements or required to comply with the Asset Management Plans.

9.6.5.2 Interfaces to Monitored Equipment and Sensors.

1. The RIIM system may be, as a method of monitoring status:

   a. Physically connect to monitored equipment and sensors via discrete inputs wired to dry contacts on the monitored equipment or sensor for monitoring digital outputs;

   b. Physically connect to monitored equipment and sensors via analog inputs capable of measuring the continuous voltage or current output of the monitored equipment or sensor;

   c. Logically connect to monitored equipment via a software interface utilizing the monitored equipment's SDK or API;

   d. Logically connect to monitored equipment via standard monitoring protocols (e.g. Simple Network Management Protocol (SNMP)); and

   e. Routed through the Integrated Information Management Platform (Section 9.6.8).

9.6.5.3 Data Collection & Interfaces to Monitored Equipment & Sensors

1. The RIIM system shall collect any data:

   a. Measurements, events, alarms, that are made available by the monitored equipment's SDK or API;

   b. Events and alarms that are made available by the monitored equipment's supported standard monitoring protocol (e.g. SNMP); and

   c. Events and alarms received via either digital or analog inputs connected to the monitored equipment and sensors.

9.6.5.4 Data Correlation

1. The RIIM system shall provide customizable correlation of the collected data (e.g., measurements, events, alarms) from different monitored equipment and sensors to raise alarms based upon such correlated data.

9.6.5.5 Graphical User Interfaces

1. The RIIM system shall provide configurable Graphical User Interfaces screens that are customized (and freely customizable at a subsequent time) to only display alarm and monitoring data that is relevant based upon a user's role and responsibilities.
2. The RIIM system GUI shall provide a uniform manner for users to perform common monitoring functions across similar equipment.
3. The RIIM system GUI shall be able to run on workstation computers as well as portable devices including tablets and smart phones.

4. The RIIM system GUI shall display real-time events and alarm data on a graphical map-based display with simultaneous display of alarm lists maintenance actions.
5. The RIIM system GUI shall overlay icons representing assets on two-dimensional maps based upon GIS coordinates of the asset such that the icon's location on the model/map accurately represents the physical location of the asset it represents.

9.6.5.6 Reports

1. The RIIM system shall generate reports automatically and on-demand.
2. The RIIM system shall generate maintenance reports that include equipment and sensor notifications, alarms, measurements and performance data.
3. The RIIM system shall generate alarm log reports, including alarm details such as the date and time the alarm originated, was acknowledged, was closed, and the user that handled the alarm.
4. The RIIM shall automatically send of reports and notifications of reports to selected personnel, which shall be freely configured by administrative personnel.

9.6.5.7 Scalability

1. The RIIM system shall be scalable to interface with all monitored equipment and sensors along the Right-of-Way and in facilities in support of the final Network.

9.6.6 Public Address and Customer Information Systems

Public Address and Customer Information Sign Systems (PACIS) provides users of the Network all of the following:

a. Train service information;
b. Safety and security information;
c. Emergency and evacuation information;
d. Information about user facilities at the station;
e. Local transit connection details; and
f. Authority-controlled advertising.

9.6.6.1 General Requirements

1. Contractor shall provide, operate, and maintain a PACIS system at all stations within the Geographical Limits.
2. Contractor shall coordinate with other parties determined by the Authority to provide the PACIS system at locations within stations and other locations.
3. PACIS information, which is real time and synchronized, shall be delivered to users via:
   a. Audio announcements;
   b. Visual messages;
   c. Digital content made available to apps and browsers on users' smartphones, computers and other communicating devices and platforms; and
   d. Audio announcements accessible via T-coil receivers.
4. All PACIS functionality shall support multiple languages, including:
   a. English; and
   b. Spanish

5. Train running information required by PACIS shall be provided in real time by the ATC system via an open, non-proprietary, documented protocol operating over Internet Protocol and made externally available on request.
6. Any interruption to the information feed from the ATC system shall:
    a. Be self-diagnosed by the PACIS as a fault; and
    b. Not result in the PACIS providing out-of-date information to customers
7. Information provided by PACIS shall always be accurate and up-to-date.
8. PACIS shall have a geographically distributed architecture, so that unavailability for any reason of any function(s) at one location does not impact the operation of other parts of the system.
9. As defined in the Emergency Response Plan, the PACIS shall comply with Emergency Voice/Alarm Communication Systems (EVACS) requirements contained within the National Fire Alarm and Signaling Code (NFPA 72).
10. All audio announcements from loudspeakers shall always provide good speech intelligibility as measured using the STI-PA metric and the STI-PA score shall meet the requirements of NFPA 72 in all locations for emergency announcements.
11. The definition of EVACS events and the corresponding behaviors of the PACIS shall be explained in the Emergency Response Plan which will be provided for each station.
12. The loudspeaker type and placement shall be so as not to impact adjacent residential neighborhoods.
13. Contractor shall coordinate with other parties, determined by the Authority, to mutually agree the format of PACIS information that is presented to users.
14. Contractor shall coordinate with other parties, determined by the Authority, to mutually agree additional PACIS information, if any, beyond the requirement specified below, that is to be presented to users.
15. PACIS, or parts thereof, may be operated by other parties determined by the Authority, who shall be able to freely operate and control the PACIS system, including the capability to freely modify the format and content of PACIS information and other content presented to passengers.
16. Contractor shall coordinate with other parties, determined by the Authority, to agree and provide suitable training courses that provide a competency to operators of the PACIS system.
17. The PACIS system shall have the capacity to serve all station areas of the Network, including the capability and capacity to support:
    a. A main departures board that shall include, at a minimum, the following information about all trains departing within the next two hours:
        i. Train number;
        ii. Scheduled departure time;
        iii. Destination;
        iv. All intermediate station stops;
        v. Expected time of arrival;
        vi. Platform;
        vii. Passenger facilities on the train;
        viii. Name of the train operator; and
        ix. Clock displaying current local time.
    b. A main arrivals visual display board that shall include, at a minimum, the following information about all trains arriving within the next two hours:

i. Train number;
ii. Scheduled arrival time;
iii. Origin;
iv. All intermediate station stops;
v. Expected time of arrival;
vi. Platform;
vii. Name of the train operator; and
viii. Clock displaying current local time.

18. PACIS clocks shall have digital displays that show local time in the 24-hour format: HH:MM:SS.
19. PACIS clocks shall be configurable to show local time in AM/PM format.
20. Displays that have dates shall use US customary format – MM:DD:YY.
21. PACIS clocks shall maintain synchronization to a 'Stratum 3' time source or better – see Network Timing Systems Requirements.
22. Contractor shall work together with the Rolling Stock supplier so that staff at the OCC may select a Rolling Stock or group of Rolling Stock and make live audio announcements and immediately display text-based messages via the Rolling Stock onboard public address and customer information display system(s).

9.6.6.2 Zoning Requirements

1. PACIS shall allow "zones" to be defined so that the information can be distributed as required within the station area.

   A PACIS outlet is defined as any PACIS audio loudspeaker, PACIS T-coil transmitter, or visual display. A zone is defined as any set of one or more PACIS outlets.

2. PACIS shall allow zones to be defined by PACIS operating personnel.
3. PACIS shall have, minimum, preconfigured zones:
   a. One zone covering the entire station;
   b. One zone covering all platforms; and
   c. A separate zone for the platform area associated with each track.
4. PACIS shall support overlapping zones.
5. PACIS shall allow different information to be distributed to different zones simultaneously.
6. PACIS shall allow the same information to be distributed to different zones simultaneously.

9.6.6.3 Visual Display Requirements

1. A "next train" visual display shall, at a minimum, display the following information simultaneously about the next departing train from the platform where it is located:
   a. Train number;
   b. Scheduled departure time;
   c. Destination station;
   d. Expected time of arrival;
   e. Platform;
   f. All intermediate station stops (may require scrolling text); and

g. Clock.

2. If there is no departing train within the next 12 hours from the platform where a “next train” visual display is located the display shall only display the clock, at a minimum.
3. A “summary of services” visual display shall, at a minimum, display the following information simultaneously about all trains departing within the next two hours at the local station (multiple time-sequenced pages may be required):
    a. Train number;
    b. Scheduled departure time;
    c. Destination station;
    d. Expected time of arrival;
    e. Platform;
    f. Origin station; and
    g. Clock.
4. A “general information” visual display shall be located alongside each “summary of services” visual display which can display multiple, sequenced pages of arbitrary, colored text and a minimum 32-bit colored graphical information as may be defined by the Service Operator, such as:
    a. Service disruption messages;
    b. Safety and Security messages;
    c. User facilities at the station and maps;
    d. Local transit services serving the station; and
    e. Advertisements.
5. Users leaving a train shall, at a minimum, be presented with one “summary of services” visual display on the signposted walking route to any exit from the platform towards another part of the station.
6. Upon arriving onto a platform from another part of the station, users shall be immediately presented with a “next train indicator” pertaining to the adjacent track(s).
7. In the case of an island platform, there shall be a “next train indicator” for each track.
8. Users on a platform with 20/20 visual acuity shall be able to read the information on a “next train indicator” pertaining to the adjacent track for all typical ambient light levels.
9. Station names shall not be abbreviated to fewer than 22 alphanumeric characters on visual displays.

9.6.6.4 Integrated Audio-Visual Requirements

1. All PACIS shall override existing audio announcements or visual messages when emergency or higher priority information needs to be provided.
2. PACIS shall provide automatically-scheduled, synchronized “next train” audio announcements and visual messages for any track or any chosen set of tracks at a station.
3. It shall be possible for PACIS operating personnel to suspend or resume automatically-scheduled announcements/messages at any time.
4. It shall be possible for PACIS operating personnel to suspend or resume automatically-scheduled audio announcements and visual messages independently of each other.
5. The information on the “next train” visual displays for a platform shall be provided via audio announcements from loudspeakers and T-coil compatible transmitters located on the same platform:
    a. Upon any change of the information that is visually displayed; and

b. Repeated every X minutes, where X is a configurable parameter.

