CALIFORNIA HIGH-SPEED TRAIN SYSTEM (CHSTS)

[incose IW14, Los Angeles, Jan 28, 2014]

Applying Verification & Validation for CHSTS Safety Certification

Presented by Jon Tapping
VERIFICATION & VALIDATION (V&V)
AGENDA

- CHSTS Program Overview
- Master Quality Plan – Overview
- CHSTS V&V Program – Overview
- Traditional Safety Certification
- CHSTS Safety Certification using V&V
- Walk-Through of Sample Safety Certification
- Practical Value of V&V
- V&V during Construction and Testing
- Summary
First High-Speed Rail in U.S.
Construction has started
SF to LA in under 3 hours by 2029
800 Miles, 24 stations
Operating Speed of 220 mph
VERIFICATION & VALIDATION (V&V)

PROJECT BACKGROUND (CONT’D)

- 29 Miles
- ~ 1 Billion Dollar
- Civil / Structural Work
- Started
Initial Operating Segment (IOS)
- Central Valley to San Fernando Valley
- “Backbone” of High-Speed Rail
- 300 Miles
- First Step Towards a Statewide High-Speed Rail System by 2022

Early Investments Underway
- Caltrain Electrification & Early Investments in the Corridor
- Regional Enhancements in Southern California
- Statewide Connectivity Projects & Investments
VERIFICATION & VALIDATION (V&V)
V&V PART OF CHSTS MASTER QUALITY PLAN

CALIFORNIA HIGH SPEED RAIL AUTHORITY
QUALITY MANAGEMENT SYSTEM
MASTER QUALITY PLAN

Figure 2.4.2 – Verification, Validation, & Self Certification Process


2. Contractor submits Technical Contract Submittal together with Contractor V&V submittal to Independent Checking Engineer (ICE) and Independent Site Engineer (ISE).

3. ICE and ISE assess and evaluate the Technical Contract Submittal in order to be able to certify that the final design/construction meets the Contract Requirements as detailed in the Contract and as reasonably inferred therefrom. ICE/ISE submits an assessment report and certification to the Authority's Representative with copy to the Contractor.


Authority's Representative performs audit and re-review as required and issues a statement of No Objection (SONO) or Approval, if given, based upon audit and review results and ICE/ISE assessment report and certificate.
2.1 Governing Legislation and Environmental Documentation

Governing legislation and other legal documentation dictate performance characteristics of the CHSTP. Proposition 1A was passed by the voters of the state of California on November 4, 2008. The following language outlines the requirements from the proposition which have since been added as Chapter 20 to Division 3 of the State Streets and Highways Code:

2704.09. The high-speed train system to be constructed pursuant to this chapter shall have the following characteristics:

(a) Electric trains that are capable of sustained maximum revenue operating speeds of no less than 200 miles per hour.

(b) Maximum nonstop service travel times for each corridor that shall not exceed the following:

(1) San Francisco-Los Angeles Union Station: two hours, 40 minutes.
(2) Oakland-Los Angeles Union Station: two hours, 40 minutes.
(3) San Francisco-San Jose: 30 minutes.
(4) San Jose-Los Angeles: two hours, 10 minutes.
(5) San Diego-Los Angeles: one hour, 20 minutes.
(6) Inland Empire-Los Angeles: 30 minutes.
(7) Sacramento-Los Angeles: two hours, 20 minutes.

