

California High-Speed Train System



TECHNICAL MEMORANDUM

Verification and Validation Management Plan (VVMP) TM 1600.01

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Revision	Date	Description
0	06/17/2013	Initial Release, R0

Note: Signatures apply for the latest technical memorandum revision as noted above.

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System Level Technical and Integration Reviews

The purpose of the review is to ensure:

- Technical consistency and appropriateness
- Check for integration issues and conflicts

System level reviews are required for all technical memoranda. Technical Leads for each subsystem are responsible for completing the reviews in a timely manner and identifying appropriate senior staff to perform the review. Exemption to the system level technical and integration review by any subsystem must be approved by the Engineering Manager.

System Level Technical Reviews by Subsystem:

Systems:	<u>Signed document on file</u> Bradley Banks, PE	<u>16 Jun 13</u> Date
Infrastructure:	<u>Signed document on file</u> John Chirco, PE	<u>30 May 12</u> Date
Operations & Maintenance:	<u>Signed document on file</u> Joseph Metzler	<u>14 May 12</u> Date
Regulatory Approvals:	<u>Signed document on file</u> Vladimir Kanevskiy, PE	<u>9 May 12</u> Date
Rolling Stock:	<u>Signed document on file</u> Frank Banko	<u>11 May 12</u> Date
Project Management Oversight:	<u>Signed document on file</u> Michael D. Lewis, PE	<u>14 Jun 13</u> Date

Note: Signatures apply for the technical memorandum revision corresponding to revision number in header and as noted on cover.



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ABSTRACT

The technical development approach for the California High-Speed Train System (CHSTS) is based on applying service-proven technology from existing European and Asian high-speed rail systems with similar performance requirements and on applying existing and applicable U.S. based requirements for passenger railroad safety. This approach is intended to ensure suitability of the high-speed rail system for the required level of performance, and in compliance with applicable and emerging high-speed rail (HSR) regulations.

The technical documents guiding development of the CHSTS are derived from several regulatory and safety source documents including the U.S. Code of Federal Regulations Title 49, Parts 200-299 which regulate passenger railroad safety in the U.S., California Public Utilities Commission (CPUC) General Orders (GO), and the European Technical Specifications for Interoperability which regulates high-speed passenger railway safety in the European Union. The CHSTS technical documents also take into account safety regulation currently in development by the Federal Railroad Administration (FRA) specific to high-speed rail operations. These new regulations are under review by the Engineering Task Force (ETF) of the FRA Railroad Safety Advisory Committee, the proceedings of which the California High-Speed Rail Authority is an active participant. In addition, the CHSTS has developed proposed CPUC General Order establishing safety regulations governing 25kV railroad electrification it intends to petition to CPUC for adoption under order instituting rulemaking proceedings.

Design criteria have been developed consistent with the safety regulations and to support the required system performance levels for a 220 mph high-speed rail operation. The technical requirements supporting the development, design and construction of the CHSTS are included in the following documents:

- CHSTS System Requirements: Minimum safety requirements consistent with existing and proposed state and federal regulations, and other international HSR safety based regulations
- CHSTS Technical Memoranda: Design criteria to support preliminary engineering and environmental assessment
- CHSTS Design Criteria Manual: Design criteria to support final design and construction
- CHSTS Performance Specifications: Performance specifications to support procurement of system-wide elements including traction power supply systems, overhead contact systems, communications systems and automatic train control systems

Readiness of the completed usable segments will be confirmed through the process of testing and acceptance of the installed components of the HSR system for performance and compliance with the requirements. This is followed by system performance testing and commissioning to confirm integration and safety certifications as the usable segment is completed.

Verification and validation of criteria, designs, inspection, testing, integration, and acceptance process is guided by this Verification and Validation Management Plan for the overall CHST Program, which requires development of detailed plans for each stage.



1.0 INTRODUCTION

1.1 PURPOSE OF THE TECHNICAL MEMORANDUM

The purpose of the memorandum is to describe the programmatic approach to Verification and Validation (V&V) for the California High-Speed Train System (CHSTS) throughout its life-cycle and to determine the V&V program requirements needed to deliver a fully compliant and functional CHST program.

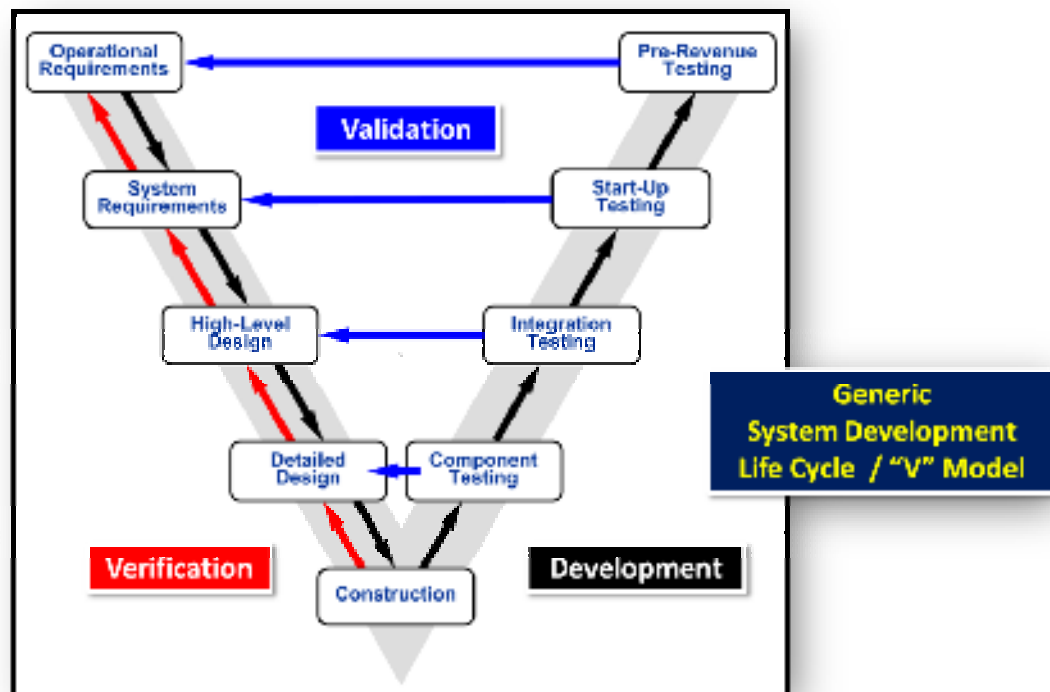
The Verification and Validation Management Plan (VVMP) establishes the overall inputs, outputs and deliverables, methods and tools, and roles and responsibilities for each stage in the CHST program.

1.2 STATEMENT OF THE TECHNICAL ISSUE

The Verification and Validation process is based on existing and proven processes, specifically the overall systems life cycle and follows the general provisions of IEC 15288 “Life Cycle Management – System Life Cycle Processes” and the Systems Engineering principles as defined in IEEE 1220 / IEC 26702 – “Systems engineering -- Application and management of the systems engineering process”.

The V&V process in the CHST project is tailored for the purpose of a multi-contract infrastructure project.

Figure 1: Generic Systems Development Life-Cycle



1.2.1 Definition of Terms

The following technical terms and acronyms and abbreviations used in this document have specific connotations with regard to the California High-Speed Train system.

Acronyms:

Authority	California High-Speed Rail Authority
Authority's Representative	Authority, PMT or PCM acting on behalf of the Authority
Objective Evidence	Design / construction / testing and acceptance / other documentation or proof demonstrating that CHSTS requirements have been fulfilled
Self-Certification	Certification by the Contractor that the contract submittals conform to Contract Requirements and as reasonably inferred therefrom
Statement of No Objection	Statement by the Authority's Representative that it does not object to the reviewed submittal
Validation	Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled
Verification	Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled

Abbreviations:

CFR	Code of Federal Regulations
CHSTS	California High-Speed Train System
CIL	Certifiable Items List
COC	Certificate of Conformance (Contractor)
COC	Certificate of Compliance (Authority's Representative)
CPUC	California Public Utilities Commission
CVVP	Contractor Verification and Validation Plan
D/B	Design/Build
D/B-C	Design/Build Contractor
EIR/S	Environmental Impact Report / Statement
ER	Environmental Review
EMT	Engineering Management Team
FRA	Federal Railroad Administration
FRA GD	FRA Guidance Document
GO	General Order
ICE	Independent Checking Engineer
ISE	Independent Site Engineer
ITP	Inspection and Test Plan
ITP	Invitation to Proposers
PE	Preliminary Engineering
PCM	Project and Construction Management Team
PHA	Preliminary Hazard Analysis



PMT	Project Management Team
QA/QC	Quality Assurance/Quality Control
RC	Regional Consultant
RFC	Ready for Construction
RFP	Request for Proposal
RPA	Rule of Particular Applicability
RVTM	Requirements Verification Traceability Matrix
SONO	Statement of No Objection
SOW	Scope of Work
SSMP	Safety and Security Management Plan
SSPP	System Safety Program Plan
SyRS	System Requirements Specification
TM	Technical Memoranda
TVA	Threat and Vulnerability Assessment
V&V	Verification and Validation
VVIP	PMT Verification and Validation Implementation Plan
VVMP	PMT Verification and Validation Management Plan