6. It shall be possible for PACIS operating personnel to assemble text-to-speech audio announcements for immediate or future use.
7. It shall be possible for PACIS operating personnel to make live audio announcements.
8. The information contained in audio announcements from loudspeakers and T-coil compatible transmitters located on a platform shall be provided in a text format on a visual display on the same platform:
   a. At the same time for automatically-scheduled, pre-recorded and pre-assembled announcements; and
   b. Within 60 seconds for live audio announcements.
9. It shall be possible for PACIS operating personnel to configure the distribution of messages and announcements to any defined zone:
   a. At one or more absolute times in the future; and
   b. At regular configurable intervals between a start time and an end time.
10. It shall be possible for PACIS operating personnel to record audio announcements and assemble visual text messages for future use.
11. It shall be possible for PACIS operating personnel to delete recorded audio announcements and visual text messages.
12. Announcements and visual text messages shall remain retrievable from an archive for at least 90 days after deletion.

9.6.6.5 Operation of the PACIS

1. Operation of the PACIS functionality shall be via a Graphical User Interface.
2. It shall be possible to operate any part of the PACIS from the OCC.
3. It shall be possible to operate any part of the PACIS from the any local station control room or from a centralized station control room.
4. It shall be possible to configure PACIS so that a location can, under normal circumstances, only operate PACIS functions pertaining to a selected set of zones at one or more locations.
5. The GUI shall visually represent appropriate parts of the entire system and sub-divisions and indicate the system's current operational status, including active zones and fault indications, with access to activity logs as well as the ability to manually control the audio announcements and visual messages in any part of the PACIS.

9.6.6.6 PACIS System Management

1. The PACIS management system shall self-diagnose system faults, including the intelligibility of the audio and visual announcements.
2. The PACIS management system shall provide a freely-configurable 'northbound interface' which shall pass selected alarms in an open, non-proprietary, and documented data format to other alarm management systems as may be required by other system requirements.
3. The PACIS management system shall make the PACIS operating personnel aware of any service-affecting (i.e. train-service or customer-service) fault of the PACIS system.
4. The PACIS management system shall make the maintainer of the PACIS aware of any fault of the PACIS system.
5. The PACIS shall maintain for at least 90 days an historical record archive of system faults, including fault event timestamp, fault location, fault type, fault cleared timestamp.

9.6.7 Universal Console

Universal consoles allow each operational console to be reconfigurable to allow multi- functional operation of the Rail Infrastructure System.

1. The Contractor shall provide, operate and maintain Universal Consoles that deliver full compliance with the relevant requirements of discrete functions and systems and provides respective Safety Integrity Levels and safety and security.
2. Universal consoles shall be located at the Operational Control Facilities or other remote locations as required.
3. Reconfiguration/reassignment of the consoles shall be via operator logon and shall not require any specialist coding.
4. The Universal Console shall interface with all relevant voice communications.

9.6.8 Integrated Information Management Platform

The Integrated Information Management Platform (IIMP) is an overarching system that brings relevant information to the attention of personnel who can act or respond accordingly to minimize any short term impact or potential impact to the operation of the Network.

1. The IIMP shall NOT replace the specialized, proprietary management and monitoring functionality that may exist as part of each underlying system.
2. If the IIMP fails all safety-critical and essential systems shall be instantly accessible.

   Figure 3 is designed to illustrate the IIMP and its interaction with underlying infrastructure systems, including:

   a. Alarm distribution as described in the Contractors Alarms Management Plan;
   b. Rolling Stock fault management system(s);
   c. Communications Network Management Systems;
   d. OCS/TES SCADA Systems;
   e. Physical Security Information Management System (PSIMS);
   f. Rail Infrastructure Information Management (RIIM) System;
   g. Hazard Detection and Early Warning System (HDEWS); and
   h. ATC System and its associated fault management systems.

The conceptual system components are highlighted using a gray background. Note that the figure is not intended to and does not prescribe the exact nature, number or locations of operational roles and responsibilities.

Referring to figure 3, underlying systems handle their own alarm information in the usual way but selected alarm information is also passed up to the IIMP via northbound interfaces.

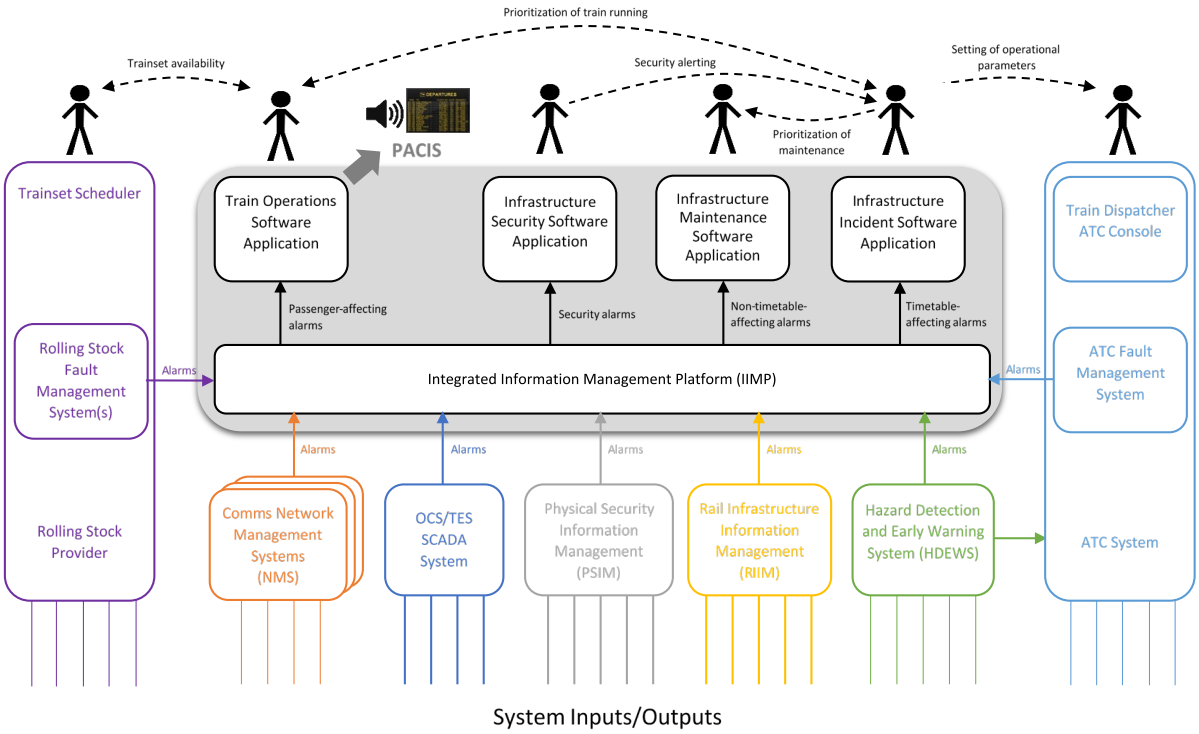


Figure 3: Integrated Information Management Platform (IIMP)

Alarm information passed up to the IIMP consists of any system events, states and conditions deemed to be significant to the short-term operation of the railroad and ability to meet the published Operational Plan. The IIMP processes and presents this information to achieve the following aims:

a. To bring relevant information to the attention of those who can act or respond accordingly to minimize any impact or potential impact to the operation of the Network;

b. To enable personnel to make rapid and informed decisions that minimize or avoid disruption to trains and passengers in the event of system failures;

c. To provide an auditable record of events and actions taken in response to incidents; and

d. To present information from a variety of underlying systems to operations and maintenance personnel in a consistent and uniform way via an IIMP software application running on a ‘universal console’, as described elsewhere in these specifications, or running on another suitable device as may be determined by the Contractor for any given role.

3. All systems which generate or process information which may have a bearing on the immediate or impending ability to run trains to the Operational Plan shall be able to generate or pass on information via a northbound interface to the integrated information management platform (IIMP).

4. Systems which generate or process information which may have a bearing on the ability to run trains to the Operational Plan shall include:

a. Rolling Stock fault management system(s);

b. Communications Network Management Systems;

c. OCS/TES SCADA Systems;

d. Physical Security Information Management System (PSIMS);

e. Rail Infrastructure Information Management (RIIM) System;

f. Hazard Detection and Early Warning System (HDEWS); and

g. ATC System and its associated fault management systems.

5. Contractor shall co-ordinate with the Authority and its selected representatives to determine all user roles of the IIMP and shall work with those parties to design and customize the IIMP software application for each user role, through to final acceptance by the Authority.
6. Information received by the IIMP which indicates an impact or potential impact to the real-time running of trains shall be filtered and presented on an IIMP software application that shall be customized for a role associated with the management of infrastructure incidents.
7. Information received by the IIMP which indicates that some part of the infrastructure requires maintenance attention shall be filtered and presented on an IIMP software application that shall be customized for a role associated with the management of faults and other maintenance activities.
8. Information received by the IIMP which is associated with the security of the Network shall be filtered and presented on an IIMP software application that shall be customized for a role associated with the security and security monitoring of the Network.
9. Information received by the IIMP which indicates an impact or potential impact to passengers shall be filtered and presented on an IIMP software application that shall be customized for a role associated with train operations.
10. The universal console shall execute the IIMP software application for all the above mentioned customized roles.
11. Contractor shall work with the Service Operator and the Rolling Stock provider and other parties determined by the Authority to successfully integrate into the IIMP alarm information from the Rolling Stock.
12. Contractor shall provide suitable training courses that provide the required level of competency to operators of the IIMP.
13. Authorized personnel shall be able to freely add and customize additional roles without restriction on the IIMP.
14. The IIMP shall freely support additional underlying systems without restriction.
15. The IIMP shall automatically timestamp, record and store for at least five years all information and inputs.
16. The IIMP shall co-ordinate with asset management systems to correctly and uniquely identify systems and components which may be the root cause of any alarm information.
17. Contractor shall provide evidence that the IIMP minimizes the impact of early component or subsystem obsolescence.
18. The IIMP shall not preclude the Authority from expanding the IIMP or underlying system via subsequent, open procurements.
19. The IIMP shall provide a means by which to retrieve and playback previously recorded and stored information and inputs through some or all the consoles so as to accurately re-enact a situation that occurred at an earlier time – e.g. for investigation and analysis purposes.
20. The IIMP shall provide a means by which to electronically export previously recorded and stored information in a standard, non-proprietary format, including CSV (comma-separated values) format.
21. The IIMP shall have geographically redundant architecture.
22. The information presented by IIMP shall be in real time.
23. The information received, processed and correlated by the IIMP shall be user-configurable and customizable without restriction.
24. The information presented by the IIMP via the application on the universal consoles shall be user-configurable and customizable without restriction.