(c) Achievable operating headway (time between successive trains) shall be five minutes or less.
VERIFICATION & VALIDATION (V&V)
WHY VERIFICATION & VALIDATION (CONT’D)
VERIFICATION & VALIDATION (V&V)

CHSTS V&V PRINCIPLES

Generic System Development Life Cycle / “V” Model
## Verification & Validation (V&V) - Traditional Safety Certification

<table>
<thead>
<tr>
<th>Status</th>
<th>Means of Verification - Design</th>
<th>Means of Verification - Construction</th>
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</thead>
<tbody>
<tr>
<td>C = Compliance</td>
<td>S = Submittal</td>
<td>M = Measurement</td>
</tr>
<tr>
<td>N = Noncompliance</td>
<td>D = Design</td>
<td>T = Test</td>
</tr>
<tr>
<td>P = Partial Compliance</td>
<td></td>
<td>V = Visual Inspection</td>
</tr>
</tbody>
</table>

### Notes or Restrictions:

Certifiable Element: __________________
Checklist Type: Master: ________ Sub: ________
Sub-Element: __________
Contract Number: __________
Safety: __________ Security: __________
Specification/Drawing Reference: __________
Document Control Number: __________
Revision: __________

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Design Cross Reference</th>
<th>Design Status</th>
<th>Design Initial</th>
<th>Design Date</th>
<th>Means of Verification</th>
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<table>
<thead>
<tr>
<th>Verification</th>
<th>Validation</th>
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</thead>
<tbody>
<tr>
<td>Development</td>
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</tr>
</tbody>
</table>

FTA Sample Design and Construction Conformance Checklist (Page 25)
VERIFICATION & VALIDATION (V&V)

TRADITIONAL SAFETY CERTIFICATION (CONT’D)

<table>
<thead>
<tr>
<th>CERTIFIABLE ELEMENT</th>
<th>SUB-ELEMENT</th>
<th>DESCRIPTION – DCM REFERENCE</th>
<th>NJ/PA DCM/SPEC OR DWG REF</th>
<th>CONTRACT PKG. SPEC. OR DWG REF.</th>
<th>DESIGN VERIFIED BY</th>
<th>INSTALLED/TESTED BY</th>
<th>DATE INSTALLED/TESTED</th>
<th>FIELD VERIFIED BY</th>
<th>STATUS</th>
<th>VERIFIED BY</th>
<th>DATE VERIFIED</th>
</tr>
</thead>
<tbody>
<tr>
<td>008</td>
<td></td>
<td>All new water mains and relocations shall comply with applicable Federal, State and local standards, and the applicable standards of ANSI and AWWA (For this contract, United Water requirements shall be complied with).</td>
<td>DCM Ch. 7, Sec. 7,1,7</td>
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<td></td>
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</tr>
<tr>
<td>009</td>
<td></td>
<td>All new water mains and relocations shall be designed to the criteria of and shall be approved by municipality/agency (For this contract, the agency is United Water).</td>
<td></td>
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<tr>
<td>010</td>
<td></td>
<td>Overhead utility lines clearances shall be in accordance with the standards adopted by the utilities involved, and those specified in the National Electrical Safety Code shall be considered the minimum requirements with respect to NJ TRANSIT’s ROW crossings catenary system, and structures.</td>
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<tr>
<td>011</td>
<td></td>
<td>The geotechnical design shall be in accordance with the current editions of codes, manuals or specifications, listed in the DCM Section 8.1.1</td>
<td>DCM Sec. 8.1.1</td>
<td></td>
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<tr>
<td>012</td>
<td></td>
<td>In addition to the applicable subsections from AREMA cited in Sections 8.2.1 and 8.2.2, foundation design requirements shall consider building codes listed in Section 8.1.1 (For this contract, NJ DOT)</td>
<td>DCM Ch. 8, Sec. 8.2</td>
<td></td>
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</table>
VERIFICATION & VALIDATION (V&V)
HOW COULD IT BE DONE BETTER?
VERIFICATION & VALIDATION (V&V)
CHSTS PROGRAM STAGES & STEPS

- Operational Requirements
- System Requirements
- High-Level Design
- Detailed Design
- Component Testing
- Construction
- Design / Build Contracts
- Final Design
- Testing / Acceptance
- Construction / Inspection
- Environmental Review
- Preliminary Engineering
- Final Integration, Testing & Certification
- Pre-Revenue Testing
- Start-Up Testing
- Integration Testing
- Testing / Acceptance
VERIFICATION & VALIDATION (V&V)
SAFETY CERTIFICATION STAGES & STEPS