1.2.2 Document References

Table 1: Document References

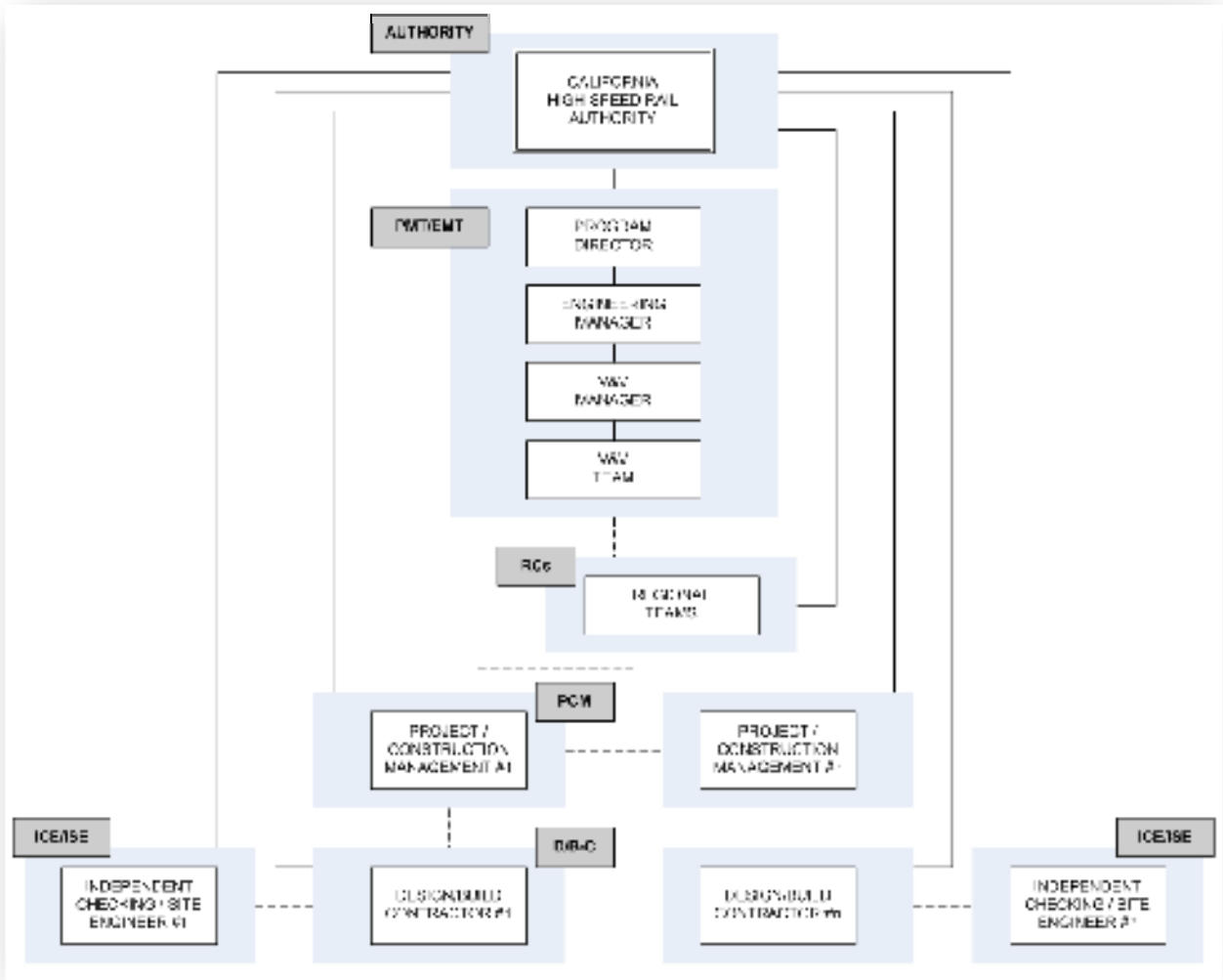
Ref	Document
1.	CHSTS TM 0.3 Basis of Design – R3
2.	CHSTS TM 0.9 Process to Support Development of a CHSTS Rule of Particular Applicability – R0
3.	CHSTS TM 300.5 RAMS Program – R0
4.	CHSTS Safety and Security Management Plan (SSMP) – R0
5.	CHSTS Preliminary Hazard Analysis (PHA) – Draft
6.	CHSTS Threat and Vulnerability Analysis (TVA) – Draft
7.	CHTSP Guidance Document of Required Safety Elements Necessary for FRA Regulatory Approval – Draft
8.	CHSTS Design Criteria Manual – R0
9.	CHSTS Directive Drawings – R0
10.	RFP No.: HSR 11-16, Book 3 – Verification, Validation and Self-Certification – R0
11.	IEC 15288 Life Cycle Management – System Life Cycle Processes
12.	IEEE 1220 / IEC 26702 Systems Engineering – Application and Management of the Systems Engineering Process



2.0 V&V ORGANIZATION

The CHST program V&V organization is presented in Figure 2. Roles and responsibilities are defined in detail for each CHST program stage in section 3.0 and in Table 2 on page 19.

Figure 2: V&V Organization



Legend:

Authority: California High-Speed Rail Authority

PMT: Project Management Team

EMT: Engineering Management Team

V&V: Verification and Validation

RC: Regional Consultant

PCM: Project and Construction Management Team

D/B-C: Design/Build Contractor

ICSE/ISE: Independent Checking Engineer / Independent Site Engineer

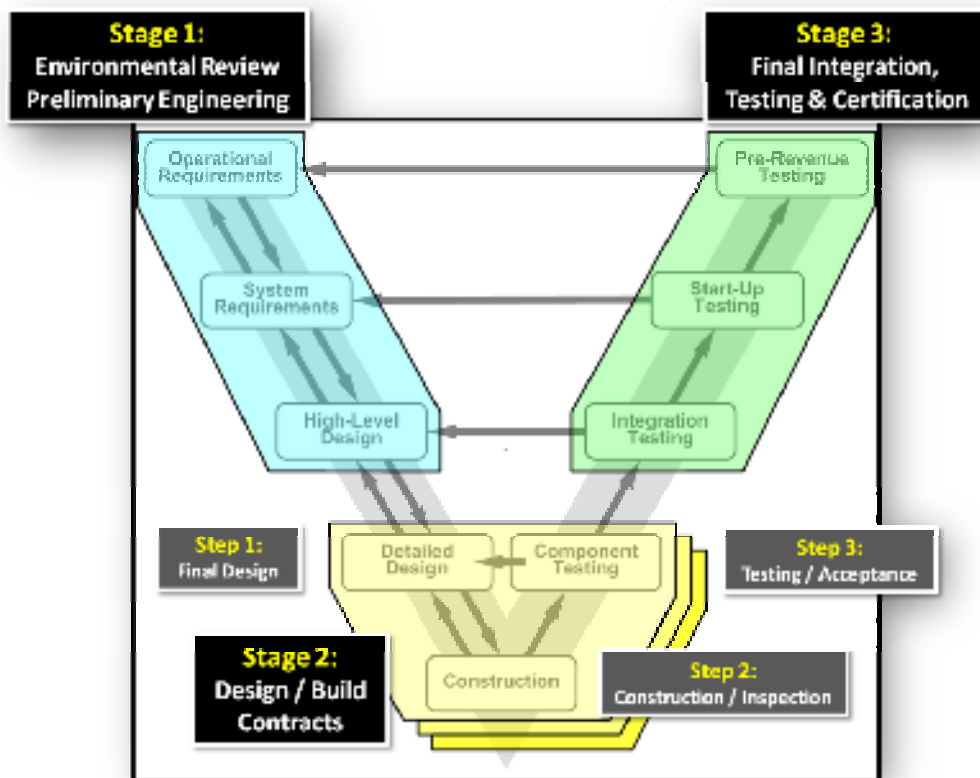


3.0 V&V LIFE-CYCLE FOR CHST PROGRAM

The V&V life-cycle applied in the CHST Project is presented in Figure 3. The life-cycle can be described in three main stages of which the design/build stage can be subdivided further into three steps:

- Stage 1: Environmental Review / Preliminary Engineering
- Stage 2: Design / Build Contracts
 - Step 1: Final Design
 - Step 2: Construction
 - Step 3: Testing / Acceptance
- Stage 3: Final Integration, Testing and Certification

Figure 3: CHSTS Program V&V Life-Cycle



For details on each stage, please refer to the subsequent sections of the V&V Management Plan.