25. The IIMP shall communicate to all other systems and to the consoles using non-proprietary, open standard interfaces and protocols.
26. The IIMP shall communicate to other systems using the Internet Protocol.
27. The IIMP shall be fault tolerant so that failure of any single IIMP system component or failure of any IIMP system input does not result in unavailability of entire IIMP system.
28. The IIMP shall self-diagnose system faults and make the information available to maintenance personnel by a means additional to the IIMP software application customized for a role associated with the management of faults and other maintenance activities.

9.6.9 Network Timing System

The Network Timing System provides a common time and date across the Rail Infrastructure System and its assets.

1. Contractor shall provide, operate and maintain a Network Timing System.
2. All devices connected to the wayside and Rolling Stock networks requiring time synchronization shall be synchronized to the Network Timing System that shall provide a common time reference source traceable to national standards.
3. The precision of the common time reference shall meet the synchronization requirements for the equipment, devices and applications requiring time.
4. The common time reference shall deliver time and date in a Coordinated Universal Time (UTC) format.
5. Applications which require to timestamp log entries, alarms, events etc., shall use Pacific Standard Time (PST) expressed in the 24-hour format: HH:MM:SS. to an accuracy of one hundredth of a second.
6. Clocks, displaying the common time reference, shall be configurable to display UTC, PST or Pacific Daylight Time (PDT) in 12- or 24-hour format.
7. If an Internet Protocol is used for time delivery, it shall be a commonly available, open sourced protocol meeting the timing requirements determined by the Contractor with an example being Network Time Protocol.
8. Customer facing and operator time displays shall be shown in Pacific Standard and Pacific Daylight time as defined for the United States.
9. The common time reference equipment and means of delivering time reference shall be hardened against spoofing and malicious intent.
10. The common time reference equipment shall be remotely managed.
11. The common time reference shall send alarms to appropriate personnel.
12. Maintenance alarms shall include intermittent and hard failures for delivering the common time reference signal.

9.7 Shelter and Wayside Cabinets Requirements

Equipment shelters are designated as non-regularly occupied and non-passenger facilities which house equipment.

Wayside cabinets are located along the Right-of-Way for housing equipment supporting operation of the Rail Infrastructure System.

1. Shelters shall be designed to meet the seismic, structural and physical design requirements that may impact the Rail Infrastructure System within the Geographic Limits.
2. Shelter and wayside cabinets shall be designed to be secure from intrusion in accordance with the requirements for System Safety and Security Management Plan.

3. Shelter and wayside cabinets shall be designed to withstand the pressure pulse from passing Rolling Stock at speeds up to the Testing Speed. Additional care shall be made in tunnel sections of route.

9.8 Test System

1. Contractor shall provide, operate and maintain a Test System that demonstrates system concept and provides an ability to test system alterations.
2. The Test System shall comprise all elements of the Rail Infrastructure System arranged to be representative of the System.
3. The Test System shall not be require to have rail vehicles on it, however, the Contractor shall provide a means of testing how train mounted Rail Infrastructure Systems integrate with the Test System.

9.9 Maintenance of Way Facilities and Sidings

1. Maintenance of Way Facilities (MOWF) and Sidings (MOWS) shall be located at designated sites and include all infrastructure, equipment and staff necessary to maintain the Rail Infrastructure System.

   The Authority is seeking environmental clearance for proposed Maintenance of Way Facilities and Sidings in and around the following locations:

   a. Gilroy – (MOWF);
   b. Los Banos (MOWS);
   c. Madera Avenue 12 (MOWF);
   d. Fresno (MOWS);
   e. Corcoran (MOWS); and
   f. Shafter (MOWF).

2. Contractor shall confirm the locations it intends to use for Maintenance of Way Facilities and Sidings and submit a Maintenance of Way Facilities and Sidings Plan for Review as stated in Section 3.2. This report shall include:

   a. layout;
   b. accommodation;
   c. welfare facilities;
   d. access;
   e. storage for plant and materials;
   f. parking;
   g. traffic management; and
   h. Utilities required at each location.

3. Contractor shall implement systems for the safe access and egress of trains, plant and equipment, and personnel, from the MOWF/MOWS to the Mainline Tracks.
4. Contractor shall provide, operate and maintain the Maintenance of Way Facilities and Sidings and shall be responsible for all activities undertaken therein, including but not limited to safe movement of plant, equipment, trains and personnel.
5. Each of the MOWF and MOWS shall enable the on- and off-tracking of Railway Equipment, high-rail and other road-rail convertible equipment.

9.10 Mechanical and Electrical Equipment

Mechanical and electrical equipment includes all mechanical and electrical equipment required to provide, operate and maintain the Rail Infrastructure System assets.

The Base Design will include any design that has been undertaken by the Interfacing Parties.

1. Contractor shall provide and maintain all mechanical and electrical equipment. This shall include, but is not limited to:
    a. Suitably conditioned and reliable power supplies for all Rail Infrastructure Systems;
    b. Lighting;
    c. Emergency lighting;
    d. Pumps;
    e. Tunnel life safety systems;
    f. Fire life safety systems;
    g. Ventilation systems;
    h. Points Heating; and
    i. Building Services for all buildings, equipment rooms and cabins.
    j. Passenger vertical circulation equipment (escalators and elevators)
2. Contractor shall provide suitable and sufficient power required by the mechanical and electrical equipment.

9.11 Transfer Tracks

A Transfer Track is the connection between third party tracks and the Rail Infrastructure System.

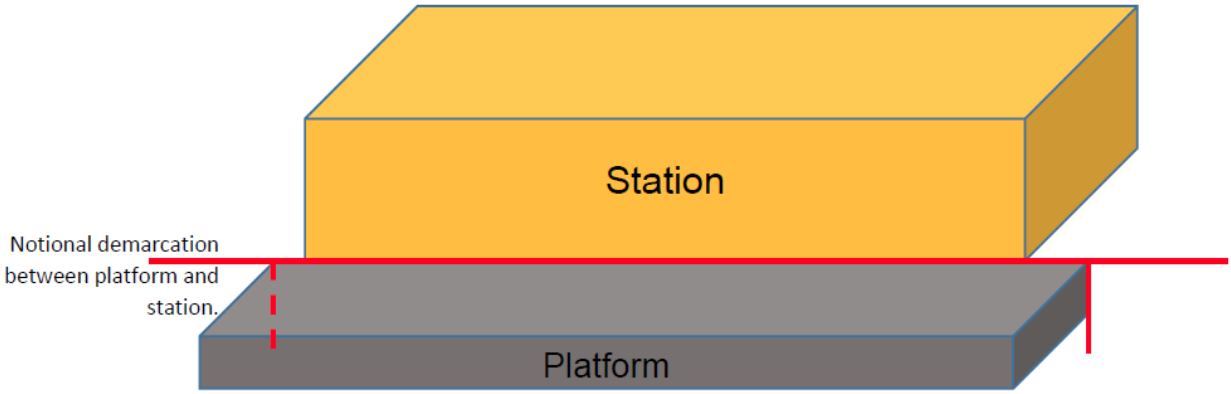
1. The Transfer Track shall be a functioning element of the Rail Infrastructure System, with all necessary Civil, Track, Automatic Train Control, Traction Electrification System and Communications systems provided to enable acceptance from and hand over to the third-party facility.
2. Transfer Tracks shall be provided at the:
    a. Rolling Stock Maintenance Facilities;
    b. Maintenance of Way Facilities;
    c. Fringes to neighbor railroads (Blended Sections); and
    d. Freight Connections (3 No. at locations to be confirmed)
3. Contractor shall integrate the Rail Infrastructure System with all third-party systems that interface with the Transfer Track.
4. Contractor shall provide Transfer Tracks up to an agreed Transfer Point.
5. To ensure the horizontal and vertical alignment is maintained to contractual tolerances the nominal Transfer Point shall be at the center of a “combined maintenance section” the length of which shall be nominally 200 m both sides of the Transfer Point.

9.12 Station Platforms

A Station Platform is a designated location adjacent to station tracks where passengers can access and egress the High-Speed Rail Train services. Station buildings beyond the platform, access and egress facilities onto the Station Platform will be provided by the Authority. Information on Rolling Stock lengths and passenger capacity is detailed in Section 19.5.2 – Rolling Stock. The Station Platforms shall be provided at stations as defined in section 6.2.3.

1. Contractor shall provide and maintain station platforms and all associated equipment related to the dispatch of trains to achieve the desired train schedule.
2. Contractor shall provide all PACIS equipment for Stations and Platforms as detailed in Section 9.6.6.

3. Contractor shall be responsible for integrating the station, platform and associated operational equipment, systems and interfaces.
4. Contractor shall provide all station platforms to allow level boarding along the full length of a single Rolling Stock from the platform face to the rear of the platform.
5. The interface between the Contractor and Stations Contractors shall be the rear of platform.



6. Contractor shall provide and maintain any equipment located on the platform for the safe dispatch of trains, or maintenance of the Rail Infrastructure System.
7. Platform faces shall allow level access to all platform side Rolling Stock doors.
8. When the Authority confirms the preferred Rolling Stock design, the platform height above top of rail will be set for each platform, as required.
9. Platforms shall be of sufficient length to allow safe access to all platform-side Rolling Stock doors for the full length of a Rolling Stock.
10. Platform width shall meet the requirements of the Americans with Disabilities Act.
11. The platform width shall be sufficient to allow accessibility and circulation for the maximum number of passengers based on projected ridership for the station.
12. Train tracks at stations shall be provided with a locally unique track number.
13. Any platform systems to facilitate testing, commissioning, entry into service and shadow operation, if a station is not available shall be provided by the Contractor.
14. Contractor shall provide, operate and maintain any required vertical circulation elements required on station platforms. This shall include, but not be limited to:
    a. Elevators;
    b. Escalators;
    c. Stairs; and
    d. Bridges.
15. Contractor shall provide all electrical and mechanical services required for the operation of all vertical circulation equipment provided at stations.
16. PE sealed design for station canopies will be provided to the Contractor by the Authority. The Contractor shall provide canopies on station platforms as shown in Authority issued designs.
17. Contractor shall provide and maintain an interface, located in a position agreed with the station Contractors, to allow station Public Address and Customer Information Systems (PACIS), station CCTV, station alarms to be communicated to the operational control center.
18. Train status data shall be communicated to station PACIS systems via suitable interfaces.