Environmental Review
Preliminary Engineering

Design / Build
Contracts

Final Integration,
Testing & Certification

Desired System

WE ARE HERE

CP01

PHA

CEHL

V&V

RST

CP2-3

...
1.5 SSMP Goals and Objectives

1.5.1 Goals

The goals of the SSMP are as follows:

- Achieve an acceptable level of risk through a systematic approach to hazard and threat/vulnerabilities management

- Ensure that the system initiated into revenue service is safe and secure for passengers, employees, emergency response personnel, and the general public through a formal program of safety and security certification

- Ensure that the design, acquisition, construction, fabrication, assembly, installation, testing of critical elements of the CHST system will be verified for conformance to the established safety and security requirements and validated for effectiveness in achieving an effective level of safety and security

- Ensure that a mechanism is provided to follow to completion the resolution of any restriction to full safety and security certification

- Establish an effective, proactive Construction Safety and Security Program that results in no accidents for construction employees and the public, as well as minimizes security breaches, during all CHSTP work activities
VERIFICATION & VALIDATION (V&V) 
SAFETY CERTIFICATION ACTIVITIES

Leading up to and through the Preliminary Engineering phase of the project, the safety and security activities encompass the following activities:

- Develop the SSMP, including a process for achieving safety and security certification, to meet all Federal Railroad Administration (FRA) requirements for a safety and security management plan in a major capital project, in conformance with the Federal Transit Administration’s Circular 5800.1 Safety and Security Management guidance for Major Capital Projects.

- Identify a list of safety-critical and security-critical elements and items for the CHSTP Preliminary designs.

- Specify safety and security certification requirements, in conformance with the CHSTP Verification and Validation Plan, in contract documents. Safety and security certification requirements will be part of the scope of work for the design/build contractors during the Final Design and Construction phases of the project, with oversight provided by the PMT.

- Implement a hazard and certification tracking system, to be developed by the PMT’s System Safety Manager working with the PMT’s Verification and Validation Manager.

- Perform Preliminary Hazard Analyses (PHA) and a Threat and Vulnerability Assessment (TVA) to identify certifiable elements and hazards/vulnerabilities requiring mitigation. Identify hazard/vulnerability mitigation from the PHA and TVA to be incorporated into preliminary and final designs. Perform additional analysis as required.

- Develop design criteria conformance checklists. The tracking system will be an integrated subset of the Verification & Validation program applied throughout the CHSTP.
VERIFICATION & VALIDATION (V&V)
STATE-OF-THE-ART SAFETY CERTIFICATION

California High-Speed Train Project

Agreement No.: HSR 13-06
Book 3, Part B, Subpart 6

Safety and Security Management Plan

California High-Speed Train System

TECHNICAL MEMORANDUM

Verification and Validation Management Plan (VVMP) TM 1600.01

Prepared by: Oliver Hoferne 17 Jun 13 Date
Checked by: Vladimir Kanevsky, PE 17 Jun 13 Date
Approved by: John Chico, PE, Engineering Manager 17 Jun 13 Date
Released by: Brent Faiker, PE Program Director 17 Jun 13 Date

<table>
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<th>Date</th>
<th>Description</th>
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<td>Initial Release, R0</td>
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<td>1</td>
<td>27 Apr 12</td>
<td>Addendum 1</td>
</tr>
<tr>
<td>2</td>
<td>31 Jul 13</td>
<td>EXECUTION VERSION</td>
</tr>
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</table>

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

Prepared by
PARSONS
for the California High-Speed Rail Authority

Integrated Approach
**VERIFICATION & VALIDATION**
**PRELIMINARY HAZARD ANALYSIS (PHA)**

![Diagram](image.png)