3.1 ENVIRONMENTAL REVIEW AND PRELIMINARY ENGINEERING

3.1.1 Technical Criteria and Preliminary Engineering for Procurement

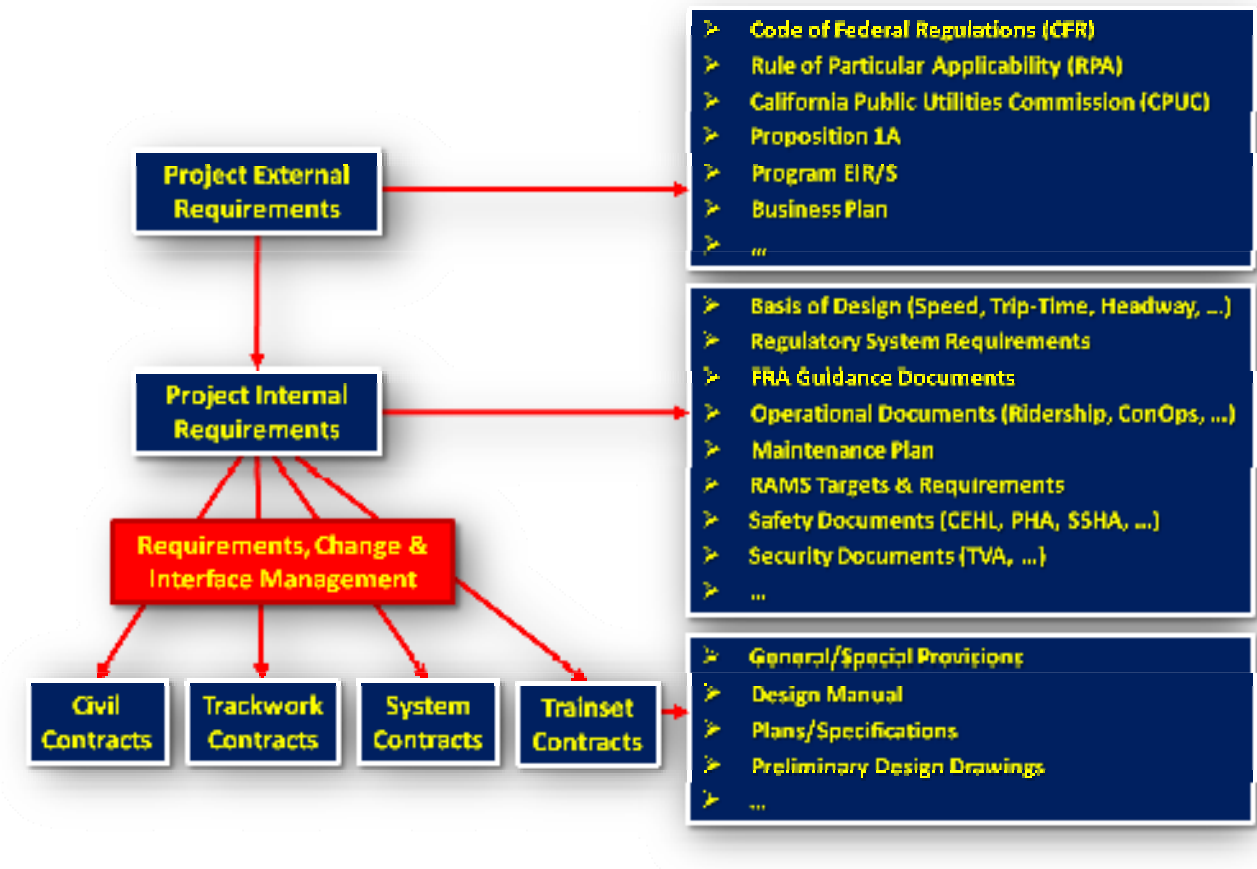
3.1.1.1 General

The main purpose of the V&V process in this stage of the CHST program is the following:

- Identify project external requirements (see Figure 4) and analyze them for applicability to the CHSTS
- Develop project internal requirement documents (see Figure 4) that tailor the project external requirements to the specifics of the CHSTS and demonstrate/verify compliance
- Apportion the project internal requirements to the specific procurement packages (see Figure 4) and demonstrate/verify compliance
- Apportion the project internal requirements to the technical criteria (e.g., design criteria, directive drawings, etc.) and demonstrate/verify compliance
- Identify critical requirements and interfaces between procurement packages and demonstrate/verify compliance
- Review the Preliminary Engineering (PE) prepared by the regional team
- Support the change process by providing change impact analysis capabilities

Validation will be performed in Stage 2 and Stage 3 of the CHST program.

Figure 4: Apportioning Requirements in the Environmental Review and PE Stage



3.1.1.2 Inputs

The stage 1 of the CHST V&V process uses the following documents as source documents, including:

Project External Requirements

- Code of Federal Regulations
- Rule of Particular Applicability
- California Public Utilities Commission General Orders
- Proposition 1A
- Program Environmental Impact Report/Statement

Project Internal Requirements

- Regulatory system requirements
- Basis of design
- FRA guidance documents
- Operational and maintenance documents and plans
- Reliability, availability, maintainability targets and requirements

Technical Criteria

- Technical memoranda
- Design criteria
- Directive and standard drawings
- Performance and standard specifications

Procurement Packages

- Scope of work
- General and specific provisions
- Technical criteria
- Preliminary Design Drawings

3.1.1.3 Outputs and Deliverables

The stage 1 of the CHST V&V process will result in the following outputs and deliverables:

- Verification and Validation Management Plan (this document)
- Verified project external and internal requirements
- Verified technical criteria
- Verified preliminary engineering for procurement
- Verified critical requirements and interfaces
- Contractor Self-Certification and V&V process requirements
- Contractor applicable list of critical items



3.1.1.4 Tools and Methods

The stage 1 of the CHST V&V process uses the tools and methods as shown Table 3 on page 21 to verify project requirements, technical criteria and critical requirements and interfaces. Refer to section 5.0 for more detailed information on tools and methods.

3.1.1.5 Roles and Responsibilities

The stage 1 of the CHST V&V process allocates as a minimum the roles and responsibilities as presented in Table 2.

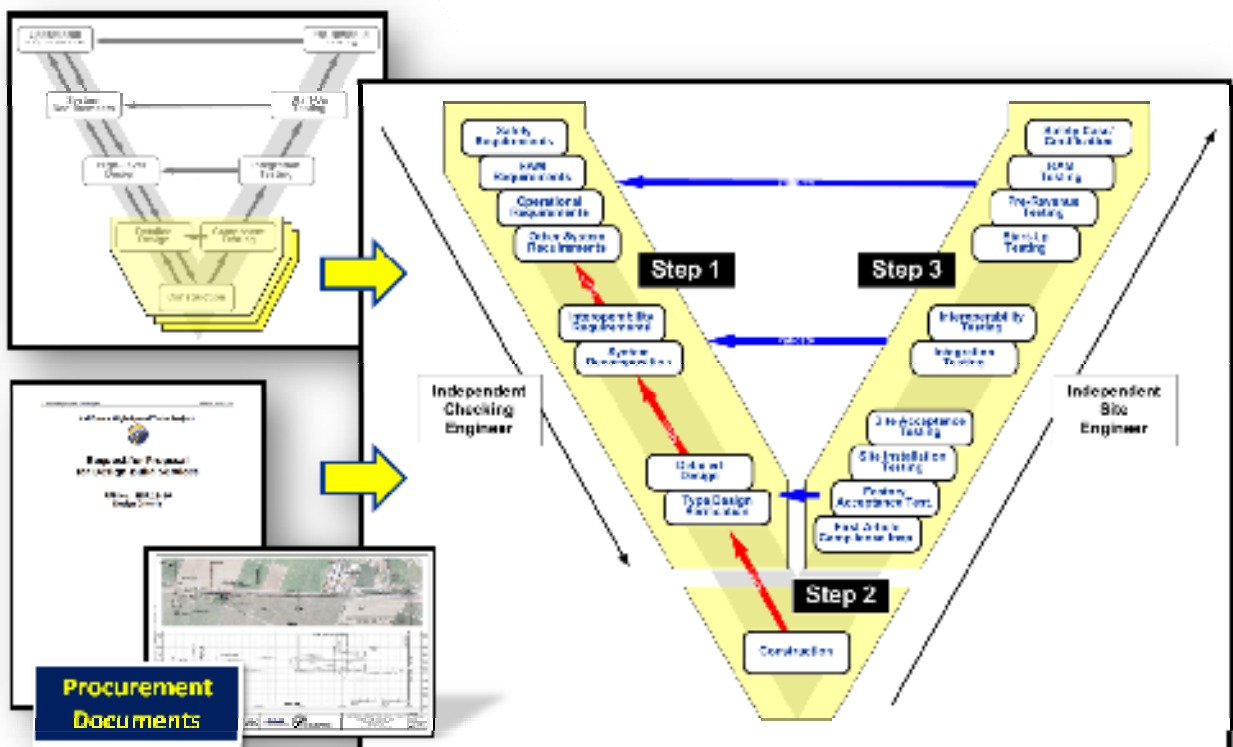
3.2 DESIGN / BUILD CONTRACTS

3.2.1 General

Each of the Design/Build contracts as shown in Figure 3 on page 6 is required to develop and implement a contract specific verification and validation (V&V) process to confirm to the Authority’s Representative that by examination and provision of objective evidence the specified contract requirements and the particular requirements for specific intended use have been fulfilled.

The contract specific V&V requirements are included in the corresponding request for proposals (RFP). Design/Build contracts will go through their own life-cycle as presented in Figure 5.