9.13 Tunnels

Authority tunnels will allow for Train Operations at speeds of up to 321 km/h (200 mph).

1. Within and around tunnels and cross passages between tunnels the Contractor shall provide and maintain all equipment required for the Rail Infrastructure System to achieve the Contract Requirements.
2. Contractor shall ensure that walkways provided in tunnels deliver the required access for both pedestrians and any materials required to inspect, operate, maintain, overhaul and renew the Rail Infrastructure System within the tunnels and associated cross passages.
3. Contractor shall provide walkways that provide the required emergency access and egress from trains to positions of safety provided within the tunnels and cross passages and shall comply with the requirements System Safety and Security Management Plan.
4. Contractor shall ensure that walkways constructed within tunnels provide all required trackway clearances in accordance the Base Design, for any rail vehicles that may be required to travel through the tunnels during the Service Period.
5. Contractor shall ensure that the physical placement of Rail Infrastructure System assets does not impact on the ability of Rolling Stock to travel through the tunnels at the Testing Speed.
6. Rail Infrastructure System assets located within tunnels or tunnel portals shall withstand fatigue and dynamic forces that may occur in a tunnel environment due to the passage of Rolling Stock up to and including the Testing Speed. The Contractor shall undertake modelling and testing to demonstrate that all Rail Infrastructure System assets comply with this requirement.
7. Rail Infrastructure System assets located within tunnels or tunnel portals shall withstand environmental conditions that may occur in a tunnel environment. The Contractor shall undertake modelling and testing to demonstrate that all Rail Infrastructure System assets comply with this requirement.
8. Rail Infrastructure System assets located within tunnels or tunnel portals shall be zero halogen, low smoke.

9.14 Vehicle Monitoring Systems

1. Contractor shall provide vehicle monitoring systems that measure characteristics of rail vehicles accessing the Network to:
    a. Minimize the risk that a damaged vehicle will damage the Network;
    b. Minimize the risk that a malfunctioning vehicle will cause a safety issue on the Network;
    c. Restrict access to the Network for vehicles that are out of gauge; and
    d. Restrict access to the Network for vehicles that are not compatible with the Rail Infrastructure System.
2. Contractor shall carry out a risk assessment that identifies:
    a. The type of monitoring system to be provided;
    b. Where the monitoring systems shall be located;
    c. Who the monitoring system shall notify in the event of an alarm; and
    d. What course of action shall be taken for vehicles that trigger an alarm event.
3. Where vehicle monitoring systems are provided and there is a requirement to integrate the alarms into a Rail Infrastructure subsystem, the Contractor shall undertake this work and shall be responsible for the integration activities.

10 RELIABILITY, AVAILABILITY AND MAINTAINABILITY

10.1 RAM Program Management Plan

1. Contractor shall submit a RAM Program Management Plan for review as defined in Section 3.2. The RAM Program Management Plan shall:
    a. Establish a preliminary Contractor RAM Program for all Rail Infrastructure System scope, including Received Civil Works and Rail Infrastructure System Civils;
    b. Comply with the requirements of the CHSR RAM Program Plan, EN 50126, and all applicable regulatory requirements including RAM requirements in 49 CFR 200-299;
    c. State the RAM Program scope and objectives, and the management processes and methodologies the Contractor will use during design, implementation, and operation; and
    d. Provide the detail level appropriate to demonstrate the Contractor's ability to:
        i. Execute the Contractor RAM Program; and
        ii. Ensure the Rail Infrastructure System meets the Contract Requirements and the Contractor MTBSI and MTTRS Estimates in revenue service.
2. During design, implementation, and operation, the Contractor shall execute a RAM Program consistent with the RAM Program Management Plan.

10.2 RAM Estimate

1. Contractor shall submit a RAM Estimate with its proposal that demonstrates the proposed work will comply with the Contract Requirements. The RAM Estimate shall:
    a. Include all Rail Infrastructure System scope;
    b. Be detailed to the subsystem level;
    c. Provide Contractor MTBSI and MTTRS Estimates for each subsystem and totals for the Rail Infrastructure System scope; and
    d. Include a report explaining how the Contractor's Rail Infrastructure System design and implementation will achieve the Contractor MTBSI and MTTRS Estimates in revenue service. The report shall include a description of project aspects critical to the achievement of Contractor MTBSI and MTTRS Estimates, including an explanation of tradeoffs between initial capital and future maintenance costs, and plans to ensure accessibility of project elements.
2. Contractor MTBSI and MTTRS Estimates shall incorporate the lifecycle maintenance strategy in the Maintenance Plan, per Section 10.
3. During design and implementation, the Contractor shall submit RAM deliverables that verify the Rail Infrastructure System will achieve the Contractor MTBSI and MTTRS Estimates. During revenue service, the Rail Infrastructure System shall comply with the Contractor MTBSI and MTTRS Estimates.

10.3 Contractor RAM Program

1. Contractor shall establish and execute a Contractor RAM Program that:
    a. Integrates the Rail Infrastructure System RAM Program with all design, analysis, testing, documentation, and certification activities for the Contractor and suppliers of all systems, facilities, equipment, and procedures which affect RAM performance through all project sections and phases;
    b. Coordinates with the Contractor RAM Program, the Authority, and other involved parties;
    c. During design and implementation, provides evidence within the System Definition Document that demonstrate the Rail Infrastructure System complies with the Contract Requirements and Contractor MTBSI and MTTRS Estimates; and

d. During operation, measures and records MTBSI and MTTRS performance, and reports performance to the Authority as required to demonstrate compliance with the Contract Requirements and Contractor MTBSI and MTTRS Estimates.

2. Contractor shall provide a Rail Infrastructure System Contractor RAM Program Plan for Review per Section 3.2.
3. Contractor RAM Program Plan shall provide:
    a. A detailed description of the Contractor RAM Program including scope, objectives, and deliverables, and explain the contents of each deliverable and the techniques and methodologies used to assure compliance with the Contract Requirements and RAM Estimate MTBSI and MTTRS estimates;
    b. A Contractor RAM Program schedule, which identifies start and completion dates for each deliverable and explains how the deliverables are coordinated with major project milestones;
    c. The organization of Contractor and supplier personnel responsible for performing the Contractor RAM Program; and
    d. Plans for the Contractor to interface to and coordinate the RAM Program with system assurance activities including system safety, design, procurement, and quality assurance.
4. Contractor shall provide all RAM deliverables specified in the Contractor RAM Program Plan.
5. Contractor shall maintain and update the Contractor RAM Program Plan at 6 month intervals for the Contract Duration, so the Contractor RAM Program description, schedule, organization, status, and interfaces are correct.
6. Contractor may provide individual RAM deliverables at the detail level appropriate to item complexity or supplier scope, or to advance the schedule if the Contractor complies with the requirements for each deliverable, and maintains a RAM deliverables status report.
7. All changes to the Contractor RAM Program shall be subject to review and acceptance by the Authority, and shall be reflected in the execution of the Contractor RAM Program upon acceptance.

11 SYSTEM VALIDATION AND ACCEPTANCE

11.1 Verification and Validation

1. All Rail Infrastructure System component systems, subsystems, elements and components shall be verified and validated by the Contractor in accordance with the Systems Validation Plan.
2. Contractor shall appoint a competent lead person who will be responsible for ensuring all required verification and validation activities are planned, agreed, documented, undertaken, evidence gathered and certified by competent personnel.
3. Contractor shall document in the System Definition Document all verification and validation activities that shall be undertaken to provide evidence of compliance with all State and federal statutes and requirements as well as Authority defined requirements.
4. The verification and validation activities that the Contractor plans to use shall be documented and issued for Approval in the System Definition Document and the Inspection and Test Plans.
5. Where verification and validation work is taking place prior to the completed system being available (stage work), the Contractor shall produce interim Verification and Validation Plans as required that demonstrate how activities shall be undertaken so that the respective area, and then the system as a whole, shall perform safely once complete.
6. Contractor shall ensure that, during the Design and Demonstration Phase, the Verification and Validation team works with the Design team on the high-level safety and operational performance principles from the commencement of the System Definition Phase so that the System can be designed to allow for effective and robust verification and validation activities to take place.
7. Contractor shall ensure that the Verification and Validation team, while working on high level principles input to the design of the System, shall not, in any way involve themselves in, and remain independent of, the detailed design process so as not to compromise the validity of their independent verification and validation activities.
8. Contractor shall provide all personnel, with the required qualifications and experience, necessary to verify, validate and certify the System.
9. Contractor shall submit for Acceptance, as stated in Section **Error! Reference source not found.Error! Reference source not found.**, their Verification and Validation specifications relating to activities detailed in the Systems Validation Plan, Inspection and Test Plan and the System Definition Document.
10. Contractor shall certify the System in accordance with the Verification and Validation specifications and provide all necessary evidence to support the certification and confirm that no unsafe conditions are masked by normal conditions or by failure conditions.
11. Contractor shall design the Verification and Validation process and schedule so that the Contractor can certify the safety and operation of the System based on the Verification and Validation process.
12. Contractor shall validate the System to certify that in the event of any failures within the System, there shall be no unsafe conditions while the System continues to operate.
13. Contractor shall validate the System to certify that, when areas of the System are under test, the System shall continue to function safely.
14. Contractor shall certify that the functionality of one part of the System does not mask a failure or an unsafe condition in another part of the System.
15. Contractor shall validate the System to identify that all safety critical failures in the System are ”self-revealing” and always result in a fail-safe condition.
16. Contractor shall validate the System to certify that the principles of the safe operation of the System are achieved and documented.