**Figure 4-1 Sample PHA**

<table>
<thead>
<tr>
<th>System: Infrastructure</th>
<th>California High-Speed Train Project</th>
<th>Prepared by: Date</th>
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<tbody>
<tr>
<td>Subsystem: R-O-W, Generally</td>
<td>Preliminary Hazard Analysis (PHA)</td>
<td>Reviewed by: Date</td>
</tr>
</tbody>
</table>

| PHA No. 1.1.1 Rev. No. 0 | DRAFT 12/08/2011 | Approved by: Date |

<table>
<thead>
<tr>
<th>General Description</th>
<th>Hazard Cause / Effect</th>
<th>Hazard Risk Index</th>
<th>Corrective Action</th>
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<tbody>
<tr>
<td>Derailment</td>
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<table>
<thead>
<tr>
<th>No.</th>
<th>System Mode</th>
<th>Hazard Description</th>
<th>Potential Cause</th>
<th>Effect on Subsystem / System</th>
<th>Initial</th>
<th>Residual (Projected)</th>
<th>Controlling Measures and Remarks</th>
<th>Resolution / Reference</th>
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<tr>
<td>4</td>
<td>A</td>
<td>Washout</td>
<td>Flooding, scouring</td>
<td>Derailment w/mass casualties, property damage, service interruption</td>
<td>I-B Unacceptable</td>
<td>II-E Acceptable w/Review</td>
<td>1) Perform hydraulics analysis and incorporate results into sub-grade design, slope protection and setting of profile. 2) Install appropriate drainage. 3) Inspection and maintenance of drainage systems. 4) Identification and monitoring by O&amp;M of potential hazardous locations.</td>
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**Safety and Security Management Plan**

This is a representation only. Refer to current PHA for identified hazards and controlling measures.
### Certifiable Elements and Hazards Log (CEHL)

#### Figure 7-1 Sample CEHL

<table>
<thead>
<tr>
<th>Certifiable Elements</th>
<th>Hazards</th>
<th>Mitigations</th>
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<td>System Elements</td>
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<td>R-O-W Generally</td>
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<td>1.1.1</td>
<td>R-O-W Generally Derailment</td>
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</table>

**Mitigations**

**Safety and Security Management Plan**

Sample representation only. Refer to current CEHL for identified hazards and required considerations. Figure 7-1 only depicts Preliminary Engineering and Final Design phases; additional considerations are added as the project matures.
CEHL MITIGATIONS IN V&V DATABASE (DOORS)

1.1.1.1 Track Failure
Cracked or broken track component (rail, ties, welds, fasteners, switch components, etc).

1.1.1.1.1 Mitigation #1
[1] O&M:
O&M program and remedial maintenance methodology that meet or exceed FRA Guidelines for Track Class to operate at 220

1.1.1.1.2 Mitigation #2
[2] INF:
Track component quality standards that meet or exceed AREMA requirements.

1.1.1.1.3 Mitigation #3
[3] RST:
Install on-board derailment containment devices.

1.1.1.1.4 Mitigation #4
[4] INF:
Install in-track derailment containment elements.

1.1.1.1.5 Mitigation #5
[5] SYS:
Require positive indication of broken rail through track circuit system.
VERIFICATION & VALIDATION
TRACKING SAFETY MITIGATIONS

1.2.1.9 Train falls from elevated structure.

1.2.1.9.1 Mitigations #1
[1] INF:
Include derailment containment wall in design of structure that keeps train on the bridge.

1.2.1.10 Person falls from elevated structure.

1.2.1.10.1 Mitigation #1
[1] INF:
Install fall prevention barriers (handrail or wall) where exposed edge allows potential fall of greater than 30°.