Figure 5: V&V in Design / Build Contract Stage



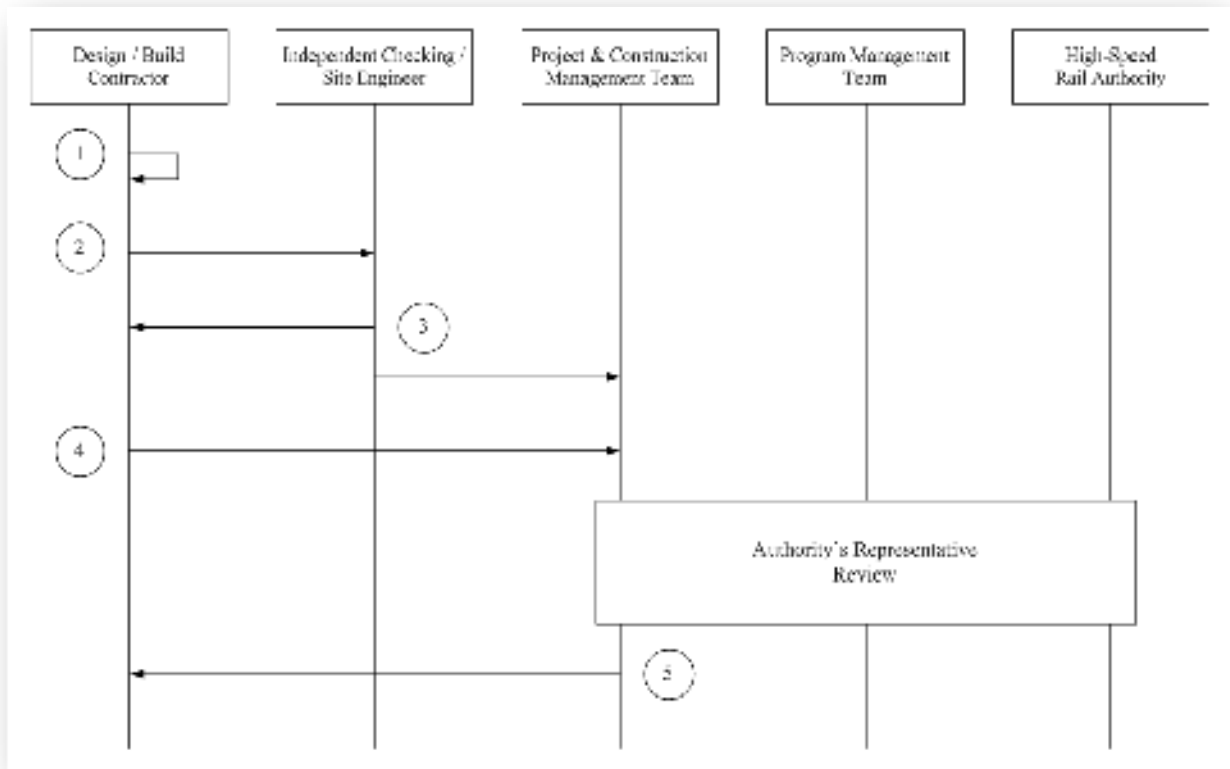
The contractor will be requested to document its V&V process in a contractor verification and validation plan (CVVP) and address as a minimum roles and responsibilities, methods, tools and metrics used. The CVVP will also have to address the requirements management, interface management and test program management.



3.2.2 Self-Certification

With every submittal, the contractor will be required to self-certify compliance and fitness for purpose as outlined in Figure 6. The numbered steps are described in more detail below the graphic in the Concept of Execution.

Figure 6: Contractor Self-Certification in Design/Build Contract Stage



Concept of Execution:

1. Contractor will prepare contract submittal (including design, construction, inspection and test submittals) as specified in the Contract and will perform quality procedures as stipulated by the Contract. Contractor will self-certify compliance with Contract Requirements and fitness for purpose.
2. Contractor will submit contract submittal together with Contractor V&V submittal to Independent Checking Engineer (ICE) and Independent Site Engineer (ISE).
3. Independent Checking Engineer and Independent Site Engineer will assess and evaluate the contract submittal in order to be able to certify that the design/construction meets the Contract Requirements as detailed in the Contract and as reasonably inferred therefrom. ICE/ISE will submit an assessment report and certification to the Authority's Representative with a copy to the Contractor.
4. Contractor will submit contract submittal, including self-certification, Contractor V&V submittal, ICE/ISE assessment report, and certification to the Authority's Representative.
5. The Authority's Representative will perform an audit and additional review as required and issue Statement of No Objection (SONO), if given, based on upon the audit and additional review results and ICE/ISE assessment report and certificate.

3.2.3 Final Design

3.2.3.1 Inputs

The stage 2, step 1 of the CHST V&V process (final design) uses the following documents as source documents, including:

- Scope of work
- General and special provisions
- Contractor Self-Certification and V&V process requirements
- Contractor applicable list of critical items
- Technical criteria

3.2.3.2 Outputs and Deliverables

The stage 2, step 1 of the CHST V&V process will result in the following outputs and deliverables:

- Contractor:
 - Contractor Verification and Validation Plan
 - Contractor design submittals including QA/QC and self-certification
 - Requirements verification traceability matrices (RVTM) demonstrating final design is in compliance with technical contract requirements
 - Certifiable Items Lists (CIL) demonstrating final design is in compliance with critical interfaces as identified and specified in contract requirements
 - V&V reports
 - Certificate of conformance in compliance with the Safety and Security Management Plan (SSMP)
- Independent Checking Engineer (ICE):
 - Assessment plan
 - Assessment reports
 - Compliance certificates
 - Independent structural calculations
 - Progress plans and status reports
- Authority's Representative:
 - Statement of No Objection, if given
 - Ready for Construction (RFC) submittals may require [Authority] approval¹

¹ Approval might be required in order to achieve the state statute that designs be "prepared in conformity with standards previously so approved".



3.2.3.3 Tools and Methods

Tools and methods will be defined in detail by the contractor in the CVVP. The stage 2, step 1 of the CHST V&V process requires as a minimum the use of the tools and methods as shown in Table 3 on page 21. Refer to section 5.0 for more detailed information on tools and methods.

3.2.3.4 Roles and Responsibilities

Roles and responsibilities will be defined in detail by the contractor in the CVVP. The stage 2, step 1 of the CHST V&V process allocates as a minimum the roles and responsibilities as presented in Table 2.

3.2.4 Construction and Inspections

3.2.4.1 Inputs

The stage 2, step 2 of the CHST V&V process (construction and inspections) uses the following documents as source documents, including:

- Inputs into the final design (RFP, see section 3.2.3.1)
- Outputs from final design (see section 3.2.3.2)
- Ready for construction (RFC) documents

3.2.4.2 Outputs and Deliverables

The stage 2, step 2 of the CHST V&V process will result in the following outputs and deliverables:

- Contractor:
 - Contractor construction submittals including QA/QC and self-certification
 - Inspection and test plan (ITP)
 - Individual inspection procedures (including inspection coverage) and reports
 - Requirements verification traceability matrices (RVTM) demonstrating construction is in compliance with contract requirements and final design
 - Certifiable items lists (CIL) demonstrating construction is in compliance with critical interfaces as identified and specified in contract requirements and final design
 - V&V reports
 - Certificate of conformance in compliance with the Safety and Security Management Plan (SSMP)
- Independent Site Engineer:
 - Assessment reports
 - Compliance certificates
 - Progress plans and status reports
- Authority's Representative:
 - Statement of No Objection, if given



3.2.4.3 Tools and Methods

Tools and methods will be defined in detail by the contractor in the CVVP. The stage 2, step 1 of the CHST V&V process requires as a minimum the use of the tools and methods as shown in Table 3 on page 21. Refer to section 5.0 for more detailed information on tools and methods.

3.2.4.4 Roles and Responsibilities

Roles and responsibilities will be defined in detail by the contractor in the CVVP. The stage 2, step 2 of the CHST V&V process allocates as a minimum the roles and responsibilities as presented in Table 2.

3.2.5 Testing and Acceptance

3.2.5.1 General

Testing and acceptance is one of several stages within the design / build stage. The contractor is expected to achieve acceptance by demonstrating compliance through a comprehensive inspection and testing program.

Depending on the type of contract (i.e. civil/structural, trackwork, facilities, rolling stock, systems, etc.), test-types will vary, including:

- Prototype Testing
- First Article Compliance Inspection
- Production Run Testing (i.e., at supplier facility during manufacturing)
- Factory Acceptance Testing
- Inspections
- Site Installation Testing
- Site Acceptance Testing
- Integration Testing
- Interoperability Testing
- Start-Up Testing
- Pre-Revenue Testing
- Reliability, Availability, Maintainability Testing
- Safety and Security Certification

3.2.5.2 Inputs

The stage 2, step 3 of the CHST V&V process (testing and acceptance) uses the following documents as source documents, including:

- Inputs into the final design (e.g., RFP, see section 3.2.3.1)
- Outputs and deliverables from final design (e.g., RFC, see section 3.2.3.2)
- Outputs and deliverables from construction (e.g., ITP, see section 3.2.4.2)



3.2.5.3 Outputs and Deliverables

The stage 2, step 3 of the CHST V&V process will result in the following outputs and deliverables:

- Contractor:
 - Contractor test and acceptance submittals including QA/QC and self-certification
 - Individual test and acceptance procedures (including test coverage) and reports
 - Requirements verification traceability matrices (RVTM) demonstrating construction is in compliance with contract requirements and final design
 - Certifiable items lists (CIL) demonstrating construction is in compliance with critical interfaces as identified and specified in contract requirements and final design
 - V&V reports
 - Certificate of conformance in compliance with the Safety and Security Management Plan (SSMP)
 - Construction certificate of conformance
- Independent Site Engineer:
 - Assessment reports
 - Compliance certificates
 - Progress plans and status reports
- Authority's Representative:
 - Statement of No Objection, if given
 - System Safety Program Plan (SSPP)
 - Certification of Compliance (COC) with System Safety Program Plan (SSPP)

3.2.5.4 Tools, Methods and Responsibilities

Tools and methods will be defined in detail by the contractor in the CVVP. The stage 2, step 3 of the CHST V&V process requires as a minimum the use of the tools and methods as shown in Table 3 on page 21. Refer to section 5.0 for more detailed information on tools and methods.