17. Contractor shall validate all safety critical data and safety critical software systems in a laboratory environment (workstation validation) and certify that the System operates as designed, and as defined in the System Definition Document, before being deployed to the field.
18. Once deployed to the field, the Contractor shall integration test the System to certify that the CHSR System, as installed, operates as designed, and as required by regulation, before trial running can commence.
19. Contractor shall certify areas of the system where there is an interface to both internal and external systems. As System Integrator, the Contractor is responsible for the safe operation of the interfaces.
20. Where verification and validation is required between the System and connected neighbor railroad systems, the Contractor shall be responsible for certifying the safety of both systems at the fringe area.
21. During system integration testing, the Contractor shall correspond each item of equipment back to its controlling and monitoring devices throughout the System. The validation of the tests shall include proving the status of equipment that could have alternate states (such as switch positions), display their actual status.
22. During system integration testing, the Contractor shall correspond each item of equipment that is displayed on the operators control panel to the equipment in the field to ensure that it is correctly displayed. The validation of the tests shall include proving the status of equipment that could have alternate states (such as switch positions), display their actual status.
23. Contractor shall maintain, and submit for audit purposes, a record of all verification and validation carried out and the name and competence of the person carrying out the work.
24. All Verification and Validation reports created by the Contractor shall be signed and dated by the person in charge of the testing.
25. Contractor shall provide a process that feeds back to the responsible designers any faults or failures in the System identified during verification and validation so that modifications can be designed and issued.
26. Once validation work is started, the Contractor shall ensure that no further installation works take place in the area being worked on without safeguards being in place to prevent changes to the respective system, or related systems, being made in an uncontrolled manner that may affect the validity of the validation.
27. Contractor shall submit for Review, as detailed in Section 3.2, a Verification and Validation Report documenting:
    a. That all installation is complete;
    b. Verification and validation work has taken place on the correct version of the" released for construction" designs;
    c. Verification and validation work has taken place on the correct version of the" released for construction" data; and
    d. Verification and validation work has taken place on the correct version of the" released for construction" software.
28. Contractor shall certify that the equipment installed as part of the System is as specified on the" released for construction" drawings.
29. Where equipment is provided that has critical commissioning values (such as switch openings and detection settings, track circuit shunt, critical voltages, signal dB levels) the Contractor shall record these values and store the data on the asset management database.
30. Contractor shall ensure that all critical commissioning values are recorded by the commissioning engineer and are available, as required locally, at the controlling equipment location for the respective equipment.

31. Contractor shall ensure that up to date versions of the as built drawings are available locally when required for the purposes of fault finding and maintenance at completion of the verification and validation activities at each location.
32. Once the equipment is commissioned, the Contractor shall ensure that any alterations to the System shall only be undertaken in a controlled manner, using approved designs, and shall only be put into service once full and comprehensive verification and validation of the alteration has taken place to ensure its safe functionality.

11.1.1 Testing and Commissioning Certificates

1. Contractor shall submit a hierarchy of certificates that certifies the safety of each element of the System and certifies the entire system of systems via a Master Verification and Validation Certificate as defined in the SEMR.
2. Each certificate submitted by the Contractor shall be uniquely identifiable and specific to the item of equipment or area of functionality for which it is submitted. The certificate shall include key commissioning values, details of validation tests undertaken, the dates on which they were undertaken and the name and signature of the person who undertook the validation.

12 SUBSTANTIAL COMPLETION

12.1 Test Track Substantial Completion

1. To be granted Substantial Completion of the Test Track the Contractor shall:
    a. Provide a Rail Infrastructure System within the Test Track Geographic Limits;
    b. Undertake all necessary inspection and testing, and submit all necessary evidence, certification, documentation and approvals required to demonstrate to the Authority that the safety of the Test Track Rail Infrastructure System complies with the requirements of all applicable legislation, standards, the System Safety and Security Management Plan, and the Contract Requirements as defined in the Contractors System Baseline and System Definition Document;
    c. Undertake all necessary inspection and testing, and submit all necessary evidence, certification, documentation and approvals required to demonstrate the security of the Test Track Rail Infrastructure System complies with the requirements of all applicable legislation, standards, the System Safety and Security Management Plan, and the Contract Requirements as defined in the Contractors System Baseline and System Definition Document;
    d. Undertake all necessary inspection and testing, and submit all necessary evidence, certification, documentation and approvals required to demonstrate that the Test Track Rail Infrastructure System allows the prototype Rolling Stock to safely achieve the Testing Speed as defined in the Contracts System Validation Plan;
    e. Operate and Maintain the Test Track for the duration of the Integrated Dynamic Prototype Qualification Tests in accordance with the Contract Requirements; and
2. Substantial Completion will not be awarded until the Contractor has demonstrated that the provision of the Rail Infrastructure System is complete, all certificates have been issued and regulatory approval for the Safety Case is received.

12.2 Segment Substantial Completion

The phased approach to implementation described in 1.1 dictates that a phased approach to substantial completion will be required.

1. For each operable segment of the system, complying with the areas described in section 1.1 and delivering the Performance Requirements for each respective area, in order to apply for Substantial Completion, the Contractor shall;
    a. Provide a Rail Infrastructure System within the Geographic Limits for each area;
    b. Undertake all necessary inspection and testing, and submit all necessary evidence, certification, documentation and approvals required to demonstrate the safety of the entire Rail Infrastructure System complies with the requirements of all applicable legislation, standards, the System Safety and Security Management Plan, and the Contract Requirements as defined in the Contractors System Baseline and System Definition Document;
    c. Undertake all necessary inspection and testing, and submit all necessary evidence, certification, documentation and approvals required to demonstrate that the Rail Infrastructure System is capable of allowing the prototype Rolling Stock to safely achieve the Contract Requirements as defined in the Contractors System Validation Plan;
    d. Recruit and train to an agreed level of competence all Operations and Maintenance staff; and
    e. Operate and Maintain the Rail Infrastructure for the duration of the Integrated Dynamic tests whilst achieving the Contract Requirements as follows:

Month after Substantial Completion of each operable area.	Achievement of Contract Requirements (MTBSI, MTTR) for a minimum period of;
1	1 service day*
2	5 service days
3	10 service days
4	15 service days
5	20 service days
6	30 service days

* 1 service day relates to 0500 to 0000 operational period

1. Substantial Completion will not be awarded until the Contractor has demonstrated that the provision of the Rail Infrastructure System is complete for each area, all certificates have been issued and regulatory approval for the Safety Case is received.

13 TRIAL RUNNING PHASE

1. Contractor shall carry out the Trial Running Phase that will be led by the Operator.
2. The Trial Running Phase shall commence only after the Contractor achieves Substantial Completion of the Rail Infrastructure System for the relevant sections of the System.
3. The Trial Running Phase shall be competed and the relevant activities, as defined in the System Definition Document, are certified by the Contractor, before the Operate and Maintain Phase commences.

13.1 Emergency Drills

1. Prior to the Trial Running Phase, the Contractor shall work with the Operator, Rolling Stock contractor, neighbor railroads and all relevant first responder services to develop and agree emergency drills that demonstrate the readiness of the System and all associated personnel to respond to emergency scenarios.
2. Contractor shall carry out the emergency drills throughout the Trial Running Phase and provide a report for Review within four weeks of each drill and upon completion of all drills prior to the completion of the Trial Running Phase.

13.2 Operating Demonstration.

1. As part of the Trial Running Phase, the Contractor shall engage in a System wide trial running period that shall:
    a. Demonstrate and provide evidence of the safe operation of the Rail Infrastructure System, Operator, Rolling Stock, First Responders, Interfacing Parties, contracts and any other entities that may be required during the Operate and Maintain Phase;
    b. Test the ability of the System to deliver the Contract Requirements;
    c. Allow for operational interfaces to be practiced and developed as required; and
    d. Allow for” infant mortality” faults to be diagnosed and fixed prior to full operation.

14 FINAL ACCEPTANCE

1. To be granted Final Acceptance the Contractor shall;
    a. Have gained approval from the Authority of the Trial Running Phase Certificate:
    b. Issued a completed Verification and Validation report;
    c. Proven that the Rail Infrastructure System achieves the Contract Requirements;
    d. Proven that the Rail Infrastructure System is certified to be ready for commencement of fare paying operations; and
    e. All Certificates of Acceptance have been granted.
2. Final Acceptance will not be awarded until all necessary federal and State safety approvals are issued.

15 SERVICE PERIOD

15.1 Timetable Planning Rules

The Timetable Planning Rules shall describe the capability of the Rail Infrastructure System and shall be used by Service Operators to develop their Operational Plan.

1. Based on the Contractors System Requirements Baseline, the Contractor shall develop Timetable Planning Rules for the Rail Infrastructure System.
2. The Timetable Planning Rules shall include details relating to:
    a. Local Operating Speed;
    b. Headway;
    c. Limitations caused by the track layout;
    d. Limitations caused by signaling principles;
    e. Sectional running times;
    f. Limitations caused by the capacity of the TES;
    g. Platform lengths;
    h. Rolling Stock Stabling rules;
    i. Connections to 3rd party railroads; and
    j. Maintenance access requirements.
3. Contractor shall provide to the Authority the Timetable Planning Rules. The Authority will provide the Timetable Planning Rules to Service Operators to allow them to develop their Operational Plans.
4. Contractor shall coordinate with relevant Interfacing Parties for the Contract Duration to ensure that the Timetable Planning Rules are understood, developed and integrated into the Interfacing Parties work as required.

15.2 Modelling and Simulation

1. For the Contract Duration, at intervals specified by the Authority, or otherwise as required, the Contractor shall provide data to the Authority, to enable the Authority to run and maintain a Rail Systems Simulator, for the proposes of:
    a. Demonstrating that the System delivers the Operational Plan;
    b. Planning alternative timetables for periods of planned service disruption; and
    c. Planning alternative timetables for periods of unplanned service disruption.

15.3 Service Period operations

Following the System Validation and Acceptance Phases and the receipt of all required certification and the acceptance of all validation and verification to allow the operation of revenue services, the System shall enter the Service Period.

1. During the Service Period, the Contractor shall deliver the Contract Requirements and:
    a. Be responsible for confirming that the timetable, provided by the Operator, conforms to the Timetable Planning Rules for the System;
    b. Be responsible for the integration of the service roster that coordinates the safety, availability and readiness of:
        i. The Rail Infrastructure System;
        ii. The Rolling Stock; and
        iii. The crew required to operate the Rolling Stock.
    c. Where any element of the above is not available as required to complete the service roster, the Contractor shall inform the responsible Interfacing Party regarding the unavailability; and

d. Any unavailability of the above elements shall be recorded and shall be a measure of the System performance in delivering Mission Quality.