References to Technical Criteria

DCM [IFR] 6.4 Containment of HST Rolling Stock
DCM [STR] 12.5.2.13 Derailment Loads (DR)
DCM [STR] 12.5.2.13.2 Track Side Containment
DD-ST-001 TYPICAL CROSS SECTION, AERIAL STRUCTURE, TWO TRACK NON
DD-ST-002 TYPICAL CROSS SECTION, AERIAL STRUCTURE, ONE TRACK NON
DD-ST-003 TYPICAL CABLE TROUGH DETAILS, AERIAL STRUCTURE
DD-ST-004 TYPICAL CABLE TROUGH DETAIL, AERIAL STRUCTURE, AT OCS PC
DD-ST-017 TYPICAL CROSS SECTION, AERIAL STRUCTURE, FOUR TRACK NON

CEHL Mitigation

CEHL in DOORS
Derailment protection walls shall be provided on mainline aerial structures at locations 6 feet minimum to 7 feet maximum from TCL toward the outside edge of deck. The height of the wall shall be minimum 0.67 feet above the level of the adjacent track’s lower rail. A transverse horizontal concentrated load of 35 kips shall be applied at top of the wall at any point of contact. A load factor of 1.4 shall be applied to the 35-kip load.
VERIFICATION & VALIDATION
CERTIFICATION PACKAGE

CHSTP Verification, Validation and Self-Certification - Certifiable Elements and Hazards List (CEHL) - Certification Sheet

<table>
<thead>
<tr>
<th>CEHL#</th>
<th>Certifiable Element or Hazard Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0276</td>
<td>R-O-W Structures/Elevated Structures 1.2.1.10: Person falls from elevated structure – Mitigation 1: Install fall prevention barriers (handrailing or wall) where exposed edge allows potential fall of greater than 30&quot;. <strong>Height changed to 30&quot; per Cal/OSHA regulations 12/18/12.</strong></td>
</tr>
</tbody>
</table>

**CEHL Mitigation**

References to Technical Criteria (Objective Evidence)

**B. Track Side Containment**

- Derailment protection walls shall be provided on mainline aerial structures at locations 6 feet minimum to 7 feet maximum from TCL toward the outside edge of deck. The height of the wall shall be minimum 0.67 feet above the level of the adjacent track’s lower rail. A transverse horizontal concentrated load of 35 kips shall be applied at top of the wall at any point of contact. A load factor of 1.4 shall be applied to the 35-kip load.
R-O-W Structures/Elevated Structures 1.2.1.10: Person falls from elevated structure – Mitigation 1: Install fall prevention barriers (handrail or wall) where exposed edge allows potential fall of greater than 30". Height changed to 30" per Cal/OSHA regulations 12/18/12.

Phase: PE – Preliminary Engineering

To all signatories: Please review the included information and sign and date in the appropriate spaces. By signing this form, you are certifying that the critical item described has been coordinated between the Specifier and all Verifiers, and that the Certifiable Item has been verified for safety and security certification in conformance with the CHSTS safety-critical and security-critical requirements. Please do not amend any of the information in the form. If you have comments on the contents, please return the form unsigned.

To Specifier: After reviewing the contents, please sign the front page and initial the individual entries in the attached table. By signing this form, you hereby certify that:
1. the documentation referenced by you accurately specifies the requirements of the critical item, and
2. the documentation referenced by the Verifier fully satisfies the requirements of the critical item.

To Verifiers: After reviewing the contents, please sign the front page and initial the individual entries in the table. By signing this form, you hereby certify that:
1. you understand the documentation referenced by the Specifier,
2. the documentation referenced by you accurately and completely verifies that the requirements of the critical item have been addressed, and
3. entries marked “(Not applicable)” accurately reflect that the requirement for that discipline does not apply.
## Verification & Validation (V&V)

### Practical Value Using V&V

1. Central Repository
2. Side-by-Side Review
3. Increased Awareness of Dependencies
4. Impact Assessment

### CEHL in DOORS

### Central Repository

1. **1.2.1.9 Train falls from elevated structure.**
   - **[1] INF:** Include derailment containment wall in design of structure that keeps train on the bridge.