3.2.5.5 Roles and Responsibilities

Roles and responsibilities will be defined in detail by the contractor in the CVVP. The stage 2, step 3 of the CHST V&V process allocates as a minimum the roles and responsibilities as presented in Table 2.



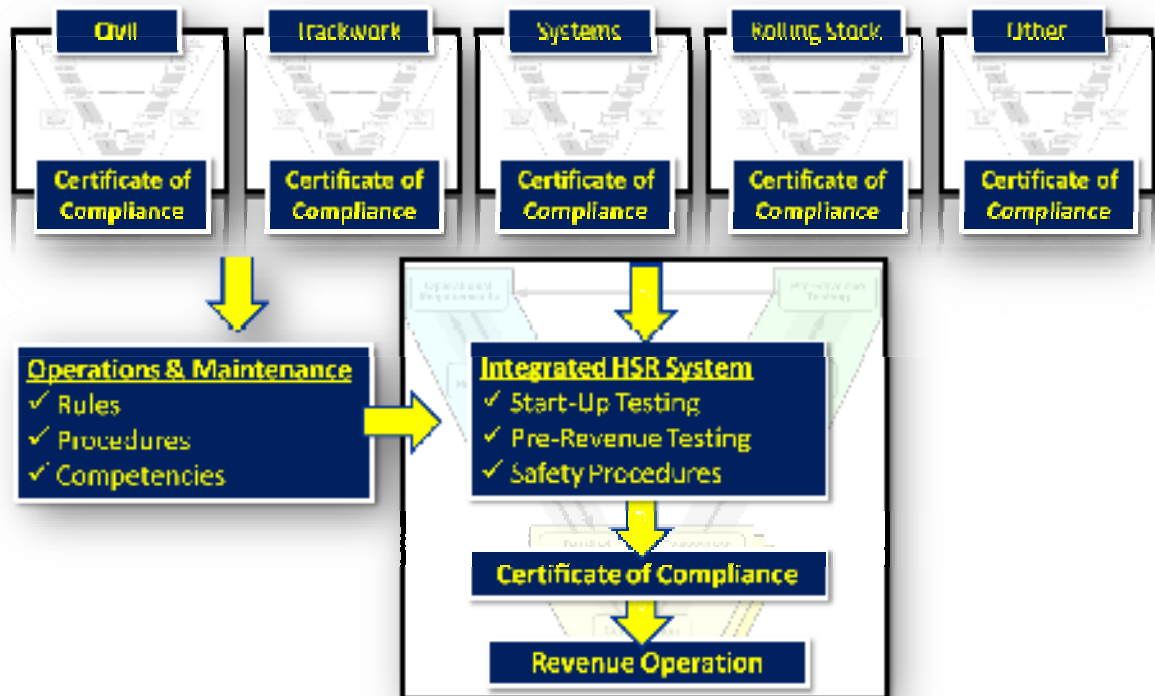
3.3 FINAL INTEGRATION, TESTING AND CERTIFICATION

3.3.1 Integrated High-Speed Rail System

3.3.1.1 General

The stage 3 of the CHST V&V process includes the final integration, testing and certification under supervision of the Authority as part of CHST program management. Once all design/build contracts have been successfully completed, the High-Speed Rail (HSR) system will be integrated, tested and certified as shown in Figure 7.

Figure 7: V&V in Final Integration, Testing and Certification Stage



Testing and commissioning plan: prior to execution of any tests as defined in this section, and in accordance with FRA regulatory approval guidelines, a detailed system-wide testing and commissioning plan (section 5.16) will be developed that identifies the tests that will need to be carried out to demonstrate the operability of all system elements, including the following:

- Civil / infrastructure
- Trackwork
- Systems, including traction power, overhead contact system, automatic train control, and communications
- Rolling stock
- Passenger stations
- Maintenance and storage facilities
- Operating and maintenance practices
- Safety and security operations

Start-up testing: includes integration readiness (qualification) testing and integrated system testing will be performed in compliance with the FRA guidance document.

- Integration readiness (qualification) testing (section 5.17) verifies that all elements to be integrated meet their contractual requirements including functional and performance requirements. These standalone system tests will mostly have been performed as part of the final testing and acceptance of the individual procurement contracts. Test reports and results will be prepared as detailed in output and deliverables section 3.2.5.3. Integration readiness (qualification) testing includes, as a minimum, including the following:
 - Civil/infrastructure elements
 - Clearance standards including dynamic train and fixed equipment envelopes and structure gauges
 - Track standards
 - Utility supplies
 - Traction power operation
 - Overhead contact system energization
 - Communication systems including the communication backbone and the radio systems
 - Automatic train control system including operation of local equipment
 - Operations/regional/local control centers
 - Local control of wayside equipment, including wayside sensors
 - Local operation of maintenance and storage facilities
- Integrated system testing: Includes description of the testing across individual procurement contracts and subsystems. It includes testing of the integrated interfaces as well as end-to-end functionally and performance testing. Integrated system testing includes, but is not limited to:
 - Track/structure interaction
 - Rolling stock/track interaction
 - Rolling stock/clearance interaction with infrastructure and stations
 - Rolling stock brake performance
 - Rolling stock/system interaction, including traction power, overhead contact system, automatic train control and communication systems
 - Rolling stock/automatic train control detection
 - Rolling stock pantograph/overhead contact system interaction
 - Remote supervisory and control of all systems, including mechanical, electrical systems from control center locations
 - System operation in normal and degraded modes
 - Maintenance practices and procedures
 - Safety and security operation
 - EMI/EMC compatibility
 - Noise and vibration



Pre-revenue operation: Prior to revenue operations CHSTS will simulate full revenue service operation for a minimum period as required by FRA regulations to verify overall system performance, and provide operating and maintenance experience. A log of all tests performed during the pre-revenue testing period will be maintained identifying any problems encountered during testing, and actions necessary to correct the defects. CHSTS will implement all actions necessary to correct defects, as identified by the log prior to the initiation of revenue service.

3.3.1.2 Inputs

The stage 3 of the CHST V&V process uses the following documents as source documents, including:

- Outputs and deliverables from completed contracts (3.2.5.3)
 - Test and acceptance reports
 - Compliance statements (RVTMs, CILs)
 - Construction certificates of conformance
 - Certifications of Compliance
- Outputs and deliverables from CHST Program planning
 - Conceptual operating plan
 - Concept of operations, including operating scenarios
 - Fire/life safety plan, including operating scenarios
 - Emergency action plan
 - Code of operating rules
 - On-board, station and other operating plans
 - Infrastructure, rolling stock, and other maintenance plans
 - Training and qualification plan
 - Critical requirements and interfaces

3.3.1.3 Deliverables

The stage 3 of the CHST V&V process will result in the following outputs and deliverables:

- Final testing and commissioning plan, procedures and test results
- Certification of Compliance with FRA approved SSPP

3.3.1.4 Tools and Methods

Tools and methods will be defined in detail in the CHST program testing and commissioning plan. The stage 3 of the CHST V&V process requires as a minimum the use of the tools and methods as shown in Table 3 on page 21. Refer to section 5.0 for more detailed information on tools and methods.



3.3.1.5 Roles and Responsibilities

Roles and responsibilities will be defined in detail in the CHST program testing and commissioning plan.

The stage 3 of the CHST V&V process allocates as a minimum the roles and responsibilities as presented in Table 2.



4.0 ROLES AND RESPONSIBILITIES

Table 2 provides an overview of CHSTS V&V process roles and responsibilities.