2. Contractor shall produce a daily Mission Quality report that shall be submitted to the Authority as defined in GP Schedule 6.
3. Where all of the safety and operations requirements are met, the Contractor shall be responsible for issuing Movement Authority to the Rolling Stock to deliver the Operator timetable.
4. In the event of a Rail Infrastructure or Rolling Stock failure and where safety shall not be compromised and a degraded mode of operation is available, the Contractor may issue Movement Authority using available degraded modes of operation.
5. In the event of service disruption, the Contractor shall coordinate with the Operator and the Rolling Stock supplier to re-plan, re-schedule or implement any agreed mitigations that may be required as a result.

15.4 Emergency Procedures

1. Contractor shall work with the Operator contractor, Rolling Stock contractor, neighbor railroads and all relevant first responder services to develop and agree Emergency Procedures that safeguard the passengers, personnel, System, neighbors and all associated.
2. For the Contract Duration, the Contractor shall implement the required Emergency Procedures as required.
3. For the Contract Duration, the Contractor shall undertake exercise drills of the Emergency Procedures to ensure their ongoing suitability and effectiveness. The Contractor shall, where required, update the Emergency Procedures where circumstances require.

16 ASSET MANAGEMENT

16.1 Objectives

The objective of Asset Management is to:

1. Ensure that the Contractor maintains the performance and condition of the assets, so as to minimize, during the Contract Duration, the risk to safety and of service loss;
2. Ensure that the Contractor adopts and continually seeks to improve asset management practices as established by reference to good industry practice;
3. Ensure that the Contractor documents, within the Strategic Asset Management Plan, its asset management system and activities, as necessary defined by this contract, applicable legal and regulatory requirements and as indicated by good industry practice;
4. Ensure that the Contractor has determined and is managing risks, so as to prevent or reduce undesired effects; and
5. Provide the Authority with assurance in relation to the above.

16.2 Information and Information Management Requirements

1. Contractor shall develop and maintain an Asset Management Information system (commonly referred to as an Enterprise Asset Management System – EAM). The chosen technology solution shall be a recognized industry standard and shall allow data to be readily transferred to other industry recognized software – including the Authority's EAM system.
2. The system shall be configured to allow a duplicate data set to be held on the Authority's EAM system. The contractor shall work with the Authority to implement consensus protocols to ensure data integrity, consistency and accuracy across the contractors and the Authority's systems. The Authority's data set shall be updated following every significant update performed on the contractors data set (e.g. new assets, change of asset status, updated work records or condition records). The Authority's data set shall be an exact replication of the contractors data-set including all asset records, condition records, fault and failure records, and work records.
3. Contractor shall ensure that the records it develops and maintains about the asset (the asset registry) are consistent with the records it develops and maintains about the work it carries out on the assets. Further, the contractor shall ensure consistency and traceability between the financial and technical data provided to the Authority – including an accurate allocation of costs by asset for lifecycle cost analysis purposes.
4. The Asset Management Information System shall be developed during the design stage, such that Asset ID's can be assigned before design commences and assets tracked throughout the design, construction, demonstration and subsequently through operations. The contractor shall begin populating the system at the initial design stage, and shall maintain an up to date record of the asset as it progresses through design, construction, demonstration and subsequently through operations.
5. The systems shall be configured to maintain a comprehensive record of all assets, and be compliant with the Authority document – Asset Information Standard. This requirement extends to both installed/in service as well as assets that are in storage or being repaired (either by the contractor or a third party vendor). It shall also extend to assets owned by third parties that extend across the ROW (e.g. utilities). The status of the asset shall be noted as per the Authority document – Asset Information Standard.
6. Contractor shall develop and maintain a comprehensive record of work completed on each asset. This shall include all inspection, maintenance, rehabilitation, repair, overhaul or replacement. The record shall also identify which competent individuals performed and signed off the work. The record shall also include a unique identifier.
7. Contractor shall develop and maintain a record of the condition of each asset. Condition shall be assessed as per the Authority document – Asset Information Standard.

8. From the commencement of Trail Running, through to the completion of the Service Period, the contractor shall produce a monthly Asset Condition Report
9. The Asset Condition Report shall be provided electronically as defined in section 3.2 and in the format presented in the Asset Information Standard.
10. The Asset Condition Report shall contain information on:
    a. The assets as-built condition;
    b. Maintenance interventions during the reporting period;
    c. Any faults or failures – including a record of the problem, the cause and corrective actions taken;
    d. Residual asset life;
    e. Asset Condition Score;
    f. Trends; and
    g. Planned works.

16.3 Asset Management Planning

1. Contractor shall develop, document and keep current a description of the lifecycle management approaches for each asset class under its stewardship. This shall be titled the Asset Class Strategy.
2. The first version of each Asset Class Strategy shall be completed during the System Definition Phase of the assets and before the asset moves into operational use. The Asset Class Strategy shall then be evaluated and as necessary updated annually, through the life of the contract. The Asset Class Strategy shall be submitted for Review as stated in Section 3.2.
3. The Asset Class Strategy shall be developed in accordance with the requirements set out in the Asset Class Strategy Guidelines and shall be submitted for Review as stated in Section 3.2. The Asset Class Strategy shall include:
    a. Scope of the assets or services covered;
    b. Performance/ Service objectives required of the asset class to meet the Contract Requirements;
    c. Risks identified and mitigation strategies; and
    d. Lifecycle management strategies that demonstrate an efficient and economic whole life cost approach to decisions regarding the balance between maintenance, overhaul, renewal and enhancement of asset systems, sub-systems and components regardless of when in the contract period such decisions are to be made.
4. Contractor shall develop, document and keep current the Asset Management Plan that documents its work plans and processes for each specific asset class under its stewardship.
5. The first version of each Asset Management Plan shall be completed during the Design and Demonstration Phase. The Asset Management Plan shall then be evaluated and as necessary updated annually, through the life of the contract. The Asset Management Plan shall be submitted for Review as stated in Section 3.2.
6. The Asset Management Plan shall be developed in accordance with the requirements set out in the Asset Management Plan Guidelines to include:
    a. Analysis of historic and current performance trends;
    b. Inspection, maintenance, overhaul, renewal and enhancement activities that are derived from the Asset Class Strategy and applied to the portfolio of assets under the Contractor's stewardship; and
    c. Activities are to be presented as both work schedules and cost tables.

7. In developing and conducting its asset management practices and activities, the Contractor shall identify, document and take actions to address risks and opportunities associated with managing the assets under its stewardship.
8. Contractor shall develop, document and maintain a risk register that demonstrates a proactive approach to reducing safety, service, operations, financial, weather and climate related and other risks associated with the management of the assets under its stewardship.

16.4 Lifecycle Delivery Activities

1. Contractor shall plan, implement and control the necessary processes and practices needed to implement the work plans identified in each Asset Management Plan.
2. Contractor shall plan, implement and control the necessary processes and practices needed to implement any work activities associated with a corrective action identified either through the Contractor's asset inspections process, data from the Asset Management System or through direction following audit by the Authority or its agent.
3. Contractor shall document the work completed and provide for Review as evidence of it delivering its planned approach to managing the assets under its stewardship.
4. Contractor shall undertake a full risk assessment and impact statement report and submit for Review before implementing any planned permanent or temporary changes to the System, the systems or subsystems.

16.5 Information Requirements

1. Contractor shall develop and maintain a comprehensive register of all assets, using their Asset Management System, in accordance with the Asset Information Standard. This requirement extends to both installed/in service assets as well as assets that are in storage or being repaired (either by the Contractor or a third-party vendor). The status of the asset shall be noted as per the Authority document - Asset Information Standard.
2. Contractor shall develop and maintain a comprehensive record of work completed on each asset. This shall be the Asset Condition Report and shall contain information on:
    a. The assets as-built condition;
    b. Maintenance intervention during the reporting period;
    c. Any failures and corrective actions taken;
    d. Residual asset life;
    e. Asset Condition Score;
    f. Trends; and
    g. Planned works.
3. From the commencement of Trail Running, through to the completion of the Service Period, the Contractor shall produce a monthly Asset Condition Report.
4. The Asset Condition Report shall be provided electronically as defined in Section 3.2 and in the format presented in the Asset Information Standard.
5. Contractor shall ensure that the records it develops and maintains about the asset (the Asset Registry) are consistent with the records it develops and maintains about the work it carries out on the assets. Further, the Contractor shall ensure consistency and traceability between the financial and technical data provided to the Authority.

16.6 Performance Monitoring and Preventive and Corrective Actions

1. When a nonconformity or incident (safety, service or other) occurs in its assets or asset management practices, the Contractor shall:

a. React to the nonconformity or incident and, as applicable, take action to control and correct it and deal with the consequences;

b. Evaluate the need for action, and as necessary implement the action to prevent re-occurrence; and

c. Report the incident to the Authority, indicating why the nonconformity or incident occurred, what has been done to correct it, what is being done to prevent it from re-occurring and consequences and how these will be dealt with.

2. Contractor shall establish processes to proactively identify potential failures in asset performance and evaluate the need for preventive action.

3. Contractor shall establish and undertake regular internal audits to provide evidence that the asset management practices, strategies and plans are being implemented and carried out as defined.

4. Contractor shall establish and conduct an independent audit program to provide assurance to the Authority that its asset management practices, strategies and plans are appropriate for the assets under its stewardship and that its practices are consistent with good industry practice and the requirements described in ISO-55001:2014.

16.7 Continual Improvement

1. With reference to General Provisions Clause 3.16, the Contractor shall establish and lead a Joint Working Group to collaboratively improve the performance of the service through better management of systems interfaces.

2. The Joint working group shall include System Development Forums - shall be conducted quarterly with all contractors to address issues, risks and opportunities related to service delivery.

3. At the Authority’s discretion, the Contractor shall schedule and attend Asset performance review meetings on a frequency to be determined (as required) by the Authority. The purpose of this meeting is to evaluate performance and address outstanding issues and risks.