### Safety & Security Group

### Engineering Group

- **DCM [IFR]** 6.4 Containment of HST Rolling Stock
- **DCM [STR]** 12.5.2.13 Derailment Loads (DR)
- **DCM [STR]** 12.5.2.13.2 Track Side Containment
- **DD-ST-001** TYPICAL CROSS SECTION, AERIAL STRUCTURE, TWO TRACK NON-RAILROAD
- **DD-ST-002** TYPICAL CROSS SECTION, AERIAL STRUCTURE, ONE TRACK NON-RAILROAD
- **DD-ST-003** TYPICAL CABLE TROUGH DETAILS, AERIAL STRUCTURE
- **DD-ST-004** TYPICAL CABLE TROUGH DETAIL, AERIAL STRUCTURE, AT OCS PC
- **DD-ST-017** TYPICAL CROSS SECTION, AERIAL STRUCTURE, FOUR TRACK NON-RAILROAD

### Side-by-Side Review

1. **1.2.1.9.1 Mitigations #1**
   - **[1] INF:**

### Increased Awareness of Dependencies

1. **1.2.1.10 Person falls from elevated structure.**
   - **[1] INF:**

### Impact Assessment

1. **1.2.1.10.1 Mitigation #1**
   - **[1] INF:**

---

### Related Requirements

- **DCM [STR]** 12.7.1.6 Miscellaneous Loads
- **DCM [STR]** 12.8.6.15 Walkways, Parapets, and Sound Walls
- **DD-ST-001** TYPICAL CROSS SECTION, AERIAL STRUCTURE, TWO TRACK NON-RAILROAD
- **DD-ST-002** TYPICAL CROSS SECTION, AERIAL STRUCTURE, ONE TRACK NON-RAILROAD
- **DD-ST-003** TYPICAL CABLE TROUGH DETAILS, AERIAL STRUCTURE
- **DD-ST-017** TYPICAL CROSS SECTION, AERIAL STRUCTURE, FOUR TRACK NON-RAILROAD
VERIFICATION & VALIDATION (V&V)
PRACTICAL VALUE USING V&V (CONT’D)

<table>
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<th>Absolute</th>
<th>Hazards &amp; Mitigations</th>
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<tr>
<td>1</td>
<td>Infrastructure</td>
<td>1.1 R-O-W Generally</td>
</tr>
<tr>
<td>2</td>
<td>1.1 Close Proximity</td>
<td>1.1.4.13 Adjacent oil/gas well has surface-level blowout. Result is fire earth displacement and intrusion into the ROW by debris from the explosion.</td>
</tr>
<tr>
<td>418</td>
<td>1.1.4.13 Mitigation #2</td>
<td>Date Identified</td>
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<tr>
<td></td>
<td></td>
<td>1.1.4.13.2 Mitigation #2</td>
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</tbody>
</table>

| #406     | only exists in current | New Mitigation                   |
| #407     | only exists in current | Changed Mitigation               |

#406 only exists in current

#407 only exists in current

#412 only exists in current

#413 only exists in current

#414 only exists in current

#415 only exists in current

#416 only exists in current

#417 only exists in current

#418 only exists in current

#420 only exists in current

#241 has differing Object Text

[2] INF: Emergency access and egress at nominal 2.5 mile intervals with a maximum interval of 3.0 miles.

#247 has differing Object Text

[3] INF: Intrusion protection berms, walls, and other barriers to prevent the intrusion of persons, animals, rail or highway vehicles as identified through site-specific hazard analysis or threat/vulnerability assessment.
VERIFICATION & VALIDATION
DESIGN-BUILD STAGE

- Operational Requirements
- System Requirements
- High-Level Design
- Detailed Design
- Component Testing
- Construction
- Pre-Revenue Testing
- Start-Up Testing
- Integration Testing

Design / Build Contracts

Contract CP01
VERIFICATION & VALIDATION (V&V)
SAFETY CERTIFICATION USING V&V

Step 1
- Safety Requirements
  - RAM Requirements
  - Operational Requirements
  - Other System Requirements
- Interoperability Requirements
- System Decomposition
- Detailed Design
- Type Design Verification

Step 2
- Construction

Step 3
- Safety Case Certification
  - RAM Testing
  - Pre-Revenue Testing
  - Start-Up Testing
- Interoperability Testing
- Integration Testing
- Site Acceptance Testing
- Site Installation Testing
- Factory Acceptance Test.
- First Article Compliance Test.