Table 2: CHSTS V&V Roles and Responsibilities

Roles and Responsibilities	STAGE 1	STAGE 2			STAGE 3
	ER / PE	STEP 1 (Final Design)	STEP 2 (Construction)	STEP 3 (Testing and Acceptance)	Final Integration, Testing & Certification
Regional Teams	<ul style="list-style-type: none"> Develop Preliminary Engineering for Procurement in compliance with Technical Memoranda (TM) and Environmental Requirements 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage
Design/Build Contractor	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> Prepares and submit final design submittals in compliance with contract Performs QA/QC in final design submittals Self-certifies compliance with contract and fitness for purpose Issues certification of conformance with SSMP 	<ul style="list-style-type: none"> Prepares and submit construction and inspection submittals in compliance with contract Performs QA/QC on construction and inspection submittals Self-certifies compliance with contract and fitness for purpose Issues certification of conformance with SSMP 	<ul style="list-style-type: none"> Prepares and submits testing and acceptance submittals in compliance with contract Performs QA/QC on testing and acceptance submittals Self-certifies compliance with contract and fitness for purpose Issues certification of conformance with SSMP Issues construction certificate of conformance 	<ul style="list-style-type: none"> N/A in this stage
Independent Checking Engineer	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> Fully checks contractors submittals Provides assessment reports and compliance certificates Prepares independent structural calculations 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage
Independent Site Engineer	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> Fully checks contractors submittals Witnesses inspections Provides assessment reports and compliance certificates 	<ul style="list-style-type: none"> Fully checks contractors submittals Witnesses acceptance tests Provides assessment reports and compliance certificates Fully checks construction certificate of conformance 	<ul style="list-style-type: none"> N/A in this stage
Project Management/ Construction Management	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> Manages execution of procurement contract Audits contractor's Self-Certification and V&V process adherence Reviews contractor submittals from contract perspective Provides SONO recommendation to Authority 	<ul style="list-style-type: none"> Manages execution of procurement contract Audits contractor's Self-Certification and V&V process adherence Reviews contractor submittals from contract perspective Provide SONO recommendation to Authority 	<ul style="list-style-type: none"> Manages execution of procurement contract Audits contractor's Self-Certification and V&V process adherence Reviews contractor submittals from contract perspective Provides SONO recommendation to Authority 	<ul style="list-style-type: none"> N/A in this stage
Project Management Team / Engineering Management Team	<ul style="list-style-type: none"> Develop project internal requirements in compliance with project external requirements 	<ul style="list-style-type: none"> Reviews contractor submittals from CHST program and system performance perspective 	<ul style="list-style-type: none"> Reviews contractor submittals from CHST program and system performance perspective 	<ul style="list-style-type: none"> Reviews contractor submittals from CHST program and system performance perspective 	<ul style="list-style-type: none"> Prepares final testing and commissioning plan Performs start-up and pre-revenue



Roles and Responsibilities	STAGE 1	STAGE 2			STAGE 3
	ER / PE	STEP 1 (Final Design)	STEP 2 (Construction)	STEP 3 (Testing and Acceptance)	Final Integration, Testing & Certification
	<ul style="list-style-type: none"> Develop technical criteria in compliance with project internal requirements Develop procurement packages in compliance with project requirements 	<ul style="list-style-type: none"> Provides SONO recommendation to Authority 	<ul style="list-style-type: none"> Provide SONO recommendation to Authority 	<ul style="list-style-type: none"> Provides SONO recommendation to Authority 	testing <ul style="list-style-type: none"> Performs safety and security certification Issues operating certificate of conformance Issues safety certificate of conformance
California High-Speed Rail Authority	<ul style="list-style-type: none"> Review and approval of CHST Program V&V management plan 	<ul style="list-style-type: none"> Issues SONO, if given Ready for Construction (RFC) submittals may require [Authority] approval¹ 	<ul style="list-style-type: none"> Issues SONO, if given 	<ul style="list-style-type: none"> Issue SONO, if given Provides Certification of Compliance with SSPP to FRA 	<ul style="list-style-type: none"> Provides self-certification of compliance with the requirements of the System Safety Program Plan to FRA
Federal Railroad Administration ²	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> N/A in this stage 	<ul style="list-style-type: none"> Reviews final testing and commissioning plan, procedures and test results Reviews and approves Authority's System Safety Program Plan

² For more information on Regulatory Approvals, refer to TM 0.9 [2] and the FRA Guidance Document [7].



5.0 SUPPORTING TOOLS AND METHODS

Table 3 provides an overview of CHSTS V&V process tools and methods. Refer to the subsequent sections for more details.

Table 3: CHSTS V&V Tools and Methods

Requirements/ Criteria	Verified Documents	Tools and Methods
Stage 1: Environmental Review / Preliminary Engineering		
Project external requirements	Project internal requirements	<ul style="list-style-type: none"> Trace by Reference (e.g. Correlation Matrix, Disposition Tables)
Project internal requirements	Technical criteria	<ul style="list-style-type: none"> Requirements Management Tool Requirements Verification Traceability Matrix
Technical criteria	Preliminary Engineering	<ul style="list-style-type: none"> Quality Assurance/ Quality Control
Critical requirements and interfaces	Project internal requirements Technical criteria Procurement package	<ul style="list-style-type: none"> Requirements Management Tool System Requirements Specification Interface Register Requirements Verification Traceability Matrix Certifiable Items List
Stage 2, Step 1: Final Design		
Contractor Self-Certification and V&V process requirements	CVVP	<ul style="list-style-type: none"> Quality Assurance / Quality Control Assessment report Compliance certificate Statement of No Objection
Technical contract requirements	Final design submittals (incl. RFC documents, reports)	<ul style="list-style-type: none"> Quality Assurance / Quality Control Requirements Management Tool Requirements Verification Traceability Matrix Certifiable Items List V&V Report Certification of conformance with SSMP Assessment report Compliance certificate Statement of No Objection
Stage 2, Step 2: Construction		
Inspection and test plan requirements	Inspection and test plan	<ul style="list-style-type: none"> Quality Assurance / Quality Control Assessment report Compliance certificate Statement of No Objection
Inspection procedure and inspection report requirements	Inspection procedures (incl. coverage), Inspection reports	<ul style="list-style-type: none"> Quality Assurance / Quality Control Requirements Management Tool Requirements Verification Traceability Matrix Certifiable Items List (as applicable) V&V Report Certification of conformance with SSMP Assessment report Compliance certificate Statement of No Objection



Stage 2, Step 3: Testing & Acceptance		
Test procedure/ coverage and test report requirements	Test and acceptance procedures (incl. coverage), Test reports	<ul style="list-style-type: none"> • Quality Assurance/Quality Control • Requirements Management Tool • Requirements Verification Traceability Matrix • Certifiable Items List (as applicable) • V&V Report • Certification of conformance with SSMP • Construction certificate of conformance • Assessment report • Compliance certificate • Statement of No Objection • Certification of Compliance with SSPP
Stage 3: Final Integration, Testing & Certification		
Final testing and commissioning plan	Integration, testing and certification documents	<ul style="list-style-type: none"> • Quality Assurance/Quality Control • FRA review
Critical requirements and interfaces	Integration, testing and certification documents	<ul style="list-style-type: none"> • Start-up testing • Pre-revenue testing • FRA review per FRA GD
Operating and maintenance plans and procedures	Integration, testing and certification documents	<ul style="list-style-type: none"> • Start-up testing • Pre-revenue testing • FRA review per FRA GD
Safety and security plans and procedures	Integration, testing and certification documents	<ul style="list-style-type: none"> • Start-up testing • Pre-revenue testing • FRA review and approval • Self-certification of compliance

5.1 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance (QA) and quality control (QC) processes following the procedures outlined in the CHSTS program and contractor quality management plans (QMP) will be used to review and assess the quality of the deliverables submitted by the design/build contractor.

5.2 REQUIREMENTS MANAGEMENT

Requirements management (RM) is used to identify, capture, document, derive, apportion, trace, manage, verify, and validate CHSTS requirements. Requirements management is absolutely essential as only well stated requirements (i.e., specific, measurable, etc.) can be successfully verified and validated.

Requirements are stored and managed in the requirements management tool (section 5.3). The PMT also uses system requirements specifications (section 5.4) for the decomposition and apportioning of CHSTS requirements.



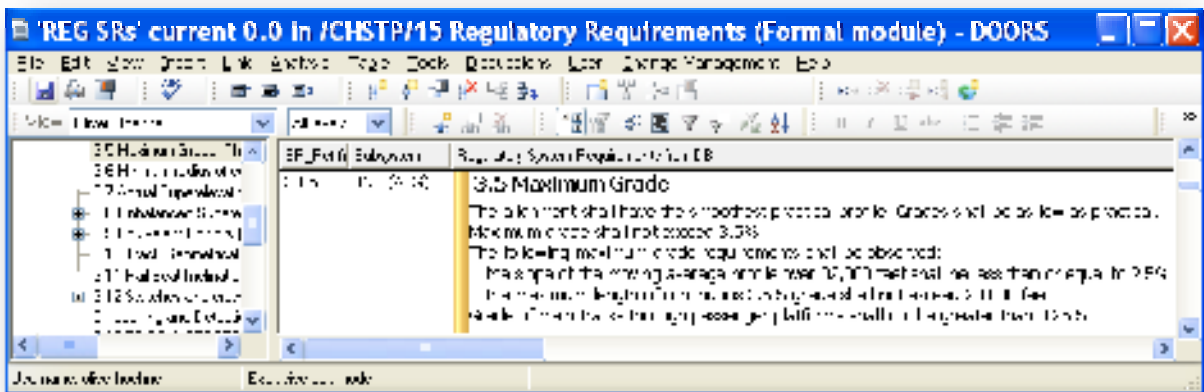
5.3 REQUIREMENTS MANAGEMENT TOOL

IBM Rational DOORS (Dynamic Object Oriented Requirements System) is used as the requirement management tool.

DOORS is used for the following purposes, including:

- Store CHSTS requirements documents
- Maintain traces between requirements and objective evidence
- Store and manage interfaces
- Create RVTMs and CILs
- Support the change impact analysis

Figure 8: IBM Rational DOORS

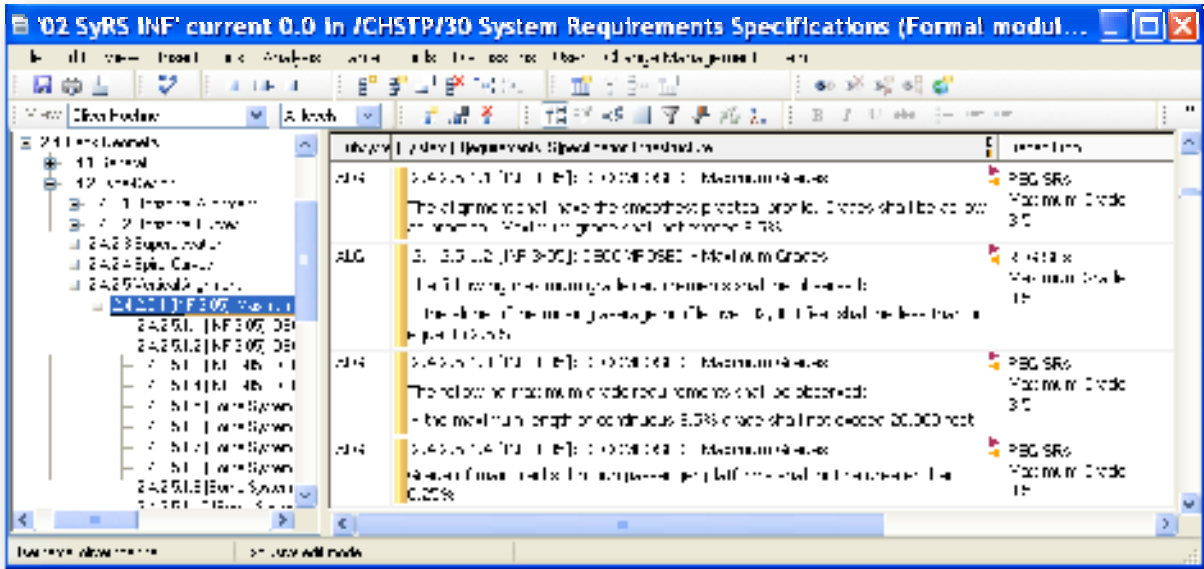


5.4 SYSTEM REQUIREMENTS SPECIFICATIONS

The PMT uses system requirements specifications (SyRS) for the systematic and structured collection of CHSTS requirements. SyRSs are held in the requirements management tool (section 5.3). SyRSs are furthermore used to support the decomposition and apportioning of requirements to subsystems and procurement packages. Requirements are typically subdivided into the following categories:

- Operational requirements
- Safety requirements
- Security requirements
- Environmental requirements
- Reliability, availability, maintainability requirements
- Functional requirements
- Performance requirements
- Physical requirements
- Interface requirements
- Expandability requirements
- Logistics, support, other requirements

Figure 9: Infrastructure System Requirements Specification



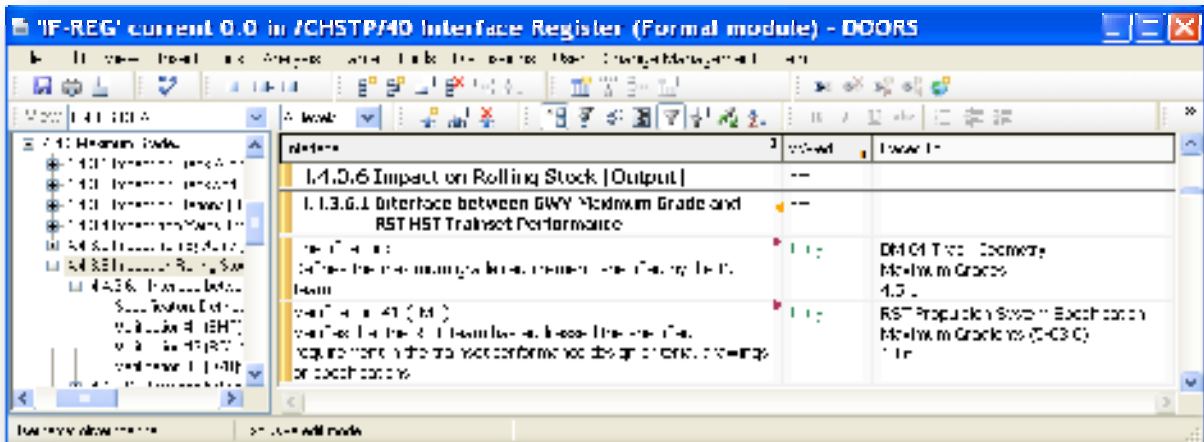
5.5 INTERFACE MANAGEMENT

Interface management (IM) is used to identify, document, specify, verify, validate and certify interfaces. Interfaces can include technical, spatial, organizational and other interfaces. Interfaces are stored in the interface register (section 5.6) and are held in the requirements management tool (section 5.3)

5.6 INTERFACE REGISTER

The interface register is used to document the identified interfaces as well as all references to the interface requirements specification (IRS) and interface design descriptions (IDD) used to verify that the interfaces requirements have been addressed appropriately.

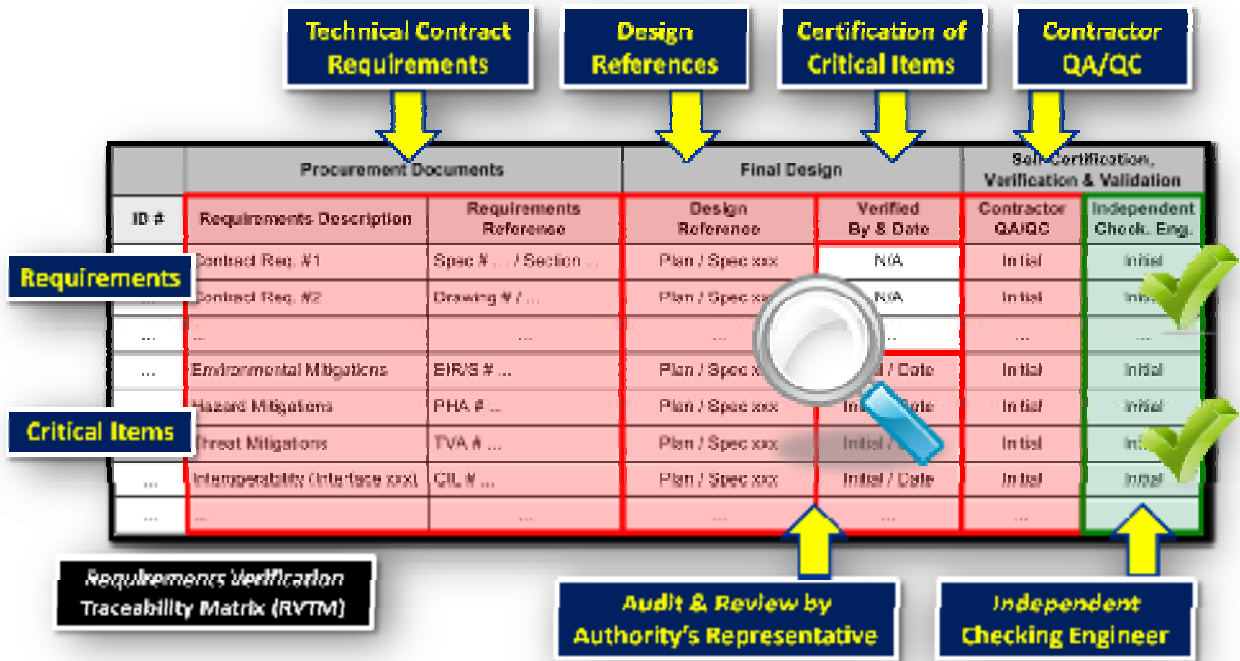
Figure 10: Interface Register



5.7 REQUIREMENT VERIFICATION TRACEABILITY MATRIX

Requirements verification traceability matrices (RVTM) are used to demonstrate compliance to requirements by providing reference to objective evidence demonstrating that the stated requirements have been fulfilled.

Figure 11: Requirements Verification Traceability Matrix



5.8 CERTIFIABLE ITEMS LIST

Certifiable items lists (CILs) are used in addition to RVTM to certify compliance with critical items by additional sign-off. They are specifically required for the safety certification. Critical items include:

- Environmental requirements and mitigations as found in the environmental documents including EIR/S, Record of Decision (ROD), permits and approvals
- Safety requirements including hazard mitigations
- Security requirements including threat mitigations
- Interoperability items with other CHSTS contracts

5.9 VERIFICATION AND VALIDATION REPORT

Verification and validation reports are requested from the contractor as an executive summary and certification of compliance with the technical contract requirements. Explanation is required on how requirements are met, inspected, tested, and accepted by the contractor's design and construction in addition to information provided by the RVTM or CILs.



5.10 ASSESSMENT REPORT

The independent checking engineer (ICE) and independent site engineer (ISE) are required to assess and evaluate all contractor submittals and provide an assessment report, checking for:

- Accuracy
- Adequacy
- Conformance to standards of practice
- Compliance with codes and standards
- Cost effectiveness
- Quality, and
- Fitness for purpose and/or function as specified and/or implied in the Contract.

5.11 COMPLIANCE CERTIFICATE

After evaluation and assessment of the contractor submittal the ICE/ISE is required to issue a compliance certificate in conjunction with the assessment report (section 5.10) stating the compliance of the contractor submittal with the applicable contract requirements.

5.12 STATEMENT OF NO OBJECTION

Upon submittal the Authority's Representative will perform an audit of the contractor's and ICE/ISE's adherence to the verification and validation process and re-check the submittal as deemed necessary.

The Authority's Representative will provide a review report for each submittal. The reports will include the Authority's Representative's determination as follows:

- Statement of No Objection (SONO)
- Statement of No Objection with incorporation of comments
- Objection with comments requiring Resubmittal

5.13 CERTIFICATES OF CONFORMANCE

Certificates of conformance are issued by either the contractor or the PMT:

- Contractor
 - Construction certificate of conformance: certifying that the contract has been executed, tested and accepted in compliance with the contract requirements
- PMT
 - Operating certificate of conformance: certifying that the applicable contracts have been integrated and successfully tested in compliance with the operating and maintenance requirements
 - Safety certificate of conformance: certifying that the applicable contracts have been integrated and successfully tested in compliance with the safety and security requirements

5.14 SAFETY AND SECURITY MANAGEMENT PLAN

The Safety and Security Management Plan (SSMP) is the document that is prepared during CHSTS stage 1 (section 3.0) to guide and administer the safety and security activities during the CHSTS stages 1 and 2.

The SSMP is reviewed and approved by the FRA, and requires self certification of compliance (COC) to ensure that safety concerns and hazards are adequately addressed prior to the initiation of passenger operations. This will be strongly supported by CILs (section 5.8) which provide:

- Specified (safety and security) requirements
- Documented objective evidence demonstrating compliance to specified requirements
- Sign-off by the responsible parties

5.15 SYSTEM SAFETY PROGRAM PLAN AND CERTIFICATION OF COMPLIANCE

In CHSTS stage 3 the System Safety Program plan will be developed to guide and administer the safety activities of the operating railroad. Also, a separate Security and Emergency Preparedness Plan (SEPP) will also be developed at this time.

The System Safety Program Plan is reviewed and approved by the FRA, and requires self certification of compliance (COC) to ensure that safety concerns and hazards are adequately addressed prior to the initiation of passenger operations. This will be strongly supported by CILs (section 5.8) which provide:

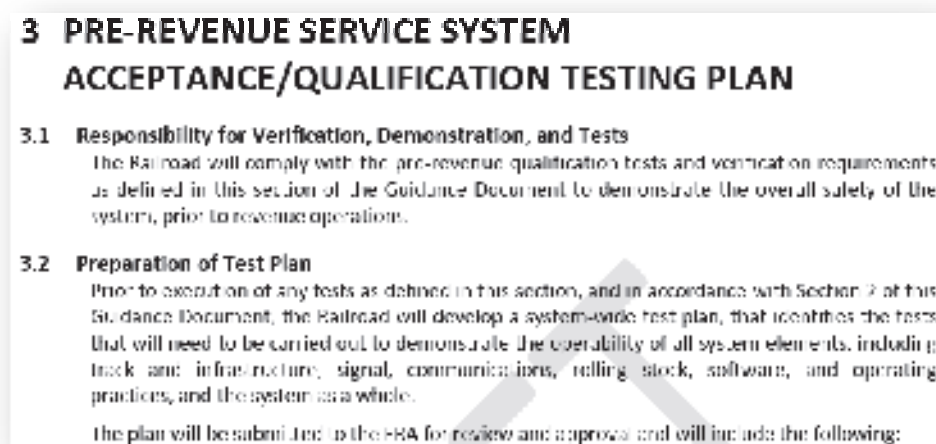
- Specified (safety) requirements
- Documented objective evidence demonstrating compliance to specified requirements
- Sign-off

5.16 FINAL TESTING AND COMMISSIONING PLAN

Prior to execution of any integration, start-up and pre-revenue testing, CHSTS will prepare a detailed system-wide testing and commissioning plan that identifies the tests that will need to be carried out to demonstrate the operability of all system elements.

The final testing and commissioning plan will be prepared in accordance with FRA regulations and as documented in the FRA guidance document (Figure 12). It will be submitted to the FRA for review and comment.

Figure 12: FRA Guidance Document Excerpt: Final Testing and Commissioning Plan



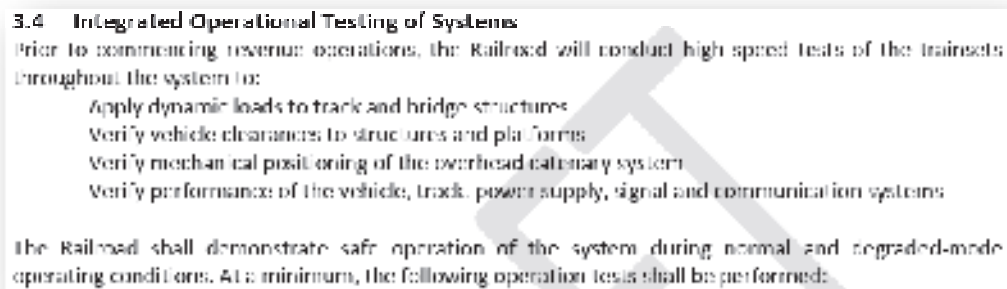
5.17 START-UP TESTING

Start-up testing will be performed in accordance with FRA regulations and as documented in the FRA guidance document, including as a minimum:

- Pre-Operational Qualification Tests
- Integrated Operational Testing of Systems (Figure 13)
- Verification of Compliance
- Vehicle/Track System Qualification

Test procedures and results will be submitted to the FRA for review and comment.

Figure 13: FRA Guidance Document Excerpt: Start-Up Testing

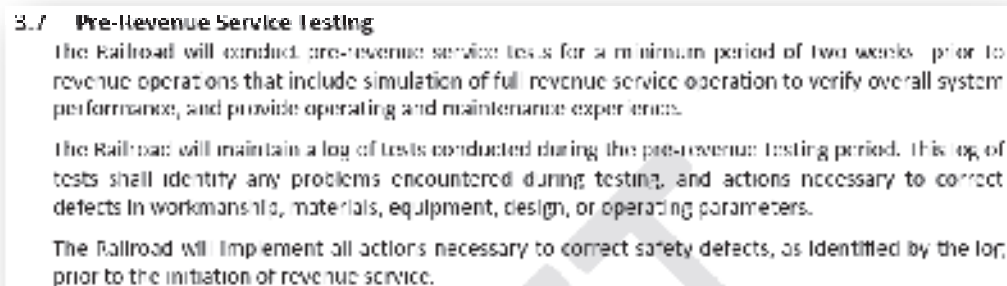


5.18 PRE-REVENUE TESTING

Pre-revenue testing will be performed in accordance with FRA regulations and as documented in the FRA guidance document (Figure 14).

Test procedures and results will be submitted to the FRA for review and comment.

Figure 14: FRA Guidance Document Excerpt: Pre-Revenue Testing



June 18, 2013

PMT-CHSRA-03437

Frank Vacca
Chief Program Manager
California High-Speed Rail Authority
770 L Street, Suite 800
Sacramento, CA 95814

RE: Request for Authority review and concurrence of
TM 1600.01 Verification and Validation Management Plan, R0

Mr. Vacca,

TM 1600.01 Verification and Validation Management Plan (VVMP) describes the California High-Speed Train System's (CHSTS) approach to Verification & Validation (V&V) and Contractor Self-Certification (SC). It is an initial release Revision 0 document and documents the complete Life-Cycle from the Environment Review/PE Stage, Final Design, Construction and Final Integration, Testing and Certification for the complete CHST System, including Infrastructure, Trackwork, Stations, Systems, Rolling Stock, and Operations and Maintenance elements.

The VVMP was developed following a series of briefings and strategy meetings with the California High-Speed Rail Authority in 2011 and 2012 to document the use of the Verification & Validation and Contractor Self-Certification process as a program-level management plan. The detailed CP-01 Contractor V&V/SC requirements were developed based on this VVMP.

The technical development approach for the California High-Speed Train System (CHSTS) is based on applying service-proven technology from existing European and Asian high-speed rail systems with similar performance requirements and on applying existing and applicable U.S. based requirements for passenger railroad safety. This approach is intended to ensure suitability of the high-speed rail system for the required level of performance, and in compliance with applicable and emerging high-speed rail (HSR) regulations.

The technical documents guiding development of the CHSTS are derived from several regulatory and safety source documents including the U.S. Code of Federal Regulations Title 49, Parts 200-299 which regulate passenger railroad safety in the U.S., California Public Utilities Commission (CPUC) General Orders (GO), and the European Technical Specifications for Interoperability which regulates high-speed passenger railway safety in the European Union. The CHSTS technical documents also take into account safety regulation currently in development by the Federal Railroad Administration (FRA) specific to high-speed rail operations.

These new regulations are under review by the Engineering Task Force (ETF) of the FRA Railroad Safety Advisory Committee, the proceedings of which the California High-Speed Rail Authority is an active participant. In addition, the CHSTS has developed proposed CPUC General Order establishing safety regulations governing 25kV railroad electrification it intends to petition to CPUC for adoption under order instituting rulemaking proceedings.

It is understood that this is a living document and will be updated as required. If this meets with your requirements, please sign below acknowledging your concurrence for adoption and use on the program.

Regards,



Brent Felker, P.E.
Program Director

California High-Speed Rail Authority
Concurrence



Frank Vacca, Chief Program Manager

Date: 6/21/2013

Enclosure: TM 1600.01 Verification and Validation Management Plan, R0