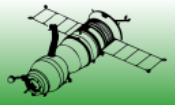
INCOSE International Symposium
Las Vegas, NV
June 30 - July 3, 2014

On Motivating People to Implement Systems Engineering

Getting from the Necessary to the Impossible

Oliver M. Hoehne, PMP
Senior Engineering Manager
Parsons Brinckerhoff, Transit & Rail Systems, Newark, NJ, USA

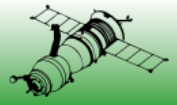





MANU KAI

Agenda

- **Why SE / Value of SE for Transportation & Infrastructure Projects**
- **SE Challenges in Transportation & Infrastructure Projects**
- **Recommendations to address the Challenges**
- **SE Opportunities**
- **California High-Speed Rail Project Overview**
- **Introducing & Applying SE:**
  - The Necessary – Tasks already required by Project
  - The Possible – Performing accepted tasks differently
  - The Impossible – Things that were never done before
- **Summary**


TRANSPORTATION & INFRASTRUCTURE

WHY SYSTEMS ENGINEERING

ISSUE: *Due to a disagreement over technical details, the approval process for the train ended up taking two years longer than planned. Siemens will now deliver 17 trains instead of the 16 originally ordered -- with one thrown in for free as an apology for the delay -- and will likely pay compensation on top of that. The company's transport division now has accrued liabilities of €360 million, largely because of the Velaro D.*

Source: http://www.spiegel.de/international/germany/velaro-d-new-generation-ice-high-speed-trains-approved-a-955754.html

TRANSPORTATION & INFRASTRUCTURE
WHY SYSTEMS ENGINEERING (CONT'D)

REASONS:

Unclear Operational Requirements: … *there were a number of disagreements over operational philosophy* …

Unclear Technical (System) Requirements: … *the disagreements were over other issues, like whether it was acceptable for there to be a 1.6-second delay between the moment the driver operates the brakes and when the brakes actually engage …*

LESSONS LEARNED:

Fixing problems later (e.g. production, testing) cost far more than fixing them earlier (e.g. during design): *… that sort of change in a train whose design is already complete is a protracted process. That half second cost the company years …*

Frontloaded (Systems) Engineering / Requirements Management: *… the developers want to work closely with the Federal Railway Authority's experts from day one, to avoid unpleasant surprises down the line (understand the requirements before offering a solution) …*

TRANSPORTATION & INFRASTRUCTURE

VALUE OF SYSTEMS ENGINEERING

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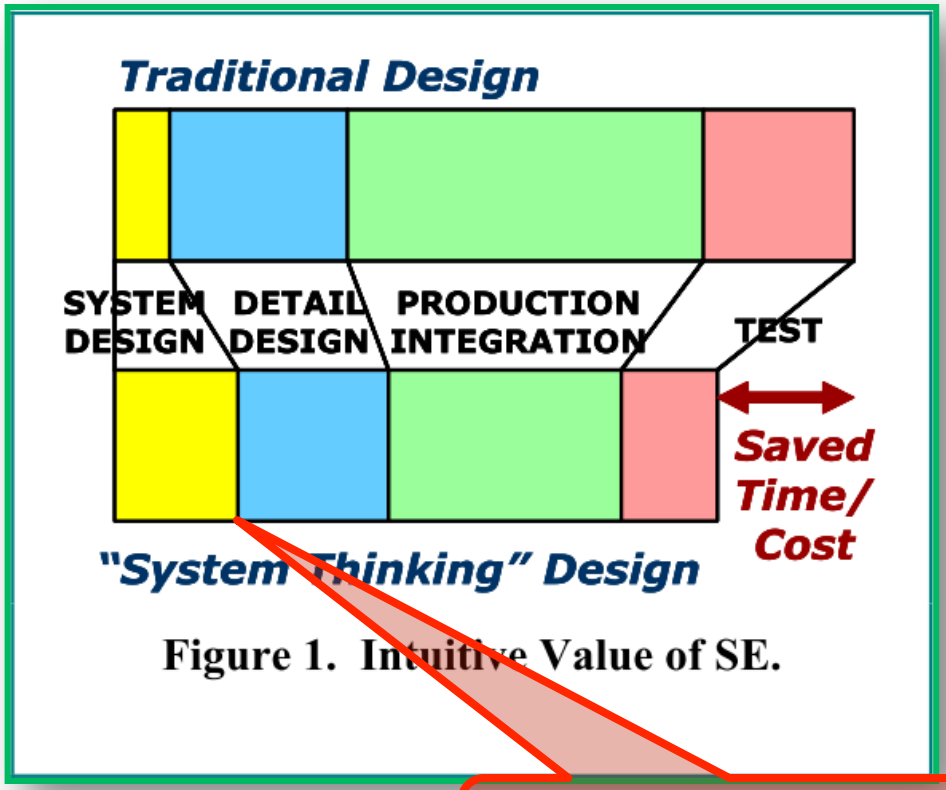


Figure 1. Intuitive Value of SE.

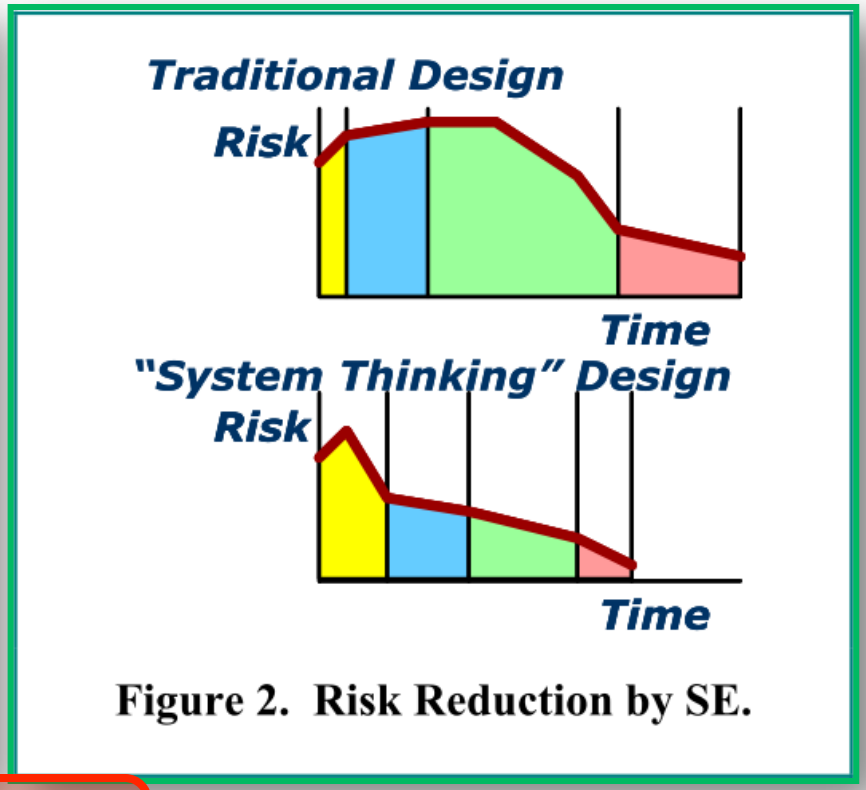


Figure 2. Risk Reduction by SE.

Benjamin Franklin — 'If you fail to plan, you are planning to fail!

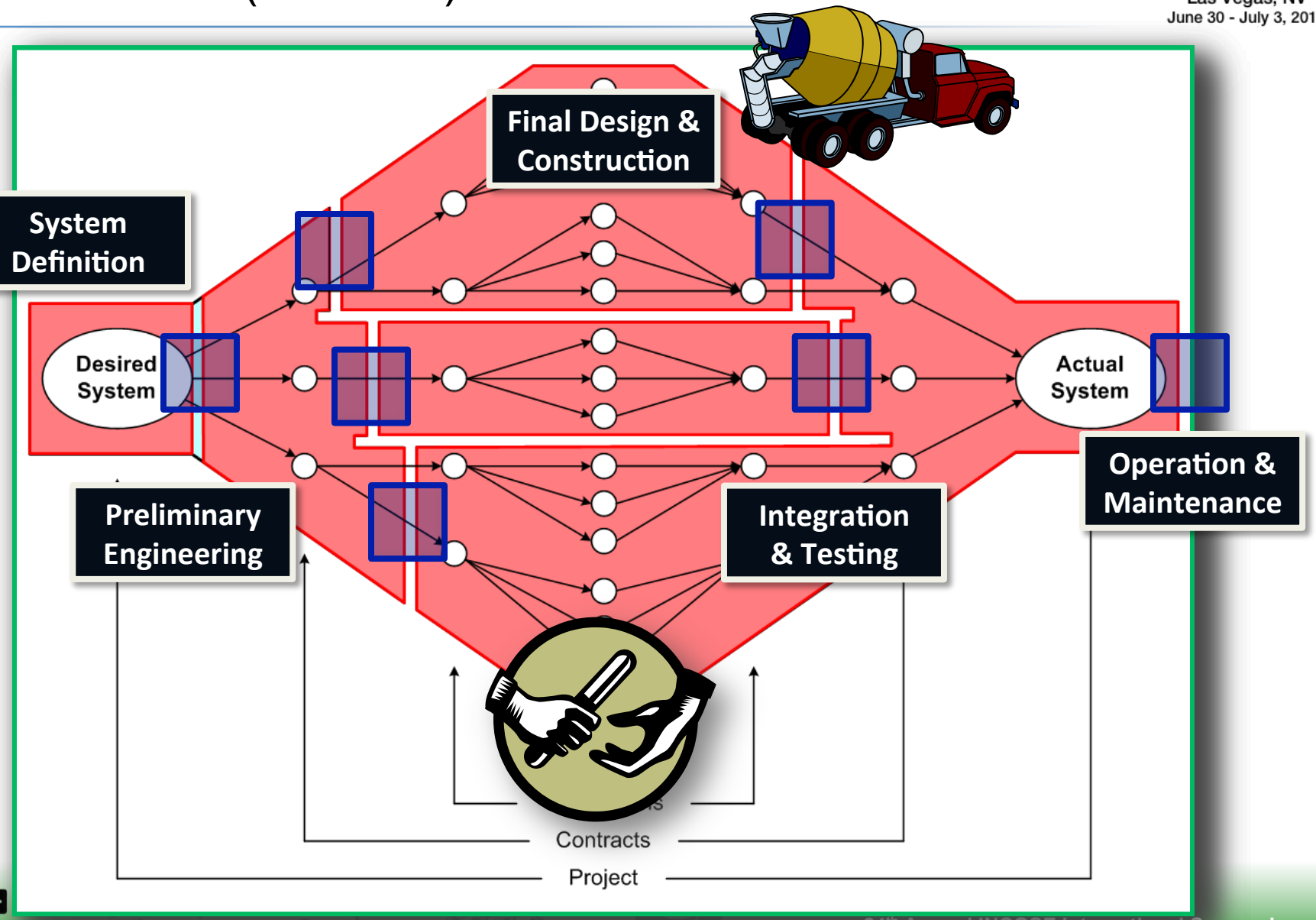
Systems Engineering reduces risk, rework, schedule delays and cost overruns.

Source: Eric Honour: Understanding the Value of Systems Engineering

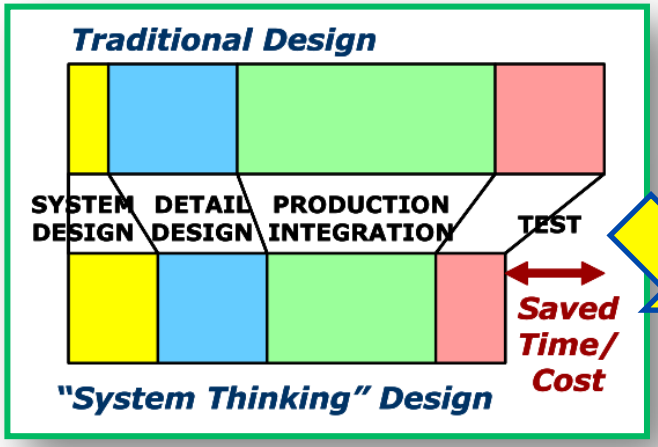
TRANSPORTATION & INFRASTRUCTURE
CHALLENGES

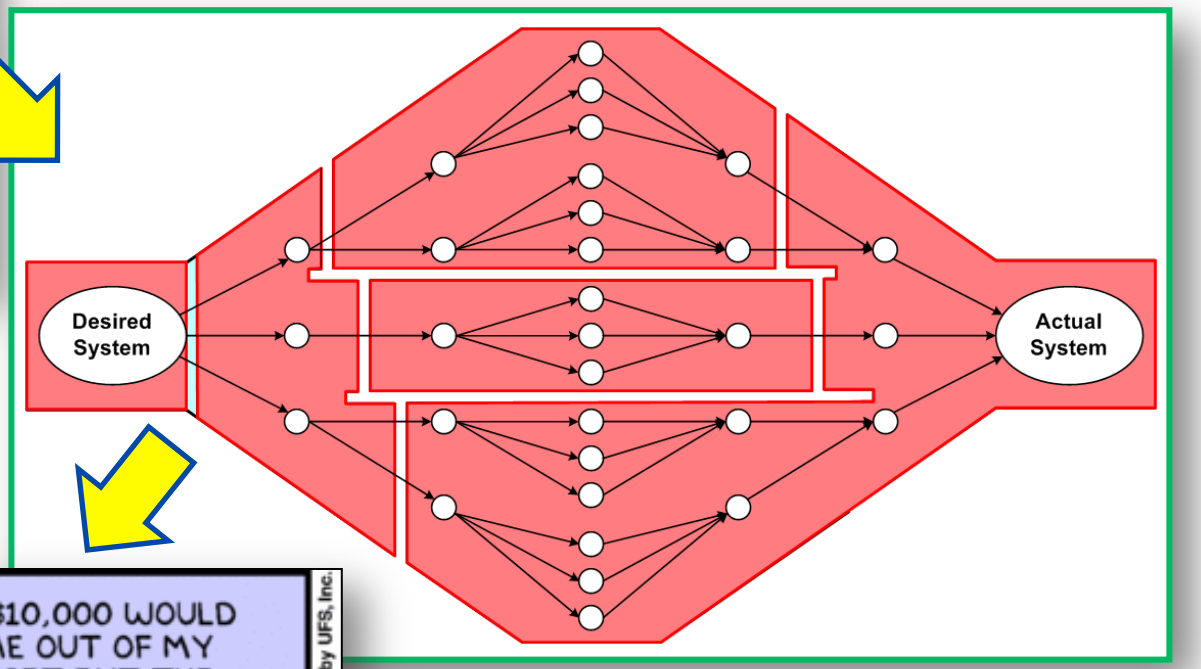
- **Funding of Highly Visible Projects**
  - Capital (Construction) vs. Operating Cost
- **Project Fragmentation / Accountability**
  - Owner, Environmental Review, Preliminary Engineering, Final Design, Construction, Construction Management, Integration, Testing & Certification, Program Oversight, etc.
- **Low-Tech Industry**
  - Infrastructure (Concrete, Steel, Earthwork, Utilities, etc.) with relatively small Systems Content (Electrification, Signals, Communications)
- **Expertise & Experience**
  - Civil / Structural Engineers lacking SE knowledge, Systems Engineers lacking infrastructure domain knowledge
- **Resistance to Change**
  - Safety conscious industry, failures are punished, successes hardly rewarded

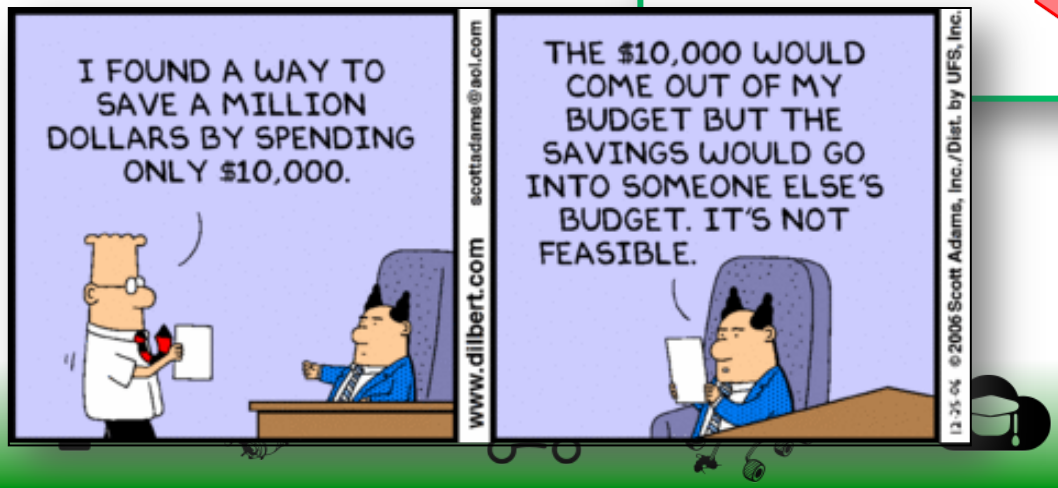
TRANSPORTATION & INFRASTRUCTURE
CHALLENGES (CONT'D)



TRANSPORTATION & INFRASTRUCTURE
CHALLENGES (CONT'D)