Independent Checking Engineer

Procurement Documents
# VERIFICATION & VALIDATION (V&V)

**DEMONSTRATION OF COMPLIANCE**

## Technical Contract Requirements

## Design References

## Certification of Critical Items

## Contractor QA/QC

## Requirements Verification Traceability Matrix (RVTM)

### Audit & Due Diligence Check by Authority’s Representative

### Independent Checking Engineer

### Requirements

<table>
<thead>
<tr>
<th>ID #</th>
<th>Requirements Description</th>
<th>Requirements Reference</th>
<th>Design Reference</th>
<th>Verified By &amp; Date</th>
<th>Contractor QA/QC</th>
<th>Independent Check, Eng.</th>
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<tr>
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<td>Contract Req. #1</td>
<td>Spec # ... / Section ...</td>
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<td>Drawing # / ...</td>
<td>Plan / Spec xxx</td>
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<tr>
<td>...</td>
<td>...</td>
<td>Environmental Mitigations</td>
<td>EIR/S # ...</td>
<td>Plan / Spec xxx</td>
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<td>...</td>
<td>...</td>
<td>Hazard Mitigations</td>
<td>PHA # ...</td>
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<td>...</td>
<td>Threat Mitigations</td>
<td>TVA # ...</td>
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<td>...</td>
<td>Interoperability (Interface xxx)</td>
<td>CIL # ...</td>
<td>Plan / Spec xxx</td>
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<td>Initial</td>
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</table>

### Critical Items

- Environmental Mitigations
- Hazard Mitigations
- Threat Mitigations
- Interoperability (Interface xxx)
VERIFICATION & VALIDATION (V&V)
INDEPENDENT VERIFICATION & VALIDATION

➢ Independent entity, not associated/affiliated in any way with Contractor

➢ Performs *Independent Conformity Assessment* of Contractor Submittals against Contract

➢ *Full Check of every Technical Contract Submittal* prior to Submittal to Authority’s Representative:
  - Independent Checking Engineer (ICE, during Design)
  - Independent Site Engineer (ISE, during Construction)

➢ *Certify Compliance* with Contract and provide *Assessment Report*

➢ *Reports directly to Authority*

➢ Based on Proven and *Internationally Accepted Standards and Practices*:
  - European Norm applied by European Railroads (Notified Bodies)
  - Used by International Firms in Taiwan High Speed Rail
  - EN 50126 Specification & Demonstration of RAMS
  - INCOSE Systems Engineering Handbook
VERIFICATION & VALIDATION (V&V)
FINAL INTEGRATION, TESTING & CERTIFICATION

Operational Requirements

System Requirements

High-Level Design

Detailed Design

Component Testing

Construction

Pre-Revenue Testing

Start-Up Testing

Integration Testing

Final Integration, Testing & Certification
VERIFICATION & VALIDATION (V&V)  
CONTRACT INTEGRATION & STARTUP

- Civil  
- Trackwork  
- Systems  
- Rolling Stock  
- Other

Operations & Maintenance:
- Rules
- Procedures
- Competencies

Integrated HSR System
- Start-Up Testing
- Pre-Revenue Testing
- Safety Procedures

Operating Safety Case

Revenue Operation
**Verification and Validation**

- Fully Embedded in CHSTS Delivery Method
  - Design, Construction, Integration, Testing, Certification
- Used as a Formal Safety Certification Program
- Demonstrates Compliance with Requirements
- Provides Objective Evidence
- Improves Team Communication
- Fewer Claim Opportunities for Contractors
- Facilitates Impact Assessment
- Get it Right the First Time
Thank you for your attention

It's QUESTION TIME!!