17 MAINTENANCE AND RENEWALS

17.1 General Requirements

1. Contractor shall monitor, inspect and maintain the Rail Infrastructure System, and overhaul and renew the Track & Systems infrastructure for the Contract Duration in accordance with the Maintenance Plan detailed in Section 4.19.
2. Contractor shall provide operational systems and procedures for the operation of the Rail Infrastructure System within the Infrastructure Performance Plan.
3. Contractor shall establish a Reliability Centered Maintenance program that shall be used for the Contract Duration to define trends, warning and alarm levels and to plan and enact interventions as defined in the Contractors Asset Management Plan.
4. Contractor shall risk assess and rank all assets to identify its criticality to delivering the Contract Requirements and establish the monitoring methodology and alarm / intervention limits for each asset. This shall be documented in the Asset Class Strategy.
5. Information from the RIIM, as detailed in Section 9.6.5, shall be used by the Asset Management Tool as a means of monitoring asset condition against the Reliability Centered Maintenance program.
6. Contractor shall undertake all regulatory inspections and implement any actions required.

17.2 Maintenance and Renewals

1. Contractor shall undertake all inspection, maintenance, overhaul and renewals activities identified in their Inspection, Maintenance, Overhaul and Renewal Schedules and Plans and any other activities that may be required to continuously achieve the Contract Requirements.
2. Contractor shall submit for Review on an annual basis, the Projected Asset Condition Score and Residual Life Report for all Rail Infrastructure System assets at the end of the following five-year period.
3. Contractor shall provide to the Authority on an annual basis an Inspection, Maintenance and Renewal Schedule and Plan for the Rail Infrastructure System that delivers the Contract Requirements and proposed asset condition scores for the following year.
4. Contractor shall demonstrate all high risk ranked assets and potential performance impacting failures have been designed out where practicable in accordance with EN 50126, or mitigated with the use of cyclical maintenance regimes specific to the operational context and/ or subject to remote condition monitoring pertaining to an Intelligent Infrastructure (II) system.
5. Contractor shall undertake a risk assessment of the Rail Infrastructure System for safety, performance criticality and maintenance intervention so as to ensure the correct condition scores are achieved and in turn the Contract Requirements are met.
6. Contractor shall undertake root cause analysis when failures occur and suitably adjust maintenance or inspection frequencies or intervention to attain asset management lifecycles and/or condition levels.
7. The Inspection, Maintenance and Renewal Schedules and Plans shall clearly identify the durations of access required to the high-speed network for safe, effective inspection, maintenance and renewal.
8. Contractor shall automate the inspection, maintenance and renewal activities.
9. The Rail Infrastructure System shall monitor and report asset condition via the RIIM and the Asset Management System.
10. Contractor shall undertake inspection, maintenance, overhaul and renewal activities as defined in the Maintenance Plan, utilizing methodologies that minimize the exposure to risk of track workers and rail infrastructure assets.

11. Contractor shall keep records of the location and condition of all Rail Infrastructure System assets and record details of all upgrades, maintenance, overhaul and renewals work undertaken on those assets and update in real time the Asset Management System accordingly.
12. Contractor shall provide, operate, inspect, maintain and renew all vehicles, plant, equipment, Railway Equipment and machinery required to safely and securely operate, inspect and maintain the Rail Infrastructure System for the Contract Duration.
13. Contractor shall assure all vehicles, plant and machinery are safe for use on the Rail Infrastructure System.
14. Contractor shall recruit, train, and manage the competency and welfare of all personnel required to safely and securely operate, maintain and manage the Rail Infrastructure System for the Service Period.
15. Contractor shall provide, operate and maintain all tools and equipment required to safely and securely operate and maintain the Rail Infrastructure System within the Geographic Limits for the Contract Duration.
16. The accuracy and calibration of any tools or equipment shall be the responsibility of the Contractor.
17. Contractor shall be responsible for the provision of all services and utilities required to safely and securely operate and maintain the Rail Infrastructure System for the Contract Duration.
18. Contractor shall recruit, train, manage competency and provide welfare of all personnel required to safely and securely overhaul and renew the Rail Infrastructure System for the Service Period, as defined in the Maintenance Plan
19. Any renewal, replacement or overhaul undertaken of the Rail Infrastructure System assets shall be to an equivalent or better standard than the original asset and shall continue to achieve the Contract Requirements.
20. Contractor shall be responsible for the procurement and storage of all replacement assets, spares and consumables required to safely and securely operate and maintain the Rail Infrastructure System for the Contract Duration.
21. Contractor shall be responsible for any strategic spares or contingency assets that may be required to support continued operation of the Rail Infrastructure System in the event of an asset failure.
22. Contractor shall be responsible for ensuring that spares are stored as required to allow their use within the Rail Infrastructure System when required to meet the Contract Requirements.
23. Contractor shall plan and undertake all inspections, maintenance and renewals in line with the Contractors Asset Management Plan and the Contract Requirements.
24. Contractor shall develop, implement and schedule cyclical inspections and maintenance activities that meet federal and state legislation or Authority requirements such that asset management lifecycles and condition levels are achieved.
25. Contractor shall be responsible for managing environmental impacts from inspection, maintenance, overhaul and renewals activities. Such activities shall be subject to environmental permit award. Tasks, methodology and locations that impact the environment shall be recorded in the Asset Management System and federal or State systems as per legislation.
26. Contractor shall be responsible for the disposal of redundant assets, equipment, machinery or any other items removed from the Right-of-Way in the course of their activities. The disposal shall comply with all applicable requirements and statute for safe and environmentally compliant disposal of contaminated, Hazardous or controlled materials.

17.3 Reliability Centered Maintenance Plan

1. Contractor shall establish a Reliability Centered Maintenance program per EN 60300-3-11 for all Rail Infrastructure System assets.

2. Contractor's Reliability Centered Maintenance approach shall be defined in the Maintenance Plan as described in 4.21.
3. Contractor shall establish life limits on safety critical assets so that the probability of failure before life limits is tolerable under normal deterioration, and shall establish condition monitoring to detect whether deterioration was abnormal.

17.4 Maintenance and Renewals Reporting

1. Every three months, the Contractor shall provide an Asset Condition Report, as defined in Section 16.5 , including asset management data, on the condition of the Rail Infrastructure System assets, including trend analysis, and prediction of forward risk and mitigations. The Contractor shall submit their proposed template for the status report for Review.

17.5 Rolling Stock On Board Assets

1. Contractor shall undertake inspection, maintenance, overhaul and renewal activities and maintain all Rail Infrastructure Systems on board assets required to achieve Rolling Stock operational readiness.
2. Contractor shall undertake inspection, maintenance, overhaul and renewal activities on Rail Infrastructure System assets for up to 95 sets of Rolling Stock.

18 HANDBACK

18.1 Handback Asset Conditions

1. Contractor shall submit for Review on a rolling five-year basis, using the Asset Management tool, the asset condition score and residual life for all Rail Infrastructure System assets being scored at the end of the Service Period.
2. Prior to the appointment of the Follow On Contractor (see section 18.2), the Authority shall confirm its agreed asset condition scores for Handback of all Rail Infrastructure System assets.
3. On completion of the Service Period, the Contractor shall return all Rail Infrastructure System assets to the Authority with residual asset life that complies with the agreed asset condition scores.
4. At regular intervals and on completion of the Service Period, the Contractor shall submit evidence of consistent maintenance.
5. On completion of the Service Period, the Contractor shall submit evidence of system performance at a consistent level in accordance with the Contract Requirements.
6. On completion of the Service Period, the Contractor shall submit evidence that all planned renewals activities are complete and certified as handed back into normal maintenance activities.
7. Residual asset life for non-technology assets shall be a minimum of 10 years or the remainder of the design life as detailed in Table 13-1, whichever is longer.

18.2 Follow-On Contractor

The Authority will appoint a Follow-On Contractor for a further service period five years before the end of the Service Period.

1. Contractor shall work with the Follow-On Contractor to develop a Handback Plan to be submitted for Review. The Handback Plan shall include:
    a. Assets to be handed over;
    b. Agreed Asset Condition Scores to be achieved at handover;
    c. Asset Data Migration Plan;
    d. Non-Technology Asset Migration Plan;
    e. Technology Asset Renewal Plan;
    f. Staff Migration Plan; and
    g. Plant and Equipment Migration Plan.
2. Contractor and the Follow-On Contractor shall undertake joint dilapidation and condition surveys to cover all Rail Infrastructure System assets to confirm that the condition of the asset complies with the condition scores identified in the Asset Class Strategy and that shown in the Asset Management tool data, and that the asset data contained within the Asset Management tool is correct. These surveys shall be undertaken at the following times:
    a. Contractor to undertake initial survey prior to award of the Follow-On contract;
    b. Contractor and Follow-On Contractor to undertake detailed survey six months following award of the Follow-On contract; and
    c. Contractor and Follow-On Contractor to undertake final survey three months prior to the completion of the Service Period.
3. If the dilapidation and condition survey highlights any deficiency between the surveyed asset and the asset condition score and the Asset Management tool data, the Contractor shall make good the deficiency to achieve the asset condition score.

4. For technology system assets (including ATC, OCC, TES, Communications Systems and Railway systems assets), the Contractor shall work with the Follow-On Contractor to integrate and facilitate the design and implementation of replacement technology systems from a date five years before the end of the Service Period.
5. Contractor shall allow the Follow-On contractor full access to all live and historic operational and Asset Management data relating to the Rail Infrastructure System.
6. All current and historic Asset Management data shall be transferred to the Follow-On Contractor in an industry recognized format to be agreed with the Follow-On Contractor. The Contractor shall certify the accuracy and integrity of the transferred Asset Management data.
7. All current and historic data shall be transferred to the Follow-On Contractor in an industry recognized format to be agreed with the Follow-On Contractor. The Contractor shall be responsible for ensuring the accuracy and integrity of the transferred data. Data to be transferred shall be:
    a. Safety Case;
    b. Design Case;
    c. Operating Case;
    d. Asset Management tools and all data within; and
    e. Requirements Management tools and all data within including the System Baseline and the System Definition Document.
8. Residual life for technology systems shall enable handover of the Rail Infrastructure System to the Follow-On Contractor with no impact on the Contract Requirements defined in this document.

Infrastructure	Design Life
Track and Civils, including: • Site, earthwork, line layout, storm drainage • Concrete slab With the exception of: • Plain line rail • Steel fastening elements • Plastic fastening elements • Rubberized fastening elements • Concrete ties • Ballast • Roadway, pavement, parking facilities • Special trackwork	 100 years 50 years 50 years 25 years 25 years 50 years 35 years 40 years 35 years
Structures, including: • Underground structures • Above-ground facilities, including bridges, aerial structures, passenger stations ventilation buildings • Retaining walls • Components of the grounding, bonding and lightening protection system embedded within concrete structures With the exception of: • Support facilities • Movement expansion joints, bearings	100 years 50 years 50 years
Mechanical, Electrical, Plumbing, Ventilation and Fire Protection Systems	30 years
Systems	**Design Life**
Traction Power Systems, including: • Traction power supply system (TPS) • Overhead contact system (OCS) support structures and conductors, with the exception of the contact wire, the life of which is dependent upon the number of pantograph passes • Grounding, bonding including any not embedded in concrete and lightening protection system	 50 years
Train Control and Communication System, including: • ATC systems • Yard signal systems and their subsystems	15 years

• Equipment and supporting cabling • Communications wired and wireless data transport systems • Communications administrative, control and timing systems • Communications safety, security and fire detection systems • Communications copper and fiber optic cable infrastructure and associated equipment	
Other technology-based systems: • Equipment and non-safety critical, microcontrollers, computers, software and similar commercial off-the-shelf (COTS) equipment • TPS protection and monitoring devices • SCADA	15 Years 15 Years
Other non-technology items: • Fencing and gates • Acoustic barriers	30 years

Table 13-1 – Design Life of Rail Infrastructure System.

This table relates to MGTPA, Prop 1 A service levels, straight level track.

19 INTERFACE REQUIREMENTS

19.1 Electromagnetic Compatibility

1. Contractor shall manage Electromagnetic Compatibility with other Interfacing Parties in accordance with the requirements for Electromagnetic Compatibility and Interference contained in Appendix 3 of this document.
2. Contractor shall additionally manage Electromagnetic Compatibility with any affected parties as defined in commitments made by the Authority relating to GO176.

19.2 Intra-Contract Interface Requirements

1. Contractor shall design, document and implement all intra-contract interfaces within the Rail Infrastructure System so the Rail Infrastructure System achieves the Contract Requirements.

19.3 Inter-Contract Interface Requirements

1. Contractor shall design, document and implement all inter-contract interfaces between the Rail Infrastructure System and the Network so that Rail Infrastructure System meets the Contract Requirements, when operated per the Operational Plan established by the Authority, excluding the effects of service interruptions caused by elements outside of Rail Infrastructure System.
2. Contractor shall ensure that all inter-contract interfaces are compatible with all:
    a. Planned California High-Speed Rail systems, facilities, equipment, and Rolling Stock;
    b. Currently ongoing California High-Speed Rail work;
    c. Previously implemented California High-Speed Rail systems, facilities, and equipment; and
    d. The Contractor shall specify the Track and Systems requirements for future Contract packages to deliver the future Contract Requirements.
3. Contractor shall inform the Authority if the Contractor needs inter-contract interface information to achieve the Contract Requirements.

19.4 Interfaces with Third Parties

1. Contractor shall design, document, and implement all interfaces between Rail Infrastructure System elements and third parties so that High-Speed Rail Trains operating on the Rail Infrastructure System achieve the Contract Requirements:
    a. When operated per the Operational Plan established by the Authority, excluding the effects of service interruptions caused by elements outside of the Rail Infrastructure System scope; and
    b. When events occur which the Rail Infrastructure System is required to mitigate. For example, when a single utility traction power supply is lost, Rail Infrastructure System service shall not be interrupted or delayed.
2. Contractor shall inform the Authority if the Contractor needs third party contract interface information to achieve the Contract Requirements.

19.5 Interfacing Parties

The following Interfacing Parties will be undertaking works on the Rail Infrastructure System during the Service Period:

a. Construction Packages;
b. Rolling Stock;
c. Service Operator;
d. Stations;

e. Utilities;

f. Union Pacific Rail Road; and

g. Caltrain.

19.5.1 Construction Packages

Construction packages do not include any Track and Systems work but include design of some elements of Civil Works to be built and maintained by the Contractor as part of the Track and Systems work.

19.5.2 Rolling Stock

The Authority will procure the Rolling Stock separately.

The Rolling Stock supplier will design, supply, build, test, commission and maintain the Rolling Stock for a 30-year period.

1. Contractor shall interface and coordinate with the Rolling Stock supplier to ensure operational, physical (including mechanical and electrical interfaces) and logical integration between their respective systems.
2. Contractor shall ensure that the Rail Infrastructure System Structure Gauge is compatible with the Dynamic Envelope of all Rolling Stock and all other rolling stock that are required to operate on the Rail Infrastructure System.
3. Contractor shall work with the Rolling Stock provider to agree space, location, accessibility, power supply, wiring, EMC, bonding, environmental, noise and vibration requirements for any Rolling Stock located Rail Infrastructure System assets.
4. Contractor shall provide, test and commission all on board Rail Infrastructure equipment.

The Rolling Stock supplier will provide Rolling Stock heavy maintenance facilities (HMF) along the Network for a 30-year period.

19.5.2.1 Rolling Stock Configuration

Rolling Stock will be 205 meters (nominally 673 ft) in length.

Rolling Stock will provide seating capacity for up to 500 passengers per 205-meter Rolling Stock.

19.5.2.2 Dynamic Envelope

The Rolling Stock supplier will confirm the Dynamic Envelope details.

19.5.2.3 Rolling Stock Power

The Rolling Stock supplier will confirm the Rolling Stock power requirements.

19.5.2.4 Rolling Stock Facilities

The Rolling Stock supplier will provide and operate all Rolling Stock facilities.

19.5.2.5 Rolling Stock On Board Equipment

The Rolling Stock supplier will install the Rail Infrastructure System On Board equipment as specified by the Contractor.

19.5.3 Service Operator

The Authority will procure a Service Operator separately.

The Service Operator will be responsible for running trains, developing an Operational Plan, marketing, ticketing, on-board safety and security, station operations, non-rail infrastructure station maintenance and other passenger services.

The Service Operator will provide all necessary data required by the Rail Infrastructure System for the monitoring and control of the Network external to the Rail Infrastructure System.

19.5.4 Stations

The Authority will procure stations separately.

Stations exclude platforms and any associated Rail Infrastructure System assets provided as part of this contract and required for the safe operation of a passenger service.

The stations contractors will provide all remaining station buildings, passenger facilities and accommodation.

Non Rail Infrastructure Assets, such as, additional station CCTV, lighting, alarms, building management systems and all other systems within the stations, shall be maintained by others.

1. The Contractor shall maintain all Rail Infrastructure Systems within stations.

19.5.5 HV Utilities for Traction Power

The Authority will procure all HV PG&E connection works separately.

A PG&E approved design and build contractor will deliver modifications required to the supply network to deliver high voltage supplies to Rail Infrastructure System assets.

This will include 115/230kV transmission lines to the traction substation and a PG&E controlled double pole disconnector between the Rail Infrastructure System assets and the PG&E assets.

1. Contractor shall undertake final testing and commissioning to the existing PG&E network in conjunction with the PG&E approved Design and Build contractor.

19.5.6 Union Pacific Rail Road

The Authority has entered an agreement with Union Pacific Railroad.

1. Contractor shall work with the Authority and Union Pacific Railroad to agree the system, operational and maintenance interfaces between the Rail Infrastructure System and the Union Pacific Railroad infrastructure.

19.5.7 Caltrain

The Rolling Stock will operate on Caltrain infrastructure between San Francisco 4th & King and CP Lick. While operating on the Caltrain Corridor, train control of Rolling Stock will be via a Caltrain train control system.

1. Contractor shall work with the Authority and Caltrain to agree the system, operational and maintenance interfaces between the Rail Infrastructure System and the Caltrain Corridor.
2. Contractor shall provide, operate and maintain systems so that voice and data communication and Rolling Stock status is available to the OCC at all times when operating on the Caltrain network.
3. The provision, operation and maintenance of train mounted train control equipment to enable operation on the Caltrain Corridor will be by others.
4. The provision, operation and maintenance of wayside equipment on the Caltrain Corridor will be undertaken by others.

19.5.8 Later Stages and Phases

As the project develops, further interfaces will materialize. These may include:

a. Transbay Transit Centre (TTC);

b. Downtown Extension (DTX);

c. Merced to Sacramento; and

d. Los Angeles to San Diego (Southern California);

1. The Contractor shall be responsible for defining the external interfaces of the Rail Infrastructure System and documenting these in a structured format to enable seamless integration between segments and phases of the project.

20 Appendix 1 - Design Survey & Mapping

This appendix will provide design survey and mapping criteria for the compilation of topographic mapping and land surveying procedures, performing engineering design land surveys, and generally describes right-of-way mapping requirements. Particular emphasis is placed on accurate field surveys of existing topographic and man-made features required for mapping, and the establishment of accurate terrain models.

21 Appendix 2 - Network and Computer Security

This appendix will detail the Network and Computer Security (NCS) Program scope requirements, guidelines and principles to design, implement, and operate the California High Speed Rail (CHSR) systems, equipment, and procedures to resist malicious network and computer actions.
This appendix will provide guidance for system and equipment designers to reduce, prevent, mitigate and discover NCS risks.

22 Appendix 3 – Electromagnetic Caompatibility

The electromagnetic compatibility (EMC) work scope will include the electromagnetic interactions and related design characteristics of:

- High-speed rail (HSR) equipment and facilities.
- Equipment and facilities of HSR neighbors.

HSR neighbors include:

- HSR's regional transportation partners
- Airports
- Hospitals
- Research facilities
- Universities
- Utilities
- Industrial and other facilities with sensitive equipment
- Farms and agricultural operations
- Homes and businesses

The EMC work scope will also include the impact of electromagnetic fields (EMFs) produced by HSR equipment and facilities on the health of persons in the vicinity of HSR, including HSR staff, HSR passengers, and the general public.
The EMC provisions of the Work affect electromagnetic interactions between HSR equipment and facilities, neighbor equipment and facilities, and persons and their equipment in the vicinity of HSR.