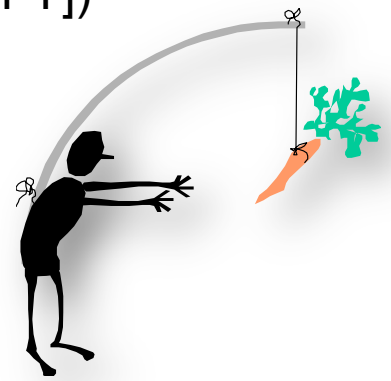






TRANSPORTATION & INFRASTRUCTURE
RECOMMENDATIONS TO ADDRESS CHALLENGES

- **Top-Down**
  - Obtain Client & Management **Buy-In**
  - Provide Credibility, Show **Applicability** to Your Industry
  - Demonstrate **Practical Value** for overall Program Approach
  - Achieve **Early Benefits** within Project / Phase
- **Bottom-Up**
  - Install Systems Engineering **Champion**
  - Identify and Work with **Early Adaptors**
  - **Communicate Clearly** (Why, What Is In It For You [WIIFY])
  - Help Others Achieving **Short-Term Results**
  - Do Not Add Just Another Process
  - Introduce **Accountability** (What, Who, When)
  - **Just do it**, Ask for Forgiveness Later
  - Be Persistent, **Don't Give Up**



TRANSPORTATION & INFRASTRUCTURE
SYSTEMS ENGINEERING **OPPORTUNITIES**

- **Federal, State and Local Regulations (Compliance)**
  - Code of Federal Regulations
  - California Proposition 1A
  - California Public Utilities Commission
- **Safety, Security & System Certification (Compliance)**
  - Preliminary Hazard Analysis Mitigations
  - Threat and Vulnerability Assessment Mitigations
  - Demonstration that System is Ready to Operate
- **Multi-Contract Environments (Complexity)**
  - Requirements Management
  - Interface and Integration Management
  - Inspection and Test Management
- **Operations and Maintenance (User Needs)**
  - Operating Plan, Concept of Operations, Operational Scenarios
  - Maintenance of Infrastructure, Rolling Stock, Storage & Maintenance Facilities

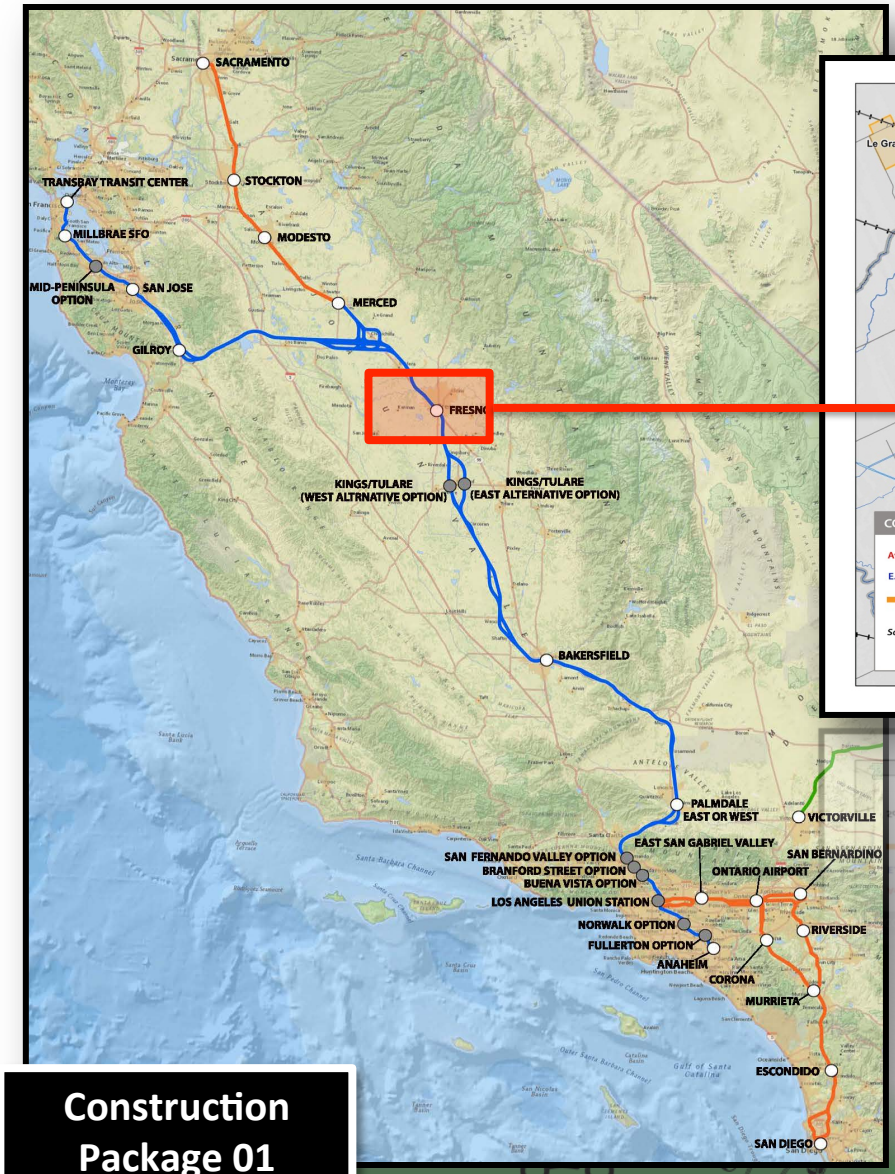
CALIFORNIA HIGH-SPEED RAIL

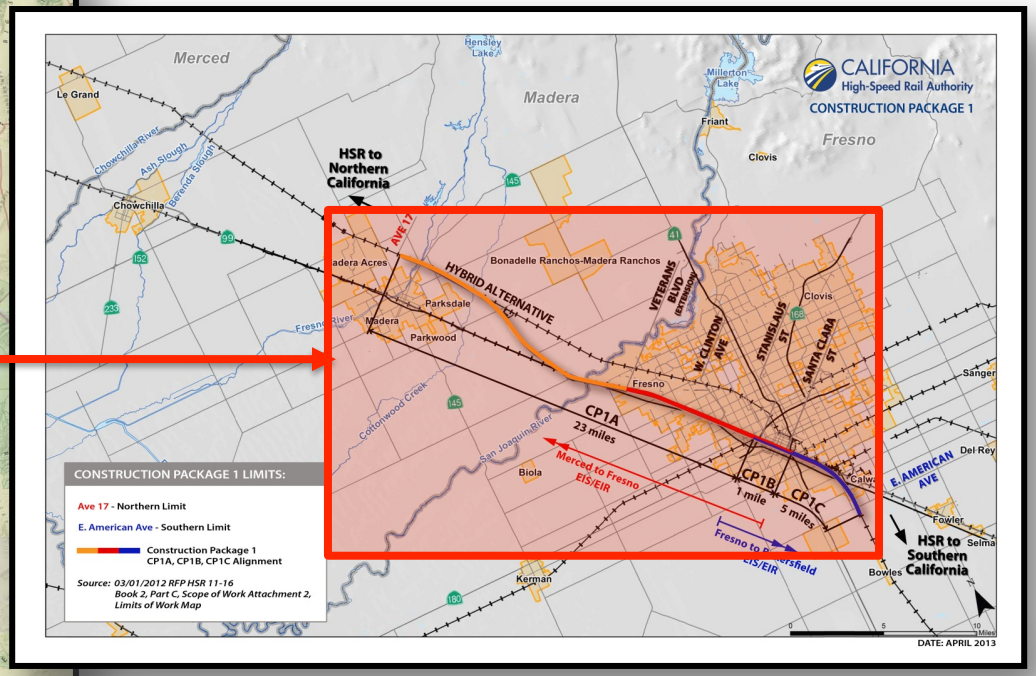
PROJECT BACKGROUND

- 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

CALIFORNIA HIGH-SPEED RAIL

PROJECT BACKGROUND (CONT'D)





- 29 Miles
- ~ 1 Billion Dollar
- Civil / Structural Work
- Started

Construction Package 01

CALIFORNIA HIGH-SPEED RAIL
PROJECT BACKGROUND (CONT'D)

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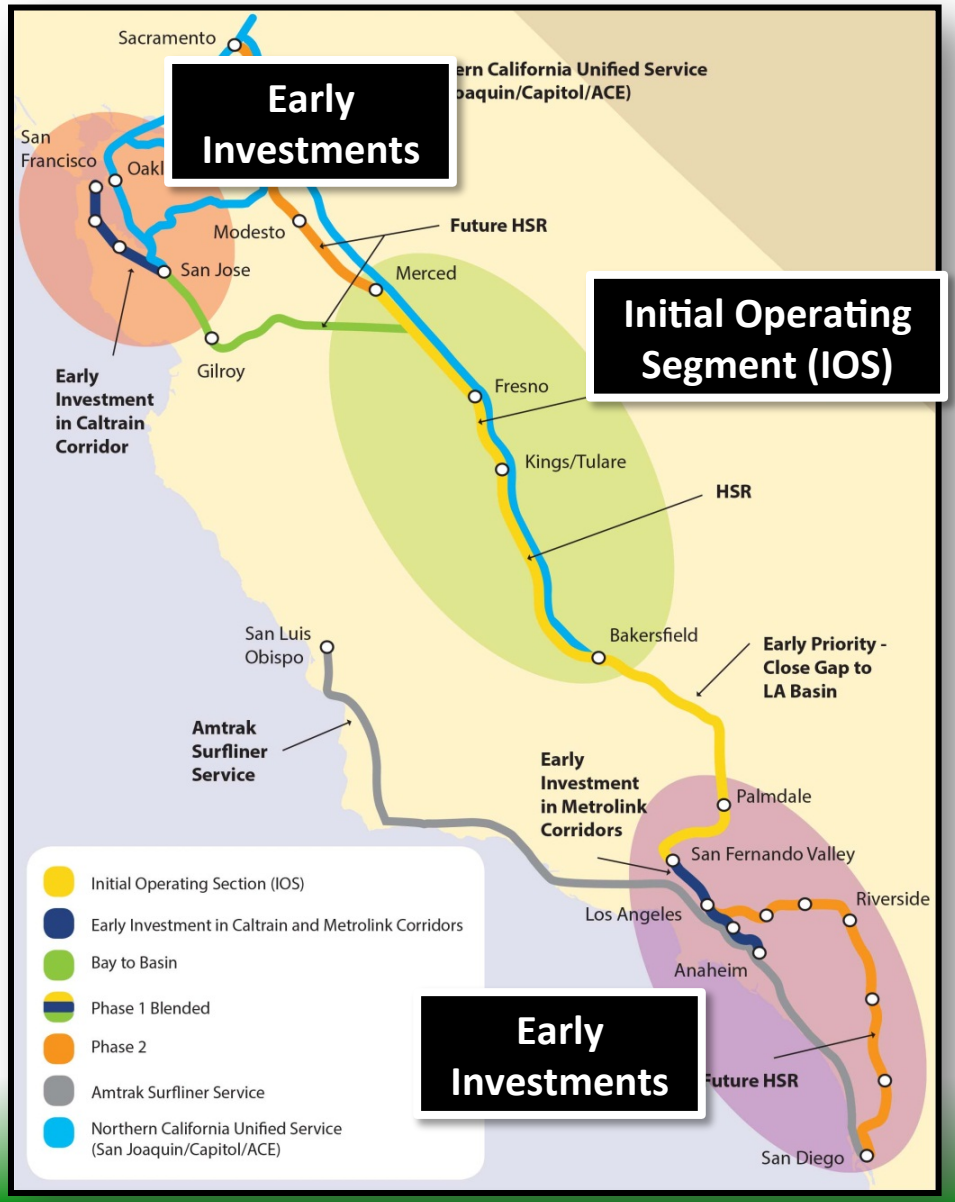
Initial Operating Segment (IOS)

- Central Valley to San Fernando Valley
- "Backbone" of High-Speed Rail
- 300 Miles
- First Step Towards a Statewide High-Speed Rail System by 2022

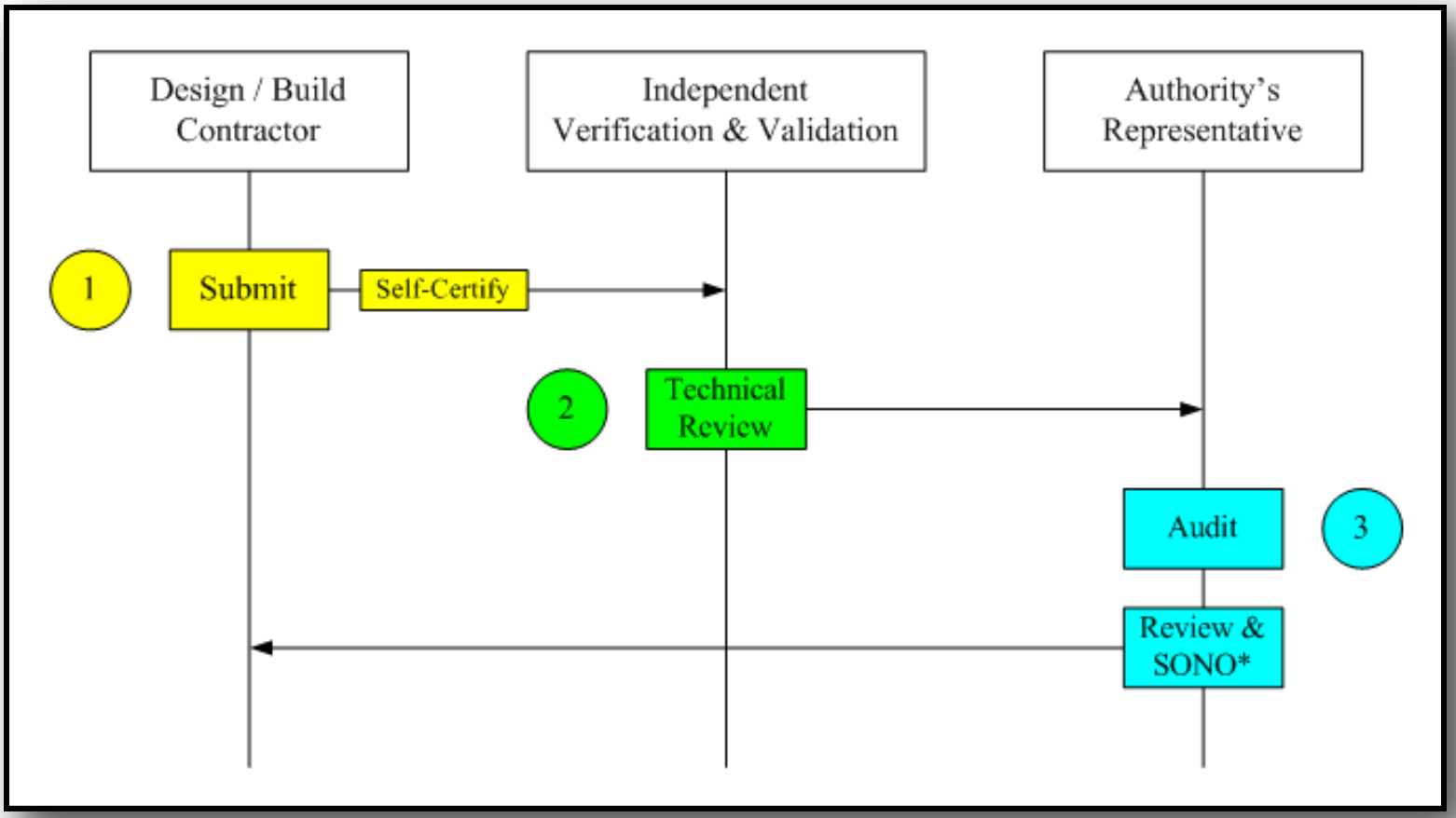
Early Investments Underway

- Caltrain Electrification & Early Investments in the Corridor
- Regional Enhancements in Southern California
- Statewide Connectivity Projects & Investments



THE NECESSARY

CONTRACTOR SELF-CERTIFICATION WITH INDEPENDANT CONFORMITY ASSESSMENT



SONO: Statement of No Objection

Contractor Self-Certification Process

THE NECESSARY

CONTRACTOR SELF-CERTIFICATION (CONT'D)

California High-Sp

Request fo
for Design-Bu

RFP No.: H
Verification, Validation

Revision No.	Date	Descriptio
0	01 Mar 12	Initial Relea
1	04 Jun 12	Interoperab
2	23 Aug 12	Third Partie
3	13 Dec 12	Minor Clarif

Table of C

3 Execution

3.1 Self-certification Process Overview

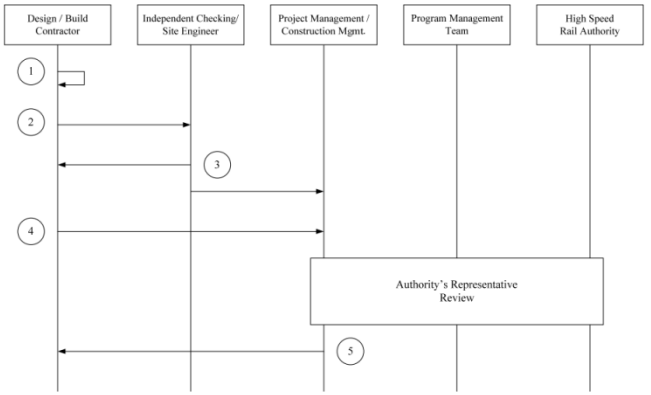


Figure 2: Self-Certification Process

Follow the self-certification process as presented in Figure 2.

1. Contractor shall prepare Technical Contract Submittal (including final design, construction, inspection and test submittals) as specified in the Contract and shall perform quality procedures as stipulated by the Contract. Contractor shall self-certify compliance with Contract Requirements and fitness for purpose.

12/17/2012 ADDENDUM 7 - RFP HSR 11-16

- Support from Senior Management
- Credibility due to proven Asian & European HSR Application
- Benefits due to early Verification results (i.e. Design)
- Major component of Risk and Quality Management

RFP Book 3
Part B: V&V

THE POSSIBLE
COMPLIANCE WITH REGULATORY REQUIREMENTS

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CALIFORNIA HIGH-SPEED TRAIN PROJECT

GUIDANCE DOCUMENT OF RE
SAFETY ELEMENTS NECESSA
FRA REGULATORY APPRO

DRAFT FOR REVIEW

Parsons Brinckerhoff
4/6/2012

This document formulates minimum safety requirements for design, construction and oper
California High-Speed Rail system.

1.3.4 Infrastructure and Track

1.3.4.1 Material and Operational Design Criteria

The Railroad will construct its track and infrastructure to meet all material and operational design criteria, within normal acceptable construction tolerances, and to meet the requirements proposed in this Guidance Document.

1.3.4.2 Nominal Track Gauge

The Railroad will operate on 56.5 inches wide nominal standard gage track.

1.3.4.3 Structure Gauge

The infrastructure will allow safe clearance for the passage of trains complying with the High-Speed Rolling Stock requirements and the overhead catenary system.

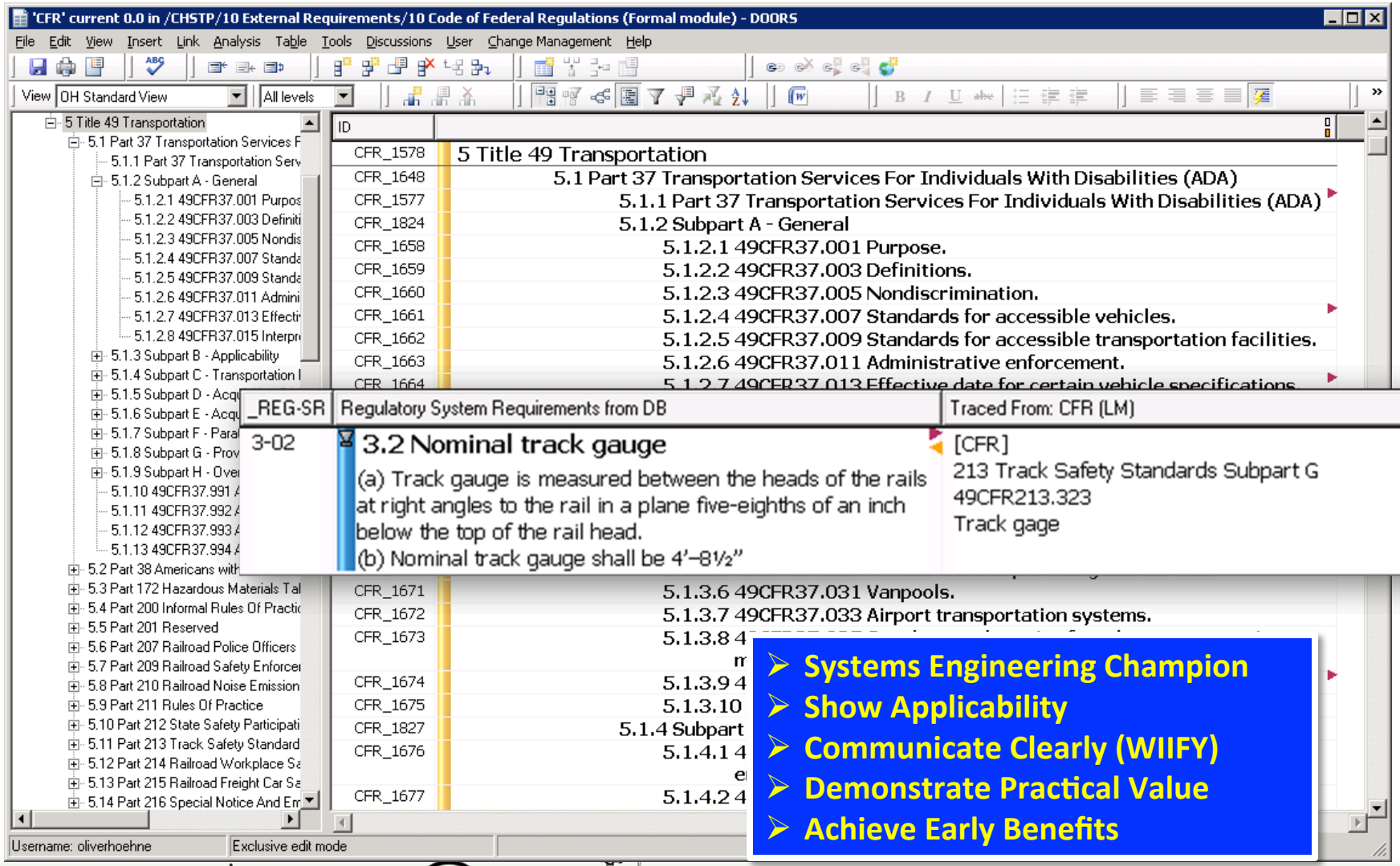
1.3.4.4 Track Centers

The Railroad will install and operate on double track throughout its entire length. The distance between track centers will be based on that required for aerodynamic considerations, design speed, and ease of maintenance. The minimum nominal distance between track centerlines will be 16.5 feet at operating speeds up to 220 mph. In Shared Track conditions where maximum

49 CFR Part No.	49 CFR Part Title	Guidance Document Section No.	Guidance Document Section
49CFR Part 214.301	Railroad Workplace Safety	4.1.2	Track Personnel
49CFR Part 217	Railroad Operating Rules	2.14	Rules Compliance Procedures R Program
49CFR Part 217.7	Railroad Operating Rules	5.1.1.1	Filing and Recordkeeping
49CFR Part 217.9	Railroad Operating Rules	1.3.5.2	Overall Functionality
49CFR Part 217.9	Railroad Operating Rules	2.14	Rules Compliance Procedures R Program
49CFR Part 217.9	Railroad Operating Rules	5.1.1.2	Operational Tests and Inspectio
49CFR Part 217.11	Railroad Operating Rules	5.1.1.3	Operating Rules Instructional Pr
49CFR Part 218	Railroad Operating Practices	2.14	Rules Compliance Procedures R Program
49CFR Part 218	Railroad Operating Practices	2.17	Rail Corridor Safety Program

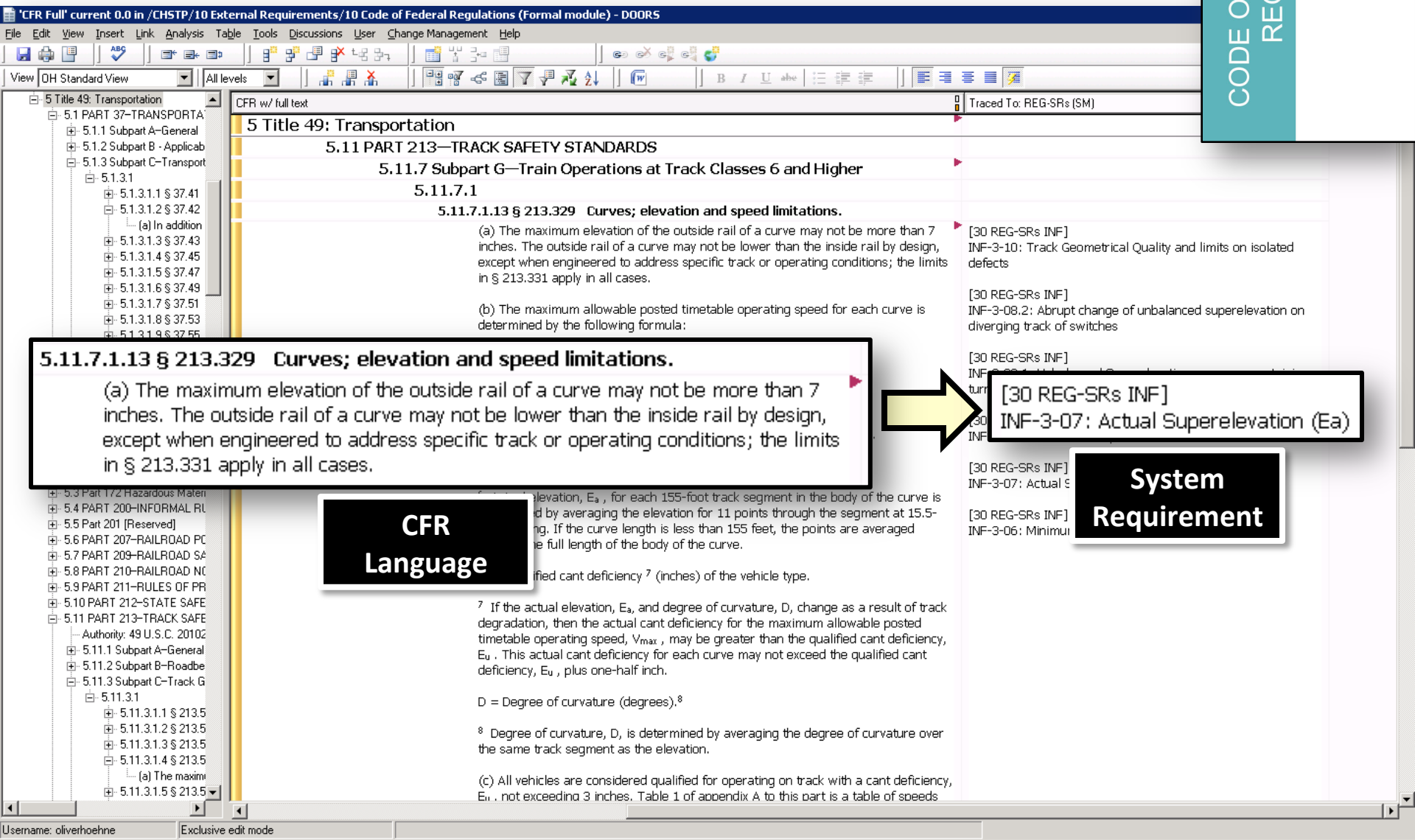
THE POSSIBLE

COMPLIANCE WITH REGULATORY REQ. (CONT'D)



- Systems Engineering Champion
- Show Applicability
- Communicate Clearly (WIIFY)
- Demonstrate Practical Value
- Achieve Early Benefits

THE POSSIBLE
REQUIREMENTS MANAGEMENT (TOOL)



CODE OF FEDERAL REGULATIONS

49
Parts 200 to 299
Revised as of October 1, 2010
Transportation

THE POSSIBLE
REQUIREMENTS MANAGEMENT TOOL (CONT'D)

'10 TSI-INF_A' current 1.0 in /CHSTP/10 External Requirements/20 Technical Specifications for Interoperability (Formal module) - DOORS

File Edit View Insert Link Analysis Table Tools Discussions User Change Management Help

Minimize

View: OH Standard View | All levels

ID	Infrastructure_A Rev. 03/19/2008	Traced To: REG-SRs (LM)	Traced To: TSI IF-REG (LM)
33	**4.2.5 Maximum rising and falling gradients**		
34	*Lines of category I* Gradients as steep as 35 mm/m are permitted for main tracks at the design phase provided the following 'envelope' requirements are observed: — the slope of the moving average profile over 10 km is less than or equal to 25 mm/m — the maximum length of continuous 35 mm/m gradient does not exceed 6 000 m. senger platforms shall not be more than 2,5 mm/m. ly less than the values allowed on high-speed lines yet the operation of trains complying with the High-Speed	[30 REG-SRs INF] INF-3-05: Maximum Grade	[80 TSI IF-REG] Interface between INF Maximum Rising and Falling Gradients and RST Maximum Gradients [80 TSI IF-REG] Interface between INF Maximum Rising and Falling Gradients and RST Brake Performance on Steep Gradients
37	**4.2.7 Track cant**		
38	The track cant is the maximum difference in height between outer and inner rails, measured at the centre of the rail head surface (in mm). Value depends upon gauge if measured in mm; value is not dependent on gauge if measured in degrees. *Lines of category I, II and III* The design cant shall be limited to 180 mm. On tracks in operation, a maintenance tolerance of ± 20 mm is allowed, subject to a maximum cant of 190 mm; this design value may be raised to 200 mm maximum on tracks reserved for passenger traffic alone.	[30 REG-SRs INF] INF-3-07: Actual Superelevation (Ea)	

TSI Language

4.2.7 Track cant

The track cant is the maximum difference in height between outer and inner rails, measured at the centre of the rail head surface (in mm). Value depends upon gauge if measured in mm; value is not dependent on gauge if measured in degrees.

Lines of category I, II and III

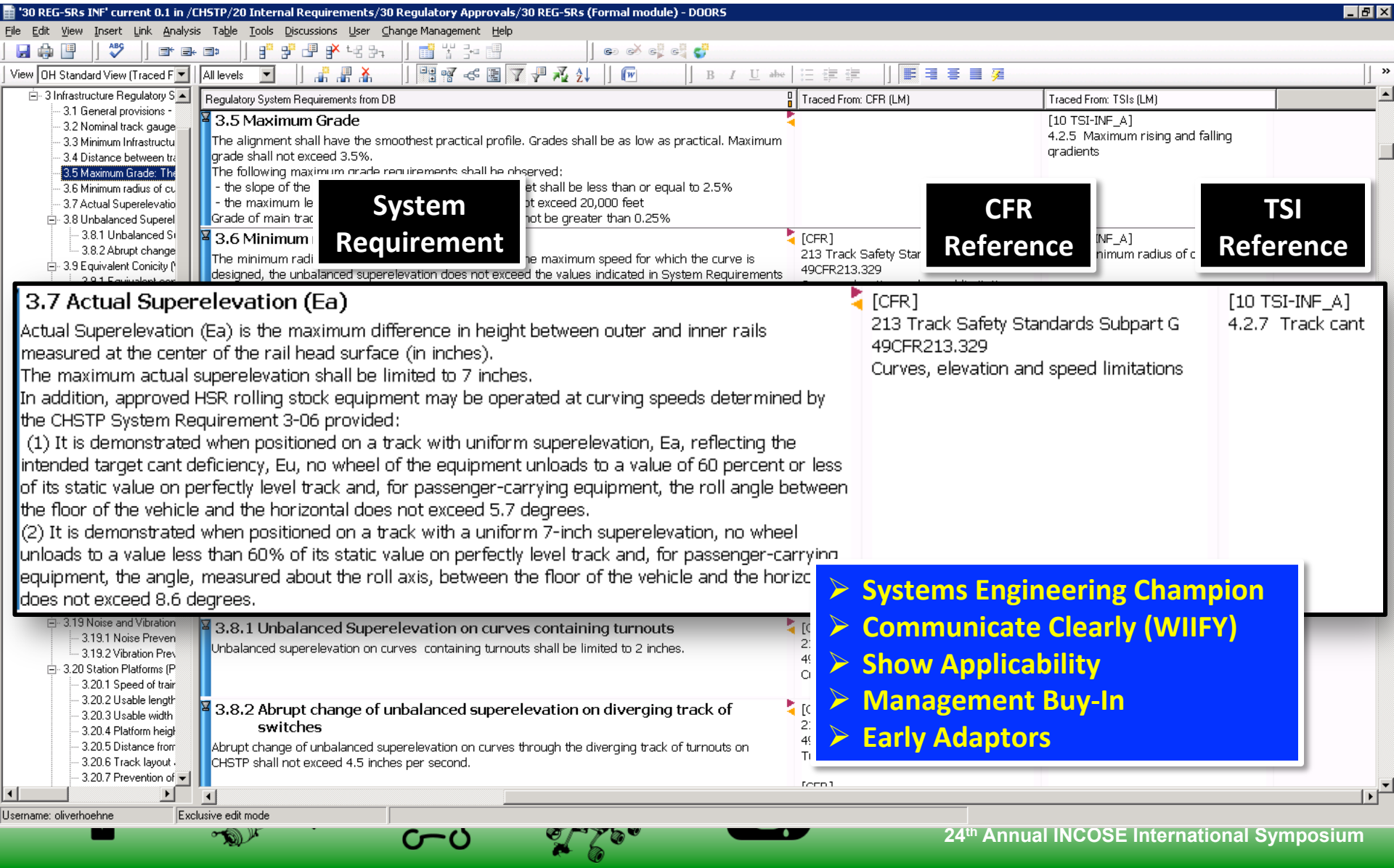
The design cant shall be limited to 180 mm.

System Requirement

[30 REG-SRs INF]
INF-3-07: Actual Superelevation (Ea)

Username: oliverhoehne | Exclusive edit mode

THE POSSIBLE
REQUIREMENTS MANAGEMENT TOOL (CONT'D)



- Systems Engineering Champion
- Communicate Clearly (WIIFY)
- Show Applicability
- Management Buy-In
- Early Adaptors

THE POSSIBLE

COMPLIANCE WITH PROGRAM PERFORMANCE REQUIREMENTS

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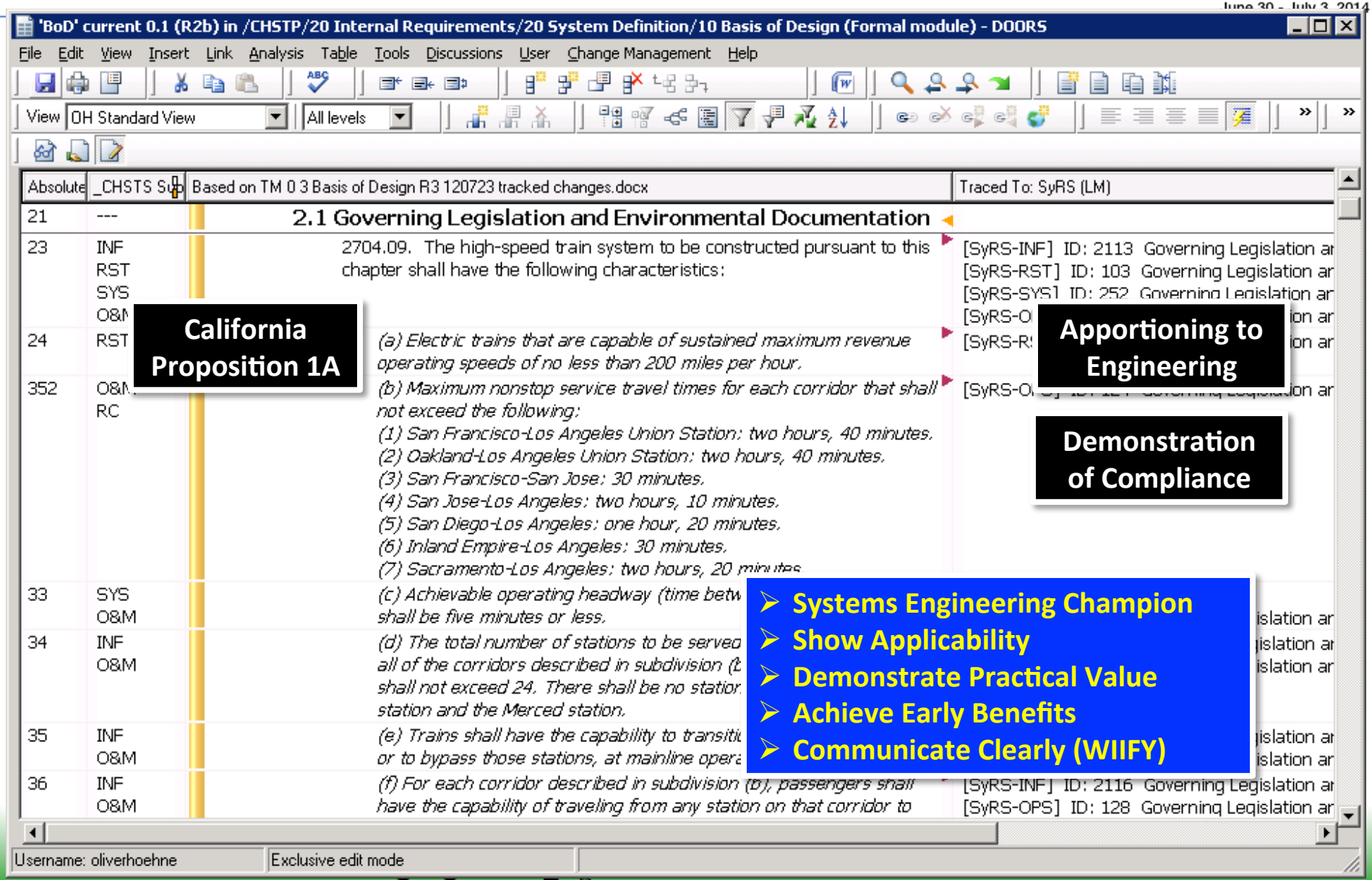


California Proposition 1A

Apportioning to Engineering

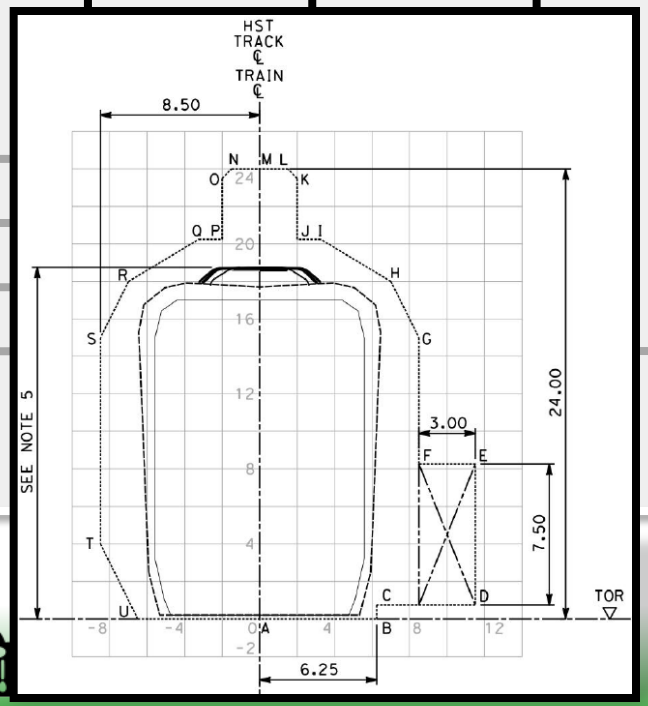
Demonstration of Compliance

- Systems Engineering Champion
- Show Applicability
- Demonstrate Practical Value
- Achieve Early Benefits
- Communicate Clearly (WIIFY)

THE POSSIBLE
INTERFACE VERIFICATION

CHSTS Program

- Operation & Maintenance
- Systems Contracts
- Rolling Stock Contracts
- Guideway (excl. Track)
- Trackwork Contracts
- Station Contracts
- Yard Contracts
- 3rd Party



RST Dimensions

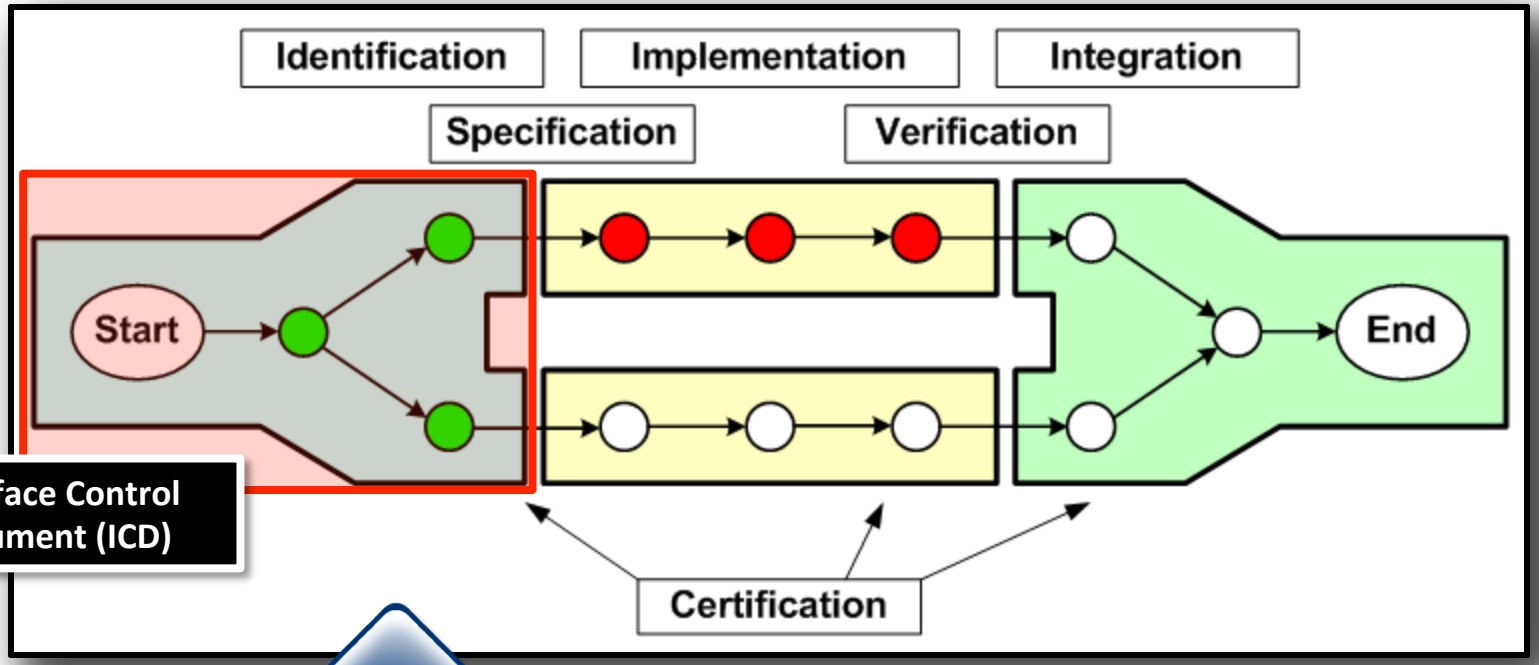
INF Clearances

THE POSSIBLE
INTERFACE VERIFICATION (CONT'D)

Environmental Review Preliminary Engineering

Design / Build Contracts

Final Integration, Testing & Certification



Interface Control Document (ICD)

Contractor

THE POSSIBLE

INTERFACE VERIFICATION (CONT'D)

RFP Book 3
Part B: V&V

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THE POSSIBLE
INTERFACE VERIFICATION (CONT'D)

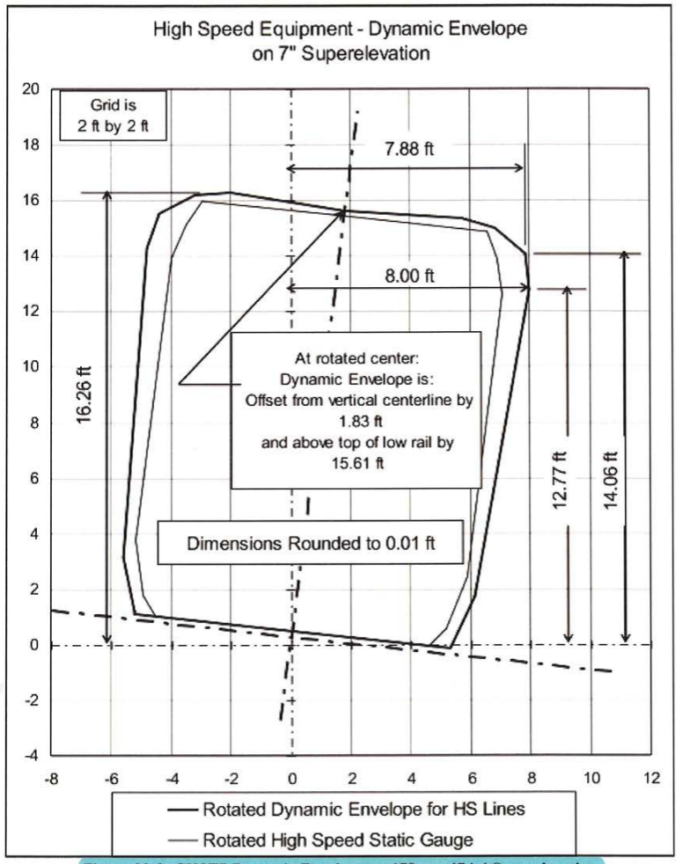
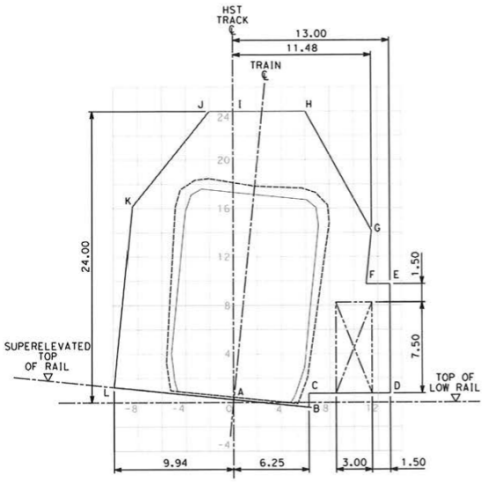


Figure 22-3: CHSTP Dynamic Envelope on 178 mm [7 in] Superelevation

Rolling Stock
Interface Requirements

Appendix 3.B Structure Gauge, Superelevated Track



SUPERELEVATED STRUCTURE GAUGE		
POINT ID	HORIZONTAL DISTANCE FROM TCL (FEET)	VERTICAL DISTANCE FROM TOR (FEET)
A	0.00	-2.44
B	6.25	-3.07
C	6.25	0.75
D	13.00	0.75
E	13.00	9.75
F	11.03	9.75
G	11.48	14.15
H	6.00	24.00
I	0.00	24.00
J	-2.00	24.00
K	-8.42	16.17
L	-9.94	1.25

Notes:
See Appendix 3.A for structure gauge notes.

Infrastructure
Interface Provisions

THE POSSIBLE
INTERFACE VERIFICATION (CONT'D)

References to Interface Requirements and Design

Interface Sign-Off by Involved Parties

CHSTP V[illegible]cation, Validation and Self-Certification - Certifiable Items List (C[illegible] - Certification Sheet CIL Item No. IF0489 - Certification Sheet Page 2 of 2

IF#	Interface Description	Trac[illegible]o	In[illegible] & Date
IF0489	Interface between RST HST Trainset Actual Superelevation Requirements (incl. Tilting) and GWY Infrastructure	External Links: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF7/Engineering/0_cc285%200489%20-%20Interface%20between%20RST%20HST%20Trainset%20Actual%20Superelevation%20Requirements%20incl.%20Tilting%20and%20GWY%20Infrastructure.Rdf	
	Purpose/Scope: Ensures that the RST HST trainset actual superelevation requirements have been addressed by the INF team		
	Specification: Defines the RST HST trainset actual sup[illegible] specified by the RST team.	RST Specs, 2.3, Design of Trains (5-01.2)	
	Verification #1 (Design Criteria): Verifies that the INF team has addressed th[illegible] alignment design criteria.		
	Verification #2 (Spatial Integration/Coordina[illegible] Verifies that the INF team has addressed th[illegible] clearance design criteria, including but not l[illegible] • Dynamic equipment envelope • Fixed equipment envelope • Structure gauge • Horizontal clearances • Vertical clearances • Catenary clearances • Track clearances • Walkway clearances • Utility clearances • Underground clearances • Other clearances (e.g. electrical clearance		

CHSTP Verification, Validation and Self-Certification
Certifiable Items List (CIL) - Certification Sheet

CIL Item No. IF0489
Certification Signoff Sheet Page 1 of 2

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 documentation referenced accurately and completely describes the specification and verification of the critical item to your satisfaction.

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.

Specifier Signature

Systems: [illegible]

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:

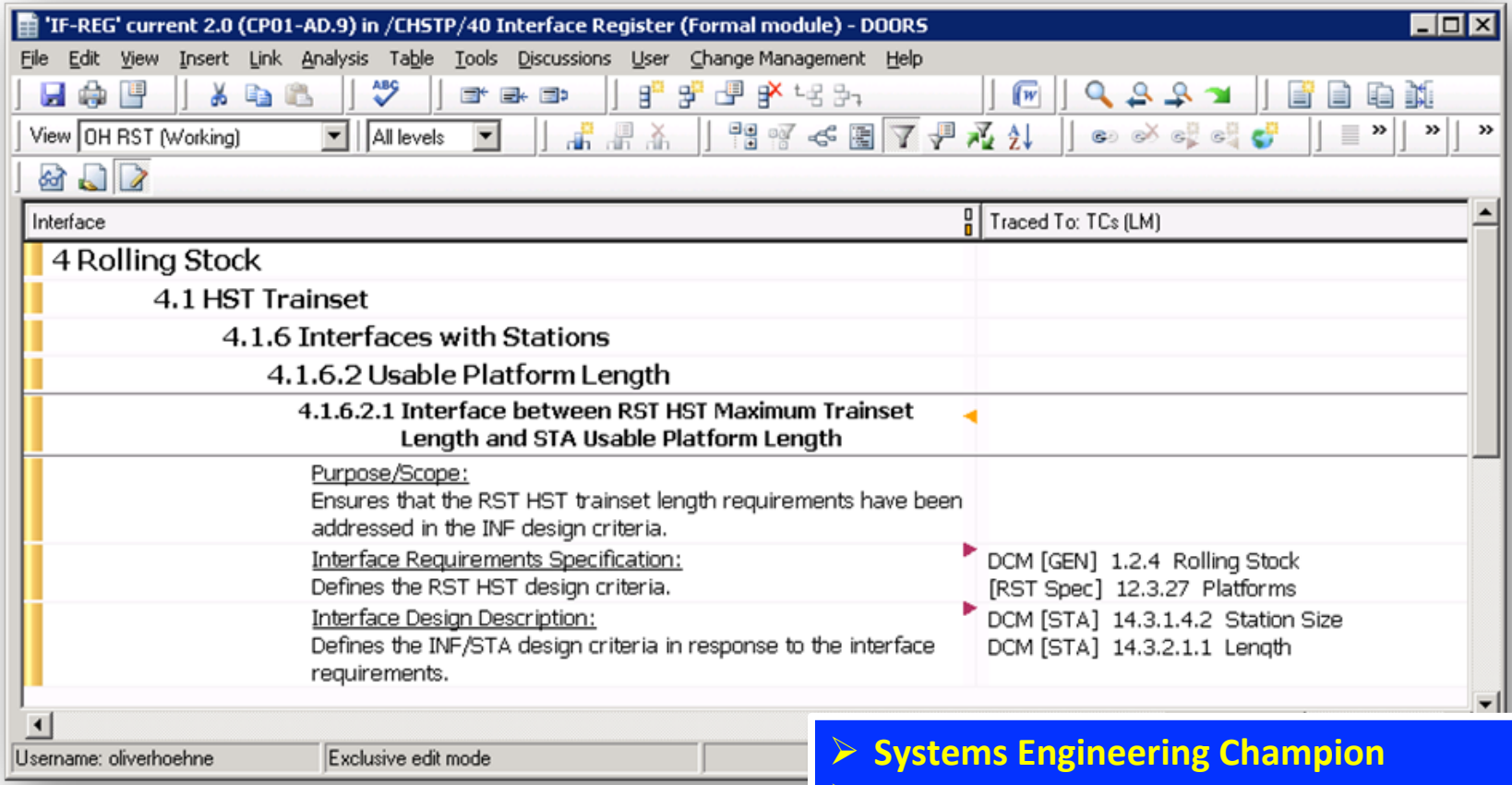
1. you understand the documentation referenced by the **Specifier**,
2. the documentation referenced by you accurately and completely verifies that the requirements of the critical item have been addressed, and
3. entries marked "(Not applicable)" accurately reflect that the requirement for that discipline does not apply.

Verifier Signatures

Track: [illegible]

Track: [illegible]

THE POSSIBLE
INTERFACE VERIFICATION (CONT'D)



- Systems Engineering Champion
- Just do it, Ask Forgiveness Later
- Help Others Achieving Short-Term Results
- Introduce Accountability (What, Who, When)

THE POSSIBLE
SAFETY & SECURITY CERTIFICATION

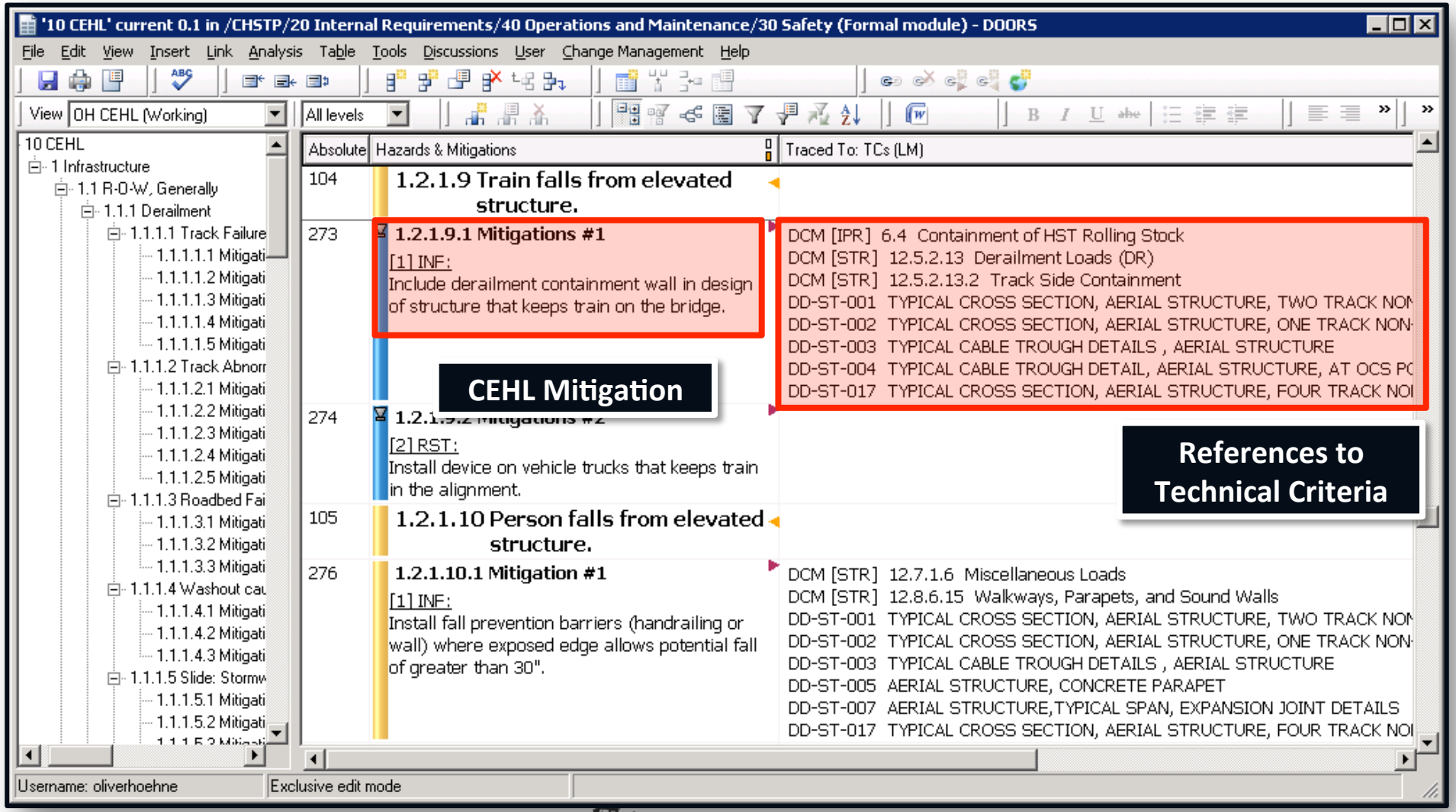
CERTIFIABLE ELEMENT:
SUB-ELEMENT:
REVISION:
CHECKLIST TYPE: MASTER: ___ SUB: __

TRANS HUDSON EXPRESS TUNNEL PROJECT
SAFETY AND SECURITY CERTIFICATION PROGRAM
SPECIFICATION CONFORMANCE & OPERATIONAL READINESS CHECKLIST
SAFETY: ___ SECURITY: ___

DATE: PAGE OF
PREPARED BY:
APPROVED BY: Date
VERIFICATION APPROVAL : Date

ITEM NO.	DESCRIPTION – DCM REFERENCE	DESIGN PHASE*		CONSTRUCTION/INSTALLATION/ TEST PHASE*		FINAL VERIFICATION*		
		NJT/PA DCM/SPEC OR DWG REF	CONTRACT PKG. SPEC, OR D...	DATE INSTALLED/ TESTED	FIELD VERIFIED BY	STATUS	VERIFIED BY	DATE VERIFIED
008	All new water mains and relocations and rearrangements or extensions of existing water mains 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).*	DCM Ch. 7, Sec. 7.2.7						
009	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).	DC... Sec...	UP-51209 UP-51210 UP-51102					
010	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.	DCI... Sec...	Exemption...					
011	The geotechnical design shall be in accordance with the current editions of codes, manuals or specifications, listed in the DCM Section 8.1.1	DCM Ch. 8, Sec. 8.1.1						
012	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*	DCM Ch. 8, Sec. 8.2	Design per Geotechnical design memoranda or Geotechnical	JFP 27MAR09 CCJ 3-26-09				

THE POSSIBLE
SAFETY & SECURITY CERTIFICATION (CONT'D)



CEHL in DOORS

THE POSSIBLE

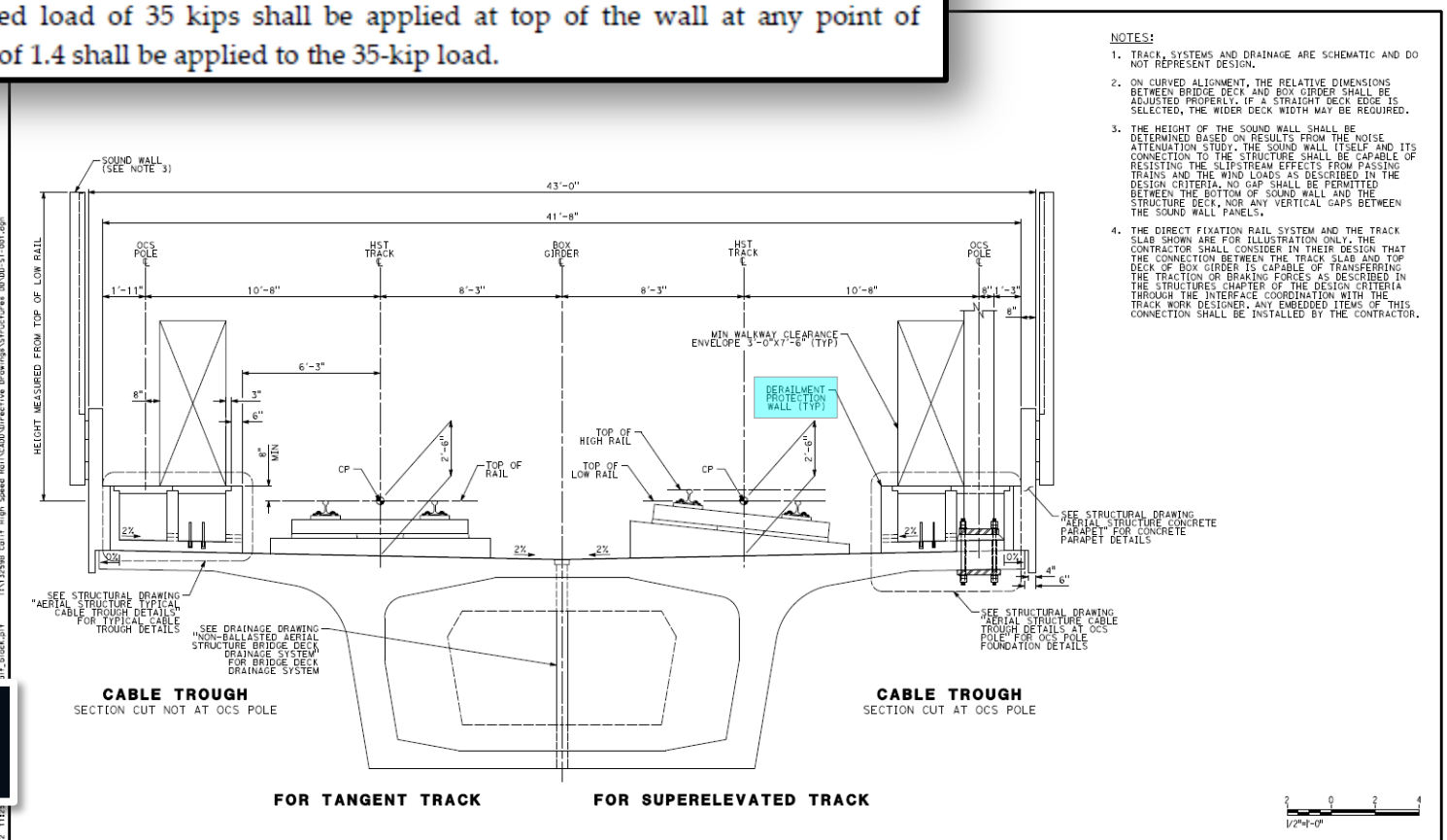
SAFETY & SECURITY CERTIFICATION (CONT'D)

Design Criteria Manual (DCM)

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.

Directive Drawings



THE POSSIBLE

SAFETY & SECURITY CERTIFICATION (CONT'D)

CHSTP Verification, Validation and Self-Certification - Certifiable Elements and Hazards List (CEHL) - Certification Sheet **Item CEHL 0276-** Certification Sheet

CEHL#	Certifiable Element or Hazard Description	Traced To	Initial & Date
0276	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". *Height changed to 30" per Cal/OSHA regulations 12/18/12.*	*DCM [STR] 12.2 Regulations, Codes, Standards, and Guidelines* *DCM [STR] 12.7.1.6 Miscellaneous Loads* *DCM [STR] 12.8.6.17 Walkways, Parapets, and Sound Wa* *[2013 0531]* *DCM [SSS] 32.18.6.1 Walkways Rev.1 DRAFT [2013 0531]* *DD-ST-001 TYPICAL CROSS SECTION, AERIAL STRUCTURE, TWO TRACK NON-BALLASTED, TYPICAL CONFIGURATION ON TOP OF DECK* *DD-ST-002 TYPICAL CROSS SECTION, AERIAL STRUCTURE, ONE TRACK NON-BALLASTED, TYPICAL CONFIGURATION ON TOP OF DECK* *DD-ST-003 TYPICAL CABLE TROUGH DETAILS , AERIAL STRUCTURE* *UCTURE, CONCRETE PARAPET* *UCTURE,TYPICAL SPAN, EXPANSION JOINT DETAILS* *OSS SECTION, AERIAL STRUCTURE, FOUR TRACK* *SS SECTIONS FOR BOX GIRDER*	

End of Certification Sheet for CEHL Item 0276

References to Design Criteria

CEHL Mitigation

CHSTS Verification, Validation and Safety/Security Certification
Certifiable Elements and Hazards Log (CEHL) - Certification Sheet

CEHL Item 0276
Certification Signoff Sheet Page 1 of 2

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". *Height changed to 30" per Cal/OSHA regulations 12/18/12.*

Phase: PE – Preliminary Engineering

ical item described has
ce with the CHSTS
eturn the form

y certify that:

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.

Verifier Signatures | **Verifier Company**

Independent 3rd Party Auditor Signatures (if applicable) | **Independent 3rd Party Auditor Company**

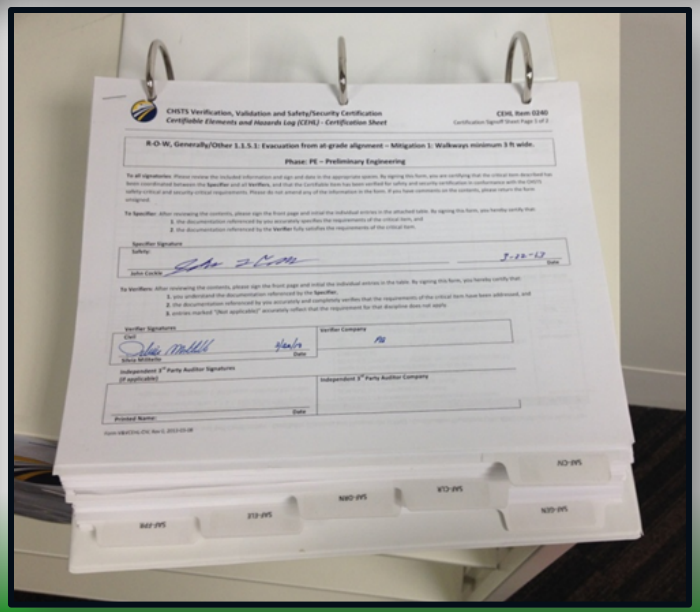
Printed Name: **Date**

Form V&VCEHL-CIV, Rev 0, 2013-03-08

1 of 14

Certification Sign-Off

- **Systems Engineering Champion**
- **Communicate Clearly (WIIFY)**
- **Show Applicability**
- **Help Others Achieving Short-Term Results**
- **Introduce Accountability (What, Who, When)**



THE POSSIBLE
IMPACT ASSESSMENT

'DCM Rev 0 AD3-6' current 0.1 (Rev 0 with changes from Addenda 3-6) in /CHSTP/50 Design Manual (Formal module) - DOORS

File Edit View Insert Link Analysis Table Tools Discussions User Change Management Help

View: OH Critical Items | All levels

Design Criteria Manual Table of Contents	Traced From: Critical Requirements
4.4.5 Superelevation	
4.4.5.1 Equilibrium (Balanced) Superelevation	
4.4.5.2 Actual Superelevation	[FRA GD]: 6.1.4 Track Geometry [FRA GD]: 6.1.4 Track Geometry [FRA GD]: 6.1.4 Track Geometry [FRA GD]: 6.1.6 Inspection [INF 3-07]: DECOMPOSED - Actual Superelevation (Ea) [INF 3-10]: DECOMPOSED - Track geometrical quality and limits on isolated defects [IF 355]: Interface between O&M Maximum Design Speed (HST Tracks) and GWY Infrastructure [IF 489]: Interface between RST HST Trainset Actual Superelevation Requirements (incl. Tilting)
Actual Superelevation Ea	
4.4.5.3 Unbalanced Superelevation	[FRA GD]: 6.1.4 Track Geometry [FRA GD]: 6.1.4 Track Geometry [INF 3-08]: Unbalanced Superelevation Eu [INF 3-08.1]: Unbalanced superelevation on curves containing turnouts [INF 3-08.2]: Abrupt change of unbalanced superelevation on curves through the diverging track c [IF 355]: Interface between O&M Maximum Design Speed (HST Tracks) and GWY Infrastructure [IF 395]: Interface between RST HST Trainset Unbalanced Superelevation Requirements and GW
4.4.5.4 Ride Quality and Superelevation	[BoD 3.4]: DECOMPOSED/DERIVED - Physical Requirements [BoD 3.4]: DECOMPOSED/DERIVED - Physical Requirements

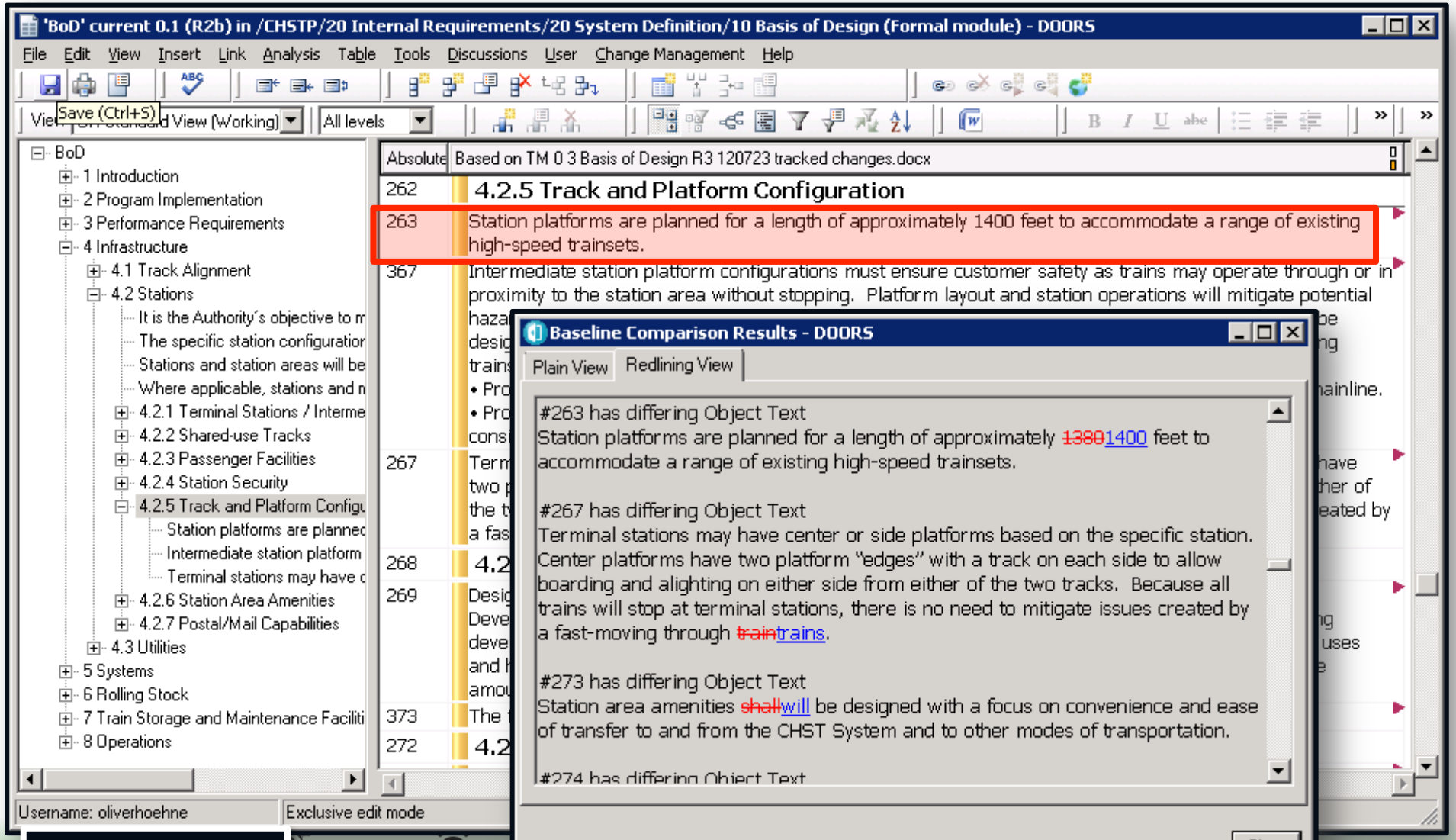
Username: oliverhoehne | Exclusive edit mode

Design Criteria Manual

Traces from Higher-Level Requirements

Design Criteria Manual Table of Contents, CP1 Version Rev 13 Jul 31	Traced From: All
• On aerial structures, protection shall be provided by a derailment protection wall designed so that the HST remains within its operating infrastructure. Refer to the *Structures* chapter.	[10 SyRS-INF] ID: 1620 Train falls from elevated structure.

THE POSSIBLE
VERSION MANAGEMENT



Basis of Design

THE POSSIBLE
VERSION MANAGEMENT (CONT'D)

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Absolute	Hazards & Mitigations	Date Identified	Traced To: TCs (LM)
1	1 Infrastructure	---	
2	1.1 R-O-W Generally	---	
14	1.1.4 Close Proximity	---	
418	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.	---	
406	1.1.4.13.2 Mitigation #2 [2] INF: Establish minimum setbacks or buffer zones of two hundred (200) feet (measured from the centerline of the nearest CHSTS track) relocating all currently active oil or gas wells	11/15/2012	DCM [UTL] 9.5.5 Utility Clearances DCM [CLR] 3.3.3 Clearances to Third Party Facilities

CEHL Mitigations

Baseline Comparison Results - DOORS

Plain View | Redlining View

#402 only exists in current
#403 only exists in current
#405 only exists in current
#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
#417 only exists in current
#418 only exists in current
#420 only exists in current

New Mitigation

Baseline Comparison Results - DOORS

Plain View | Redlining View

#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.

Changed Mitigation

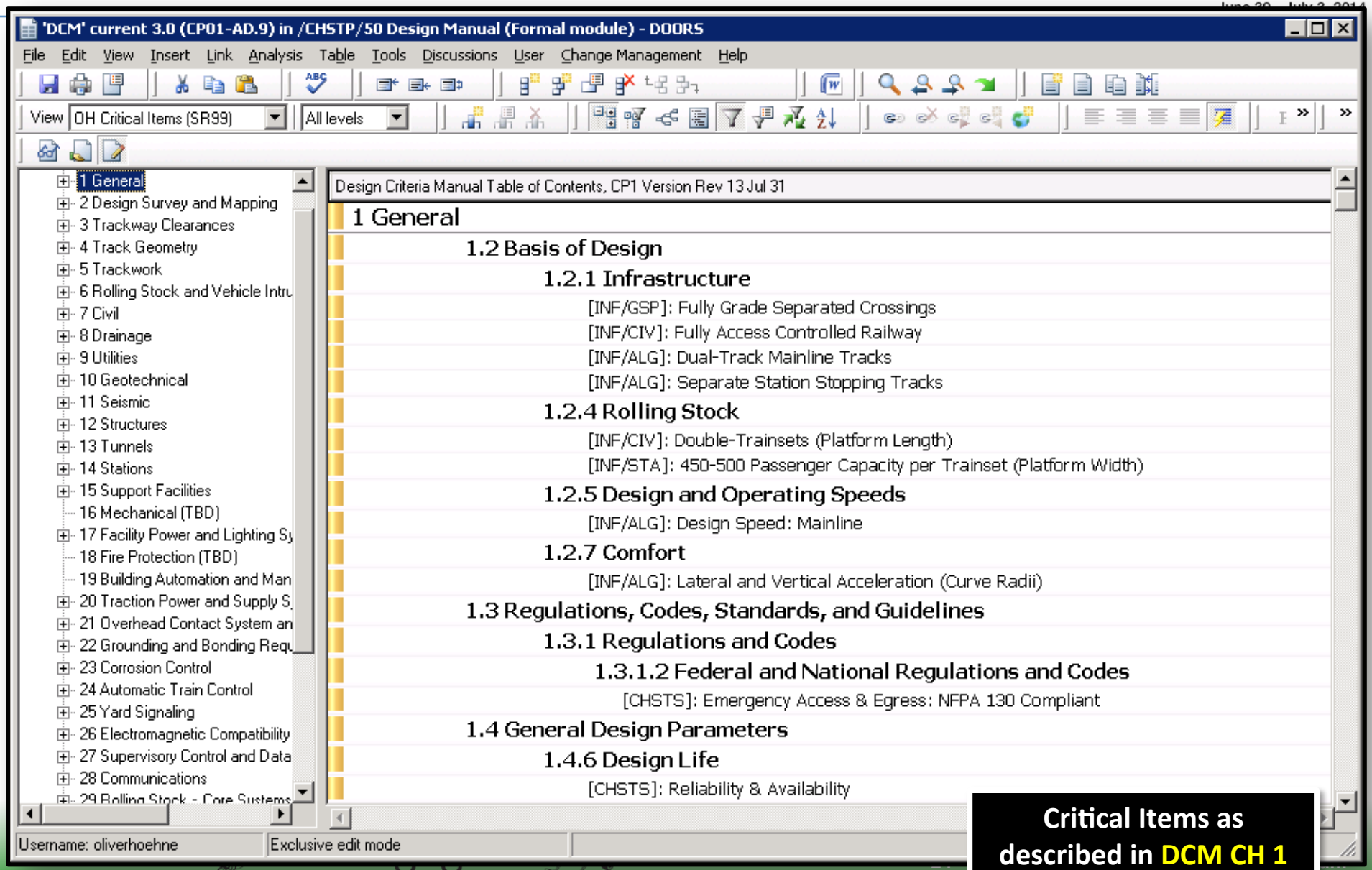
#247 has differing Object Text
[3] INF:
Intrusion protection berms, walls, and other barriers to prevent the intrusion of persons, animals, rail or highway vehicles as identified through site-specific hazard analysis or threat/vulnerability assessment

Close

THE POSSIBLE

DESIGN SUBMITTAL REVIEW CHECKLISTS

INCOSE International Symposium
Las Vegas, NV



Critical Items as described in DCM CH 1

THE POSSIBLE
DESIGN SUBMITTAL REVIEW CHECKLISTS

Critical Item | **Cheat-Sheet Data** | **DCM Reference**

ID	DCM Checklist	Cheat-Sheet	Traced To: TC Section Heading (LM)
1	**1 General**		
2	**1.1 Basis of Design**		
11	**1.1.1 Design and Operating Speeds**		
12	[INF/ALG]: Design Speed: Mainline	Design Speed = 250 mph Operating Speed= 220 mph	DCM [GEN] 1.2.5 Design and Operating Speeds
54	**2 Track Geometry**		
55	**2.1 Horizontal Alignment**		
56	**2.1.1 Minimum Radii**		
57	[INF/ALG]: Minimum Radii	250 mph: R=45,000, M=28,000 220 mph: R=35,000, M=22,000	DCM [ALG] 4.4.3 Minimum Radii
58	**2.1.2 Superelevation**		
59	**2.1.2.1 Actual Superelevation**		
60	[INF/ALG]: Actual Superelevation Ea	Ea = 6" max	DCM [ALG] 4.4.5.2 Actual Superelevation
61	**2.1.2.2 Unbalanced Superelevation**		
62	[INF/ALG]: Unbalanced Superelevation Eu	Eu = 3" max	DCM [ALG] 4.4.5.3 Unbalanced Superelevation
63	**2.2 Vertical Alignment**		
73	**2.2.1 Vertical Curves**		
74	**2.2.1.1 Minimum**		
75	[INF/ALG]: Vertical C		Vertical Curve Lengths

DCM Language

[DCM] ID: 4300
1.2.5 Design and Operating Speeds
A design speed of 250 mph where cost-effective and where topographic, geometric, operational, and environmental conditions permit. The design shall allow for sustained operating speed of 220 mph.

[DCM] ID: 4301
1.2.5 Design and Operating Speeds
In areas where shared-use track is anticipated, such as San Francisco–San Jose and Los Angeles–Anaheim, the maximum design speed is 125 mph.

THE POSSIBLE
DESIGN SUBMITTAL REVIEW CHECKLISTS

ID	DCM Checklist	Cheat-Sheet	QA/QC
1	**1 General**		
2	**1.1 Basis of Design**		
11	**1.1.1 Design and Operating Speeds**		
12	[INF/ALG]: Design Speed: Mainline	Design Speed = 250 mph Operating Speed= 220 mph	✓
54	**2 Track Geometry**		
55	**2.1 Horizontal Alignment**		
56	**2.1.1 Minimum Radii**		
57	[INF/ALG]: Minimum Radii	250 mph: R=45,000, M=28,000 220 mph: R=35,000, M=22,000	✓
58	**2.1.2 Superelevation**		
59	**2.1.2.1 Actual Superelevation**		✓
60	[INF/ALG]: Actual Superelevation Ea	Ea = 6" max	
61	**2.1.2.2 Unbalanced Superelevation**		✓
62	[INF/ALG]: Unbalanced Superelevation Eu	Eu = 3" max	
63	**2.2 Vertical Alignment**		
73	**2.2.1 Vertical Curves**		
74	**2.2.1.1 Minimum Vertical Curve Lengths (LVC)**		
75	[INF/ALG]: Vertical Curve Lengths	L VC = 3.5 V or L VC = 2.15 V 2 ('%/100) / 0.90 ft/sec 2 but not less than 200 ' %	✓

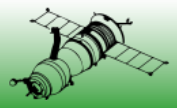
Requirements as Input into QA/QC Checklists

THE POSSIBLE
DESIGN SUBMITTAL REVIEW CHECKLISTS

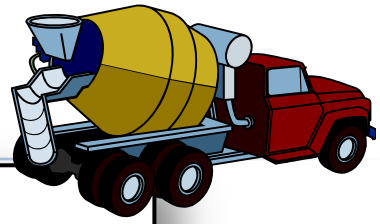
ID	DCM Checklist	Cheat-Sheet	QA/QC	RVTM
1	**1 General**			
2	**1.1 Basis of Design**			
11	**1.1.1 Design and Operating Speeds**			
12	*[INF/ALG]: Design Speed: Mainline*	*Design Speed = 250 mph* *Operating Speed= 220 mph*	✓	CP01OP1 T0150-A HYBRID ALIGNMENT - TRA ... CP01A TT-D0001 PACKAGE 1A - TRACK GUIDE ... CP01C TT-D0002 PACKAGE 1C - TRACK GUIDE ...
54	**2 Track Geometry**			
55	**2.1 Horizontal Alignment**			
56	**2.1.1 Minimum Radii**			
57	*[INF/ALG]: Minimum Radii*	*250 mph: R=45,000, M=28,000* *220 mph: R=35,000, M=22,000*		
58	**2.1.2 Superelevation**			
59	**2.1.2.1 Actual Superelevation**			
60	*[INF/ALG]: Actual Superelevation Ea*	*Ea = 6" max*		
61	**2.1.2.2 Unbalanced Superelevation**			
62	*[INF/ALG]: Unbalanced Superelevation Eu*	*Eu = 3" max*		
63	**2.2 Vertical Alignment**			
73	**2.2.1 Vertical Curves**			
74	**2.2.1.1 Minimum Vertical Curve Lengths (LVC)**			
75	*[INF/ALG]: Vertical Curve Lengths*	*L VC = 3.5 V or* *L VC = 2.15 V 2 ('%/100) / 0.90 ft/sec 2* *but not less than 200 ' %*		

- Systems Engineering Champion
- Communicate Clearly (WIIFY)
- Show Applicability
- Help Others Achieving Short-Term Results
- Early Adaptors

Building an RVTM


THE IMPOSSIBLE
CONCEPT OF OPERATIONS



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System Operation

Alerts detected by the IDS will be sent to Operations Control Center (OCC) via the WDS system. Receipt of a [illegible] designated control ce[illegible] system to automatically impose a s[illegible] area. Based on the type, severity, [illegible] the alarm will trigger one of followi[illegible]

- Level 1 –Potentially critical [illegible] subsystem and requiring st[illegible] affected trains by the train [illegible]
- Level 2 –Intrusion event de[illegible] commands b[illegible]
- Level 3 – Intrusion alarm th[illegible] definitive action is taken. R[illegible] dispatcher.

Specific details regarding what eve[illegible] and vulnerability analysis conducte[illegible]

Why

When

Operational Scenario

Scenario 4-4.1a: CHST Train on CHST Track – IDS Detects Level 1 Intrusion Event

The IDS detects intrusion indications from two or more different intrusion detection subsystems at a roadway overpass. A Level 1 alarm is sent to the train dispatcher and other designated OCC workstations via the WDS system. In this case, the initiation of the alarm will cause the train control system to automatically initiate a brake application on trains approaching the overpass that will bring them to a stop.

User	Location	Role and Responsibilities
Immediate Reactions to Event Occurrence		
Engineer	Train Cab	• Engineer receives a Level 1 intrusion event indication on OCD. • Train brakes apply automatically until train stops.
Train Dispatcher	OCC	• TD receives visual and audible alert on workstation indicating a Level 1 intrusion event.
DOC	OCC	• DOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.
SOC	OCC	• SOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.
IOC	OCC	• IOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.
Users Assess Conditions and Initiate Response		
Engineer	Train Cab	• Monitor train's automatic brake response. • After stopping, contact OCC by radio to confirm event and request instructions. • Contact and inform conductor by intercom [illegible]ition. • After receiving permission from TD, proceed at Reduced Speed to point of incursion and report conditions to OCC. (In this instance,

Who

Where

What

THE IMPOSSIBLE
CONCEPT OF OPERATIONS

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6.3.7.1.1 System Operation

Alerts detected by the IDS will be sent to Operations Control Center (OCC) via the WDS system. Receipt of an alert will trigger an audible and visual alarm on train dispatcher and other designated control center workstations. The initiation of this alarm may cause the train control system to automatically impose a stop command or speed restriction on trains approaching that area. Based on the type, severity, location or other factors related to the alert, the

- Level 1 –Potentially critical in
commands be immediately and
- Level 2 –Intrusion event dete
issued to affected trains by the
- Level 3 – Intrusion alarm tha

Radio contact with trains may

Specific details regarding wha
analysis conducted at a later d

DOORS Import

6.3.7.1.2.1 Scenario 4-4.1a: CHST Train on CHST Track – IDS Detects Level 1 Intrusion Event

The IDS detects intrusion indications from two or more different intrusion detection subsystems at a roadway overpass. A Level 1 alarm is sent to the train dispatcher and other designated OCC workstations via the WDS system. In this case, the initiation of the alarm will cause the train control system to automatically initiate a brake application on trains approaching the overpass that will bring them to a stop.

User	Location	Role and Responsibilities
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DOC	OCC	• DOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.
SOC	OCC	• SOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.
IOC	OCC	• IOC receives visual and audible alert on workstation indicating a Level 1 intrusion event.

User	Location	Role and Responsibilities
Users Assess Conditions and Initiate Response		
Engineer	Train Cab	• Monitor train's automatic brake response. • After stopping, contact OCC by radio to confirm event and request instructions. • Contact and inform conductor by intercom or radio of condition. • After receiving permission from TD, proceed at Reduced Speed to point of incursion and report conditions to OCC. (In this instance, upon arrival at scene engineer reports that a car has crashed into the overpass barrier and a piece of concrete is resting on the track.) • Receives instructions from the TD to return to the previous station and off-load passengers for alternative bus service.

THE IMPOSSIBLE
DERIVED SYSTEM REQUIREMENTS

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Scenario Overview

It is early evening on a rainy, gray day and an CHSRA Train is approaching Fresno headed south-bound at a speed of 190mph. The train is decreasing in speed as it approaches an HST bridge viaduct just south of the 7th Street and SR-99 intersection. As the train approaches the viaduct, seismic activity, in conjunction with unstable ground from record rainfall, compromises track. The train is upright, but tilted and derailed. There is minimal visual, structural damage and no danger of the train coming off the elevated structure. The nearest access gate is about 1000' north of the incident and is secured per CAHSR protocol.

The incident is reported by the train engineer to the Operations Control Center (OCC) of the CHSRA [Event 1]. The OCC then reported the event to the first responders via 911 with an official report of the incident [Event 2]. First responders mobilized and deployed to the access gate [Event 3]. Pass ming train traffic, approves opening of access gate, and nc rst responders enter the RO

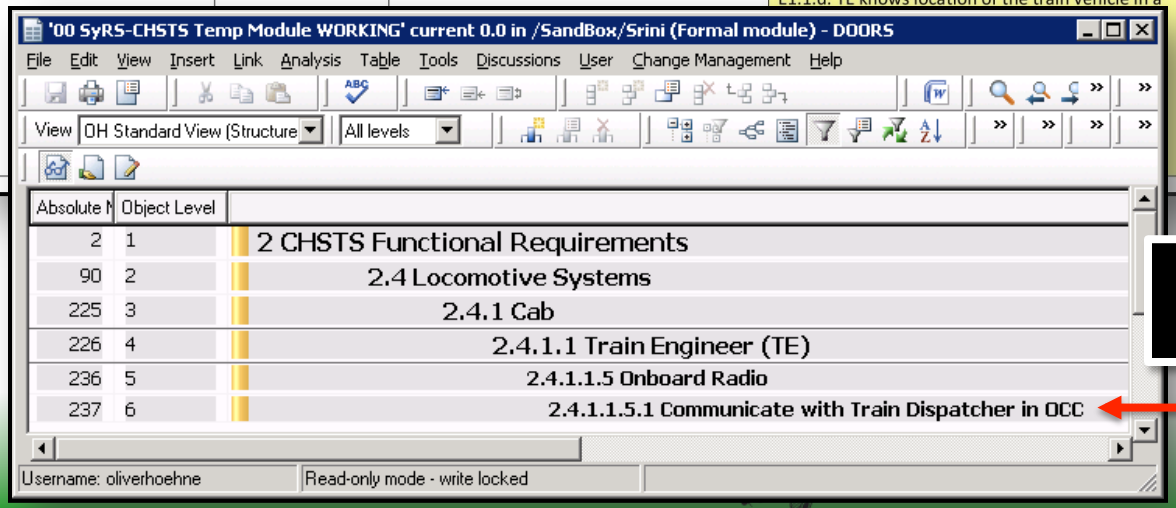
Operating Scenario

Derived (Re-Phrased) Operation Need

Derived Functional Requirements

Operational Scenario

Agency/Facility	Location	Scenario	Operational Need	Functional Requirement	How well
Event 1: Report of Derailment CHSRA Train crew reports incident to CHSRA OCC					
Agency/Facility	Location	Scenario			
Train Engineer	Incident train	1) Train Engineer contacts OCC with notice of incident, including train/crew identification, status of train, location and condition of vehicle, visible or known damage, status of passengers and other crew.	E1.1.a. Train Engineer (TE) communicates with the Train Dispatcher (TD) in the OCC using voice communication.	E1.1.a. On-board communication systems in the cab shall enable the TE to have real-time voice communications with the TD in the OCC.	E1.1.a. real-time = within 500 ms On-board = in viewing frame of TE
			E1.1.b. TE knows train and crew identification. (How does TE know this?)	E1.1.b. Crew Manage ent System shall display crew names a d identification numbers from in cab.	
			E1.1.c TE knows health status of train.	E1.1.c. Health Status S stem (?) shall display system condit ns in the cab.	
			E1.1.d. TE knows location of the train vehicle in a	E1.1.d. ATS System sh ll display location of train in the cab.	
				E1.1.e. CCTV System(/ ear view mirrors?) shall provide a real-tim e visibility of the outside of the train.	



CHST Document Structure

THE IMPOSSIBLE

DERIVED SYSTEM REQUIREMENTS (CONT'D)

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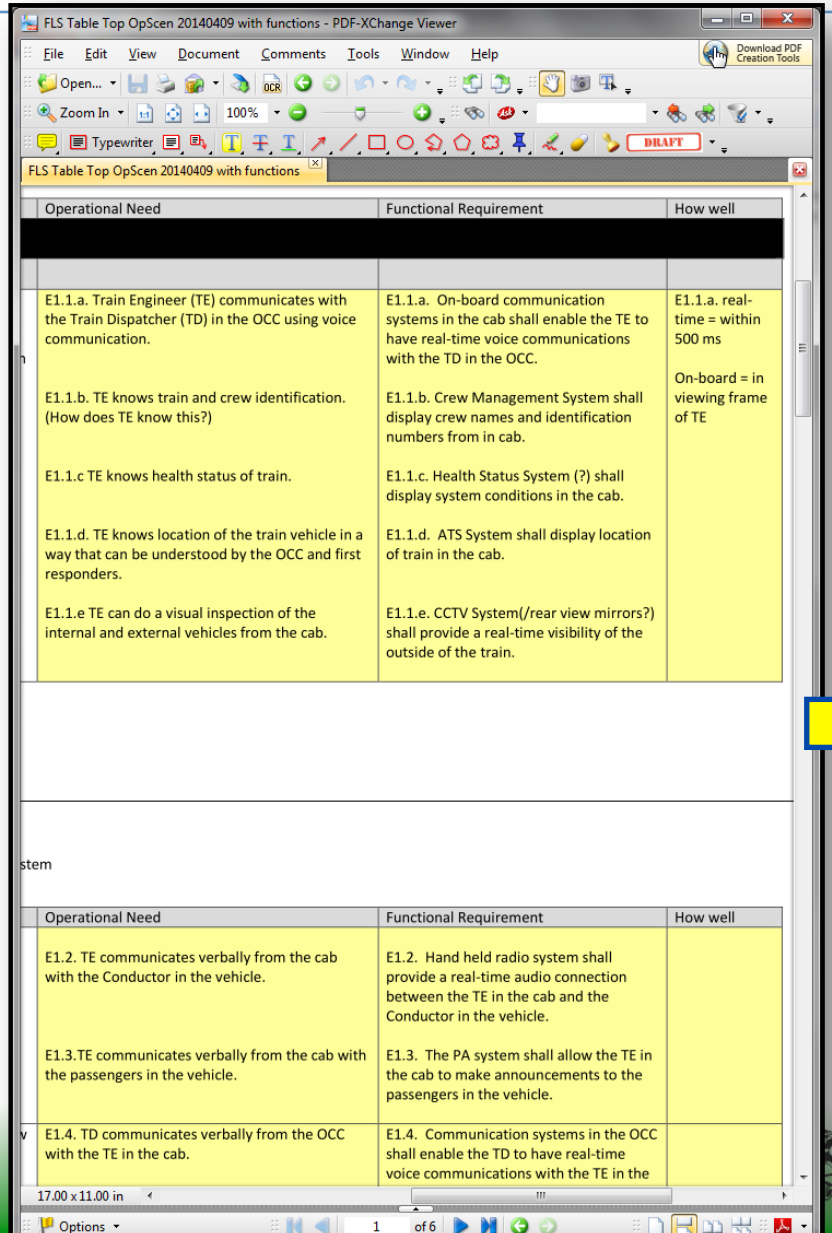
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FLS Table Top OpScen 20140409 with functions

Operational Need	Functional Requirement	How well
E1.1.a. Train Engineer (TE) communicates with the Train Dispatcher (TD) in the OCC using voice communication.	E1.1.a. On-board communication systems in the cab shall enable the TE to have real-time voice communications with the TD in the OCC.	E1.1.a. real-time = within 500 ms
E1.1.b. TE knows train and crew identification. (How does TE know this?)	E1.1.b. Crew Management System shall display crew names and identification numbers from in cab.	On-board = in viewing frame of TE
E1.1.c TE knows health status of train.	E1.1.c. Health Status System (?) shall display system conditions in the cab.	
E1.1.d. TE knows location of the train vehicle in a way that can be understood by the OCC and first responders.	E1.1.d. ATS System shall display location of train in the cab.	
E1.1.e TE can do a visual inspection of the internal and external vehicles from the cab.	E1.1.e. CCTV System(/rear view mirrors?) shall provide a real-time visibility of the outside of the train.	

stem

Operational Need	Functional Requirement	How well
E1.2. TE communicates verbally from the cab with the Conductor in the vehicle.	E1.2. Hand held radio system shall provide a real-time audio connection between the TE in the cab and the Conductor in the vehicle.	
E1.3.TE communicates verbally from the cab with the passengers in the vehicle.	E1.3. The PA system shall allow the TE in the cab to make announcements to the passengers in the vehicle.	
E1.4. TD communicates verbally from the OCC with the TE in the cab.	E1.4. Communication systems in the OCC shall enable the TD to have real-time voice communications with the TE in the	

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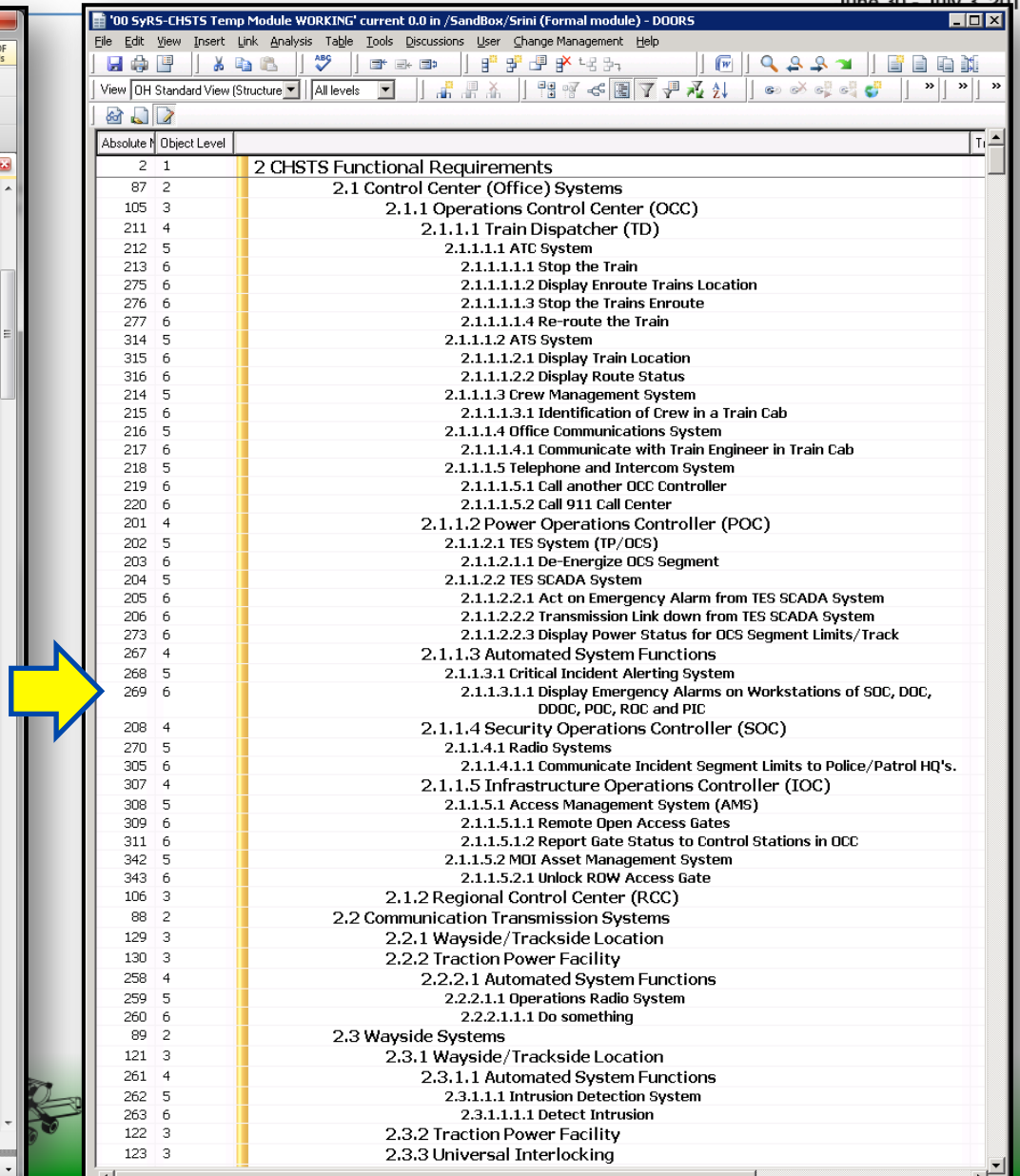

'00 SyRS-CHSTS Temp Module WORKING' current 0.0 in /SandBox/Srini (Formal module) - DOORS

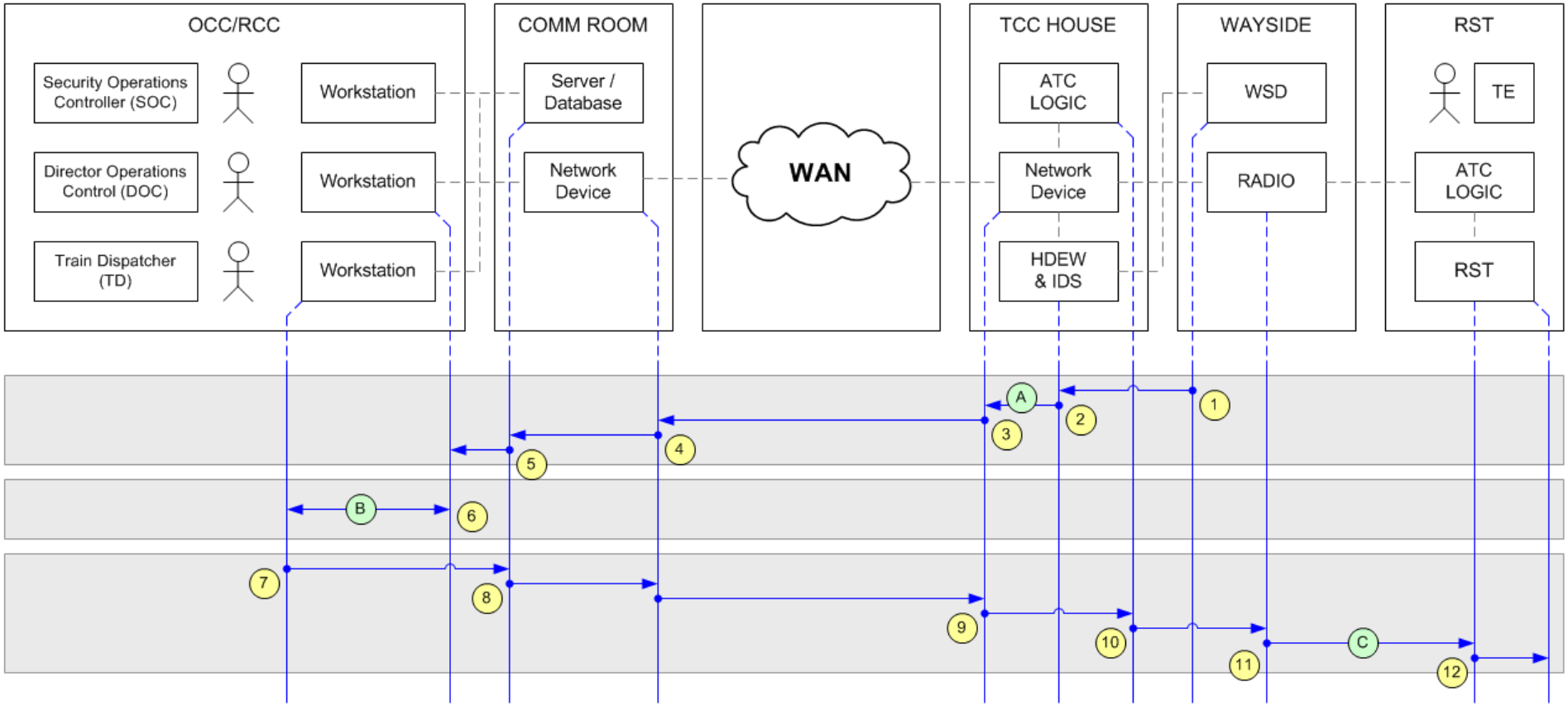
File Edit View Insert Link Analysis Table Tools Discussions User Change Management Help

View: OH Standard View (Structure) | All levels

Absolute N	Object Level	
2	1	2 CHSTS Functional Requirements
87	2	2.1 Control Center (Office) Systems
105	3	2.1.1 Operations Control Center (OCC)
211	4	2.1.1.1 Train Dispatcher (TD)
212	5	2.1.1.1.1 ATC System
213	6	2.1.1.1.1.1 Stop the Train
275	6	2.1.1.1.1.2 Display Enroute Trains Location
276	6	2.1.1.1.1.3 Stop the Trains Enroute
277	6	2.1.1.1.1.4 Re-route the Train
314	5	2.1.1.1.2 ATS System
315	6	2.1.1.1.2.1 Display Train Location
316	6	2.1.1.1.2.2 Display Route Status
214	5	2.1.1.1.3 Crew Management System
215	6	2.1.1.1.3.1 Identification of Crew in a Train Cab
216	5	2.1.1.1.4 Office Communications System
217	6	2.1.1.1.4.1 Communicate with Train Engineer in Train Cab
218	5	2.1.1.1.5 Telephone and Intercom System
219	6	2.1.1.1.5.1 Call another OCC Controller
220	6	2.1.1.1.5.2 Call 911 Call Center
201	4	2.1.1.2 Power Operations Controller (POC)
202	5	2.1.1.2.1 TES System (TP/OCS)
203	6	2.1.1.2.1.1 De-Energize OCS Segment
204	5	2.1.1.2.2 TES SCADA System
205	6	2.1.1.2.2.1 Act on Emergency Alarm from TES SCADA System
206	6	2.1.1.2.2.2 Transmission Link down from TES SCADA System
273	6	2.1.1.2.2.3 Display Power Status for OCS Segment Limits/Track
267	4	2.1.1.3 Automated System Functions
268	5	2.1.1.3.1 Critical Incident Alerting System
269	6	2.1.1.3.1.1 Display Emergency Alarms on Workstations of SOC, DOC, DDOC, POC, ROC and PIC
208	4	2.1.1.4 Security Operations Controller (SOC)
270	5	2.1.1.4.1 Radio Systems
305	6	2.1.1.4.1.1 Communicate Incident Segment Limits to Police/Patrol HQ's.
307	4	2.1.1.5 Infrastructure Operations Controller (IOC)
308	5	2.1.1.5.1 Access Management System (AMS)
309	6	2.1.1.5.1.1 Remote Open Access Gates
311	6	2.1.1.5.1.2 Report Gate Status to Control Stations in OCC
342	5	2.1.1.5.2 MOI Asset Management System
343	6	2.1.1.5.2.1 Unlock ROW Access Gate
106	3	2.1.2 Regional Control Center (RCC)
88	2	2.2 Communication Transmission Systems
129	3	2.2.1 Wayside/Trackside Location
130	3	2.2.2 Traction Power Facility
258	4	2.2.2.1 Automated System Functions
259	5	2.2.2.1.1 Operations Radio System
260	6	2.2.2.1.1.1 Do something
89	2	2.3 Wayside Systems
121	3	2.3.1 Wayside/Trackside Location
261	4	2.3.1.1 Automated System Functions
262	5	2.3.1.1.1 Intrusion Detection System
263	6	2.3.1.1.1.1 Detect Intrusion
122	3	2.3.2 Traction Power Facility
123	3	2.3.3 Universal Interlocking

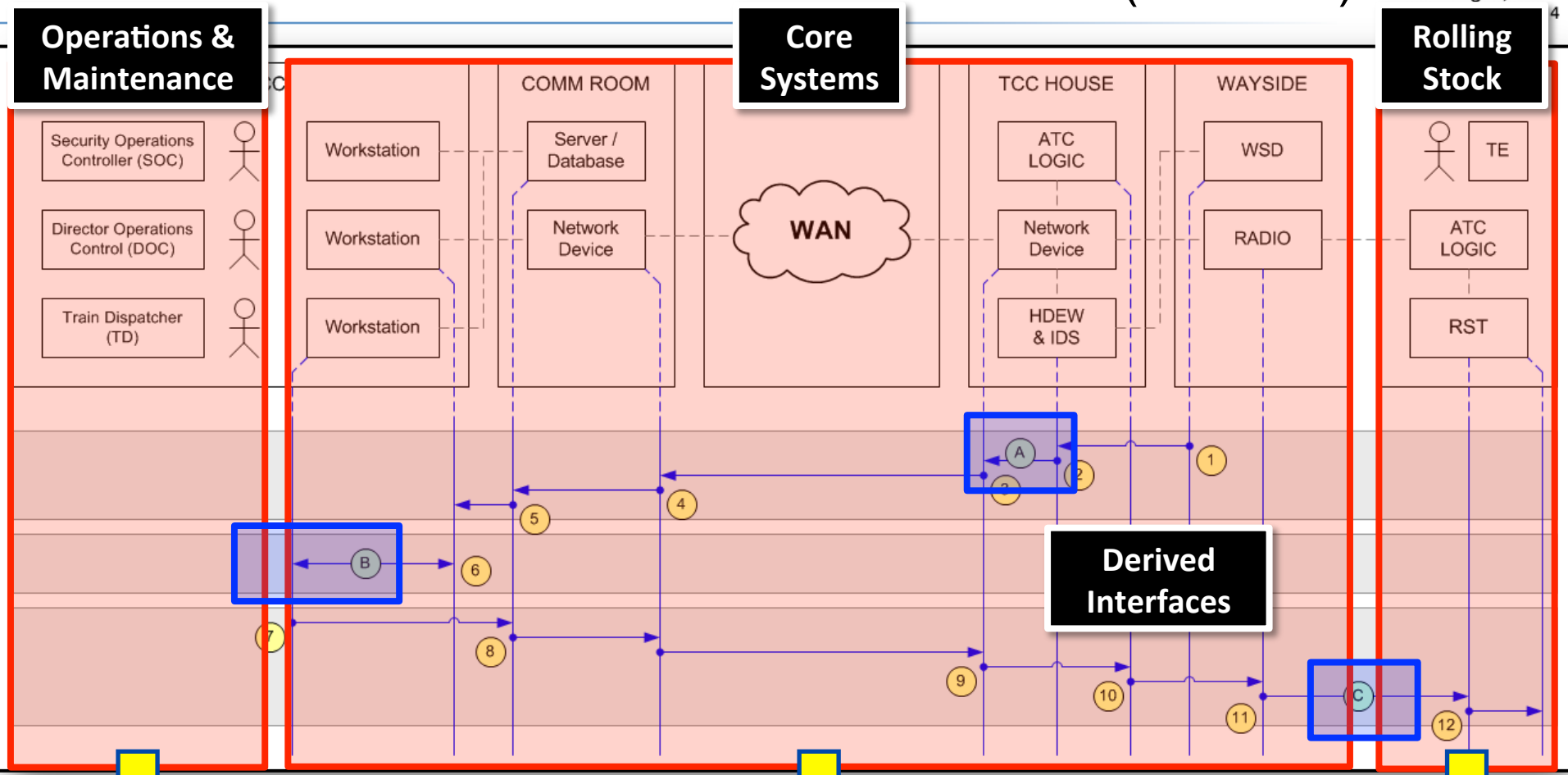
THE IMPOSSIBLE

SYSTEM ARCHITECURE & CONCEPT OF EXECUTION



THE IMPOSSIBLE

SYSTEM ARCHITECURE & CONCEPT OF E. (CONT'D)



Derived Requirements

Derived Requirements

Derived Requirements

THE IMPOSSIBLE
SYSTEM TESTING

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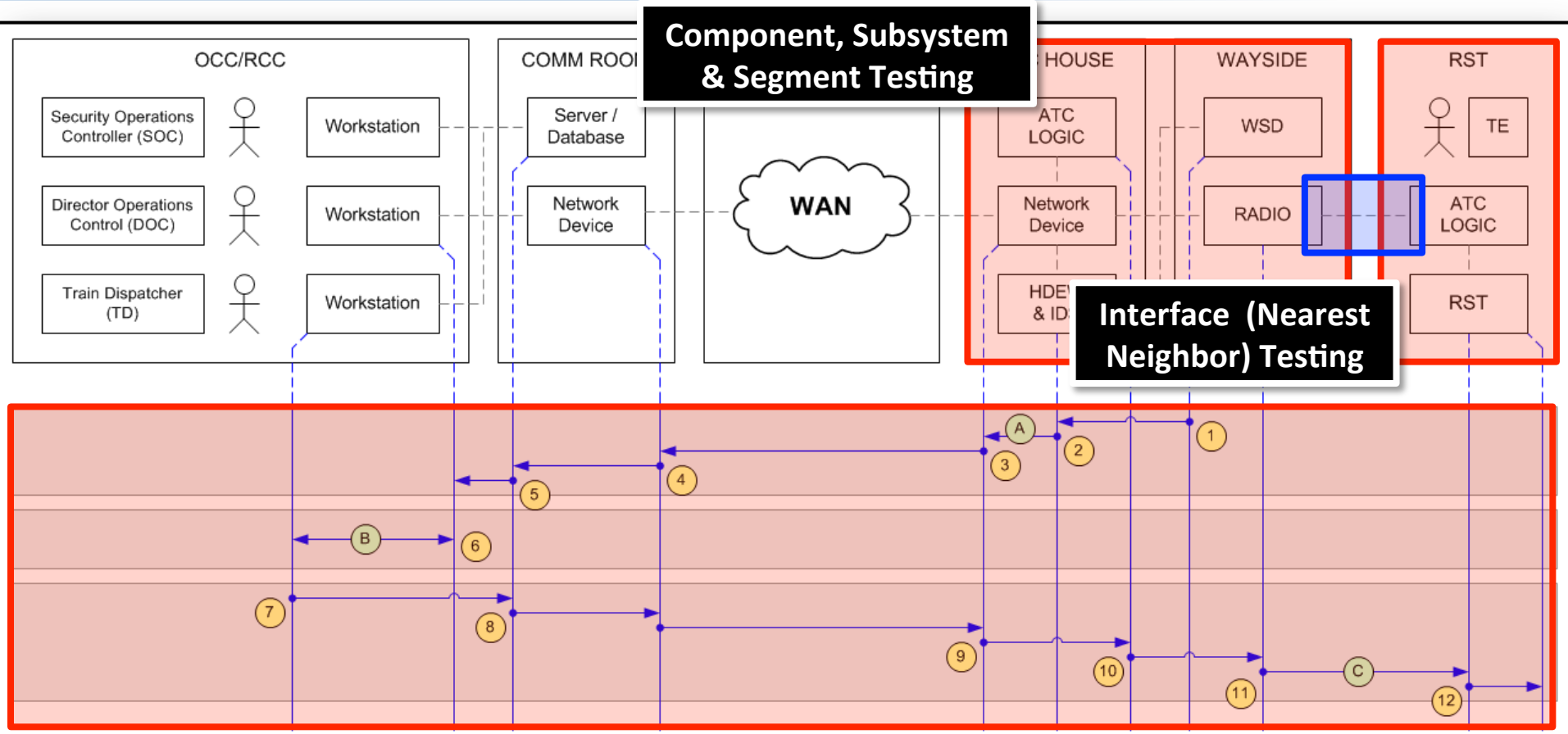

THE IMPOSSIBLE

SYSTEM ARCHITECURE & CONCEPT OF E. (CONT'D)

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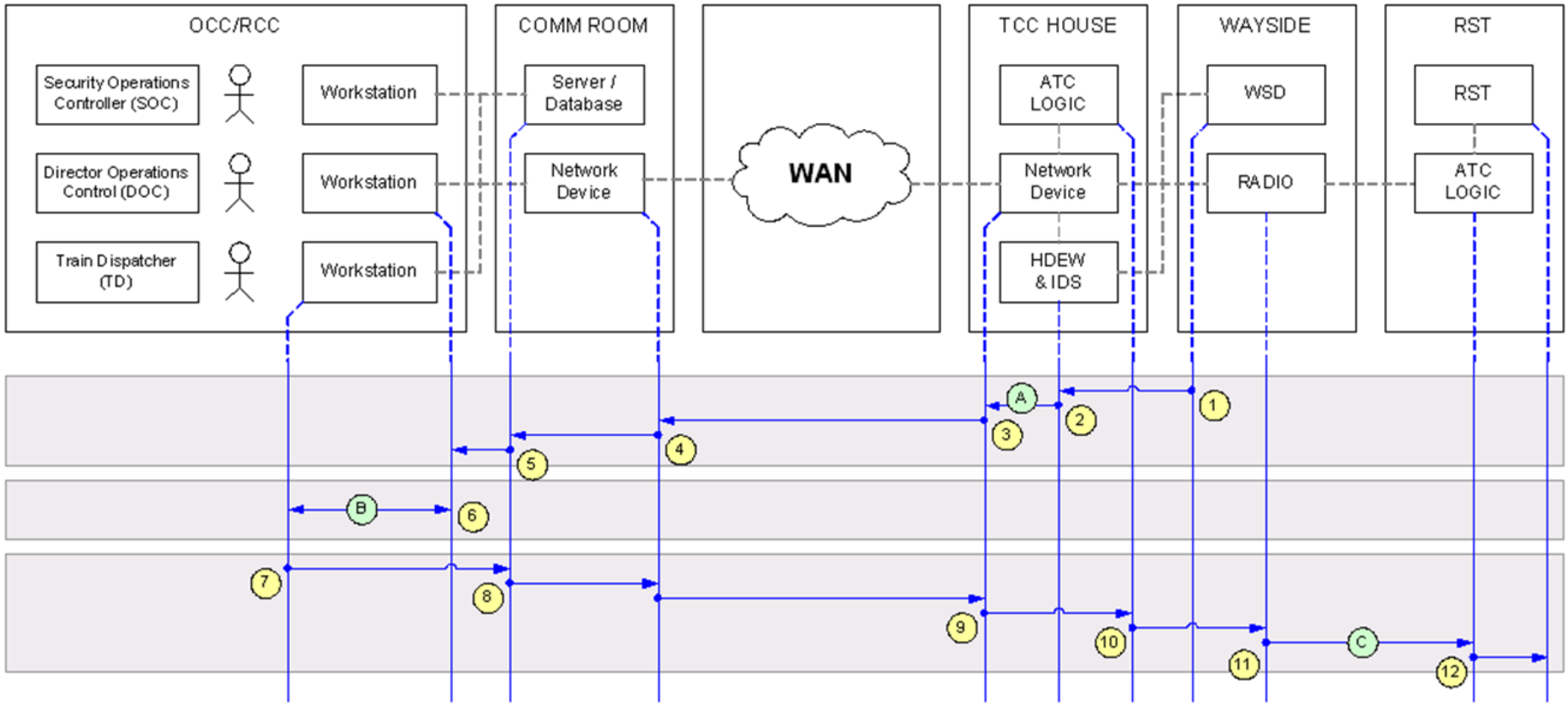
1 CHSTS Operational Requirements

1.1 General System Operation

1.1.1 Normal Operation

1.1.2 Intrusion Detection System

1.1.2.1 Concept of Execution



(1) The Wayside Detection (WDS) system detects an intrusion and forwards the detection to the Hazard Detection Early Warning (HDEW) system.

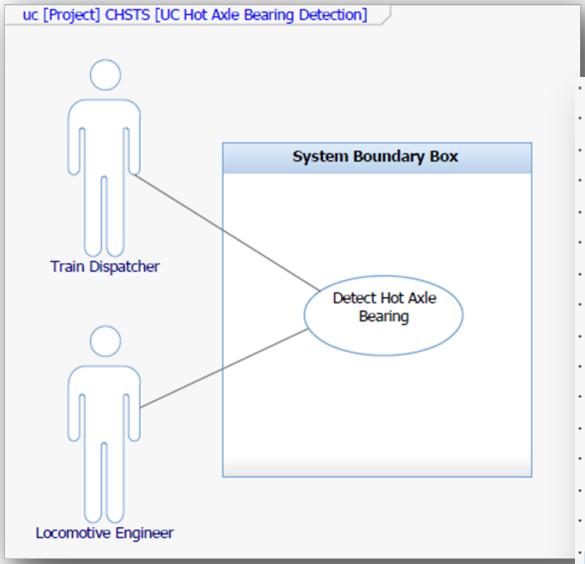
(2) HDEW system processes intrusion alarm and forwards it to OCC via TCC house Network Device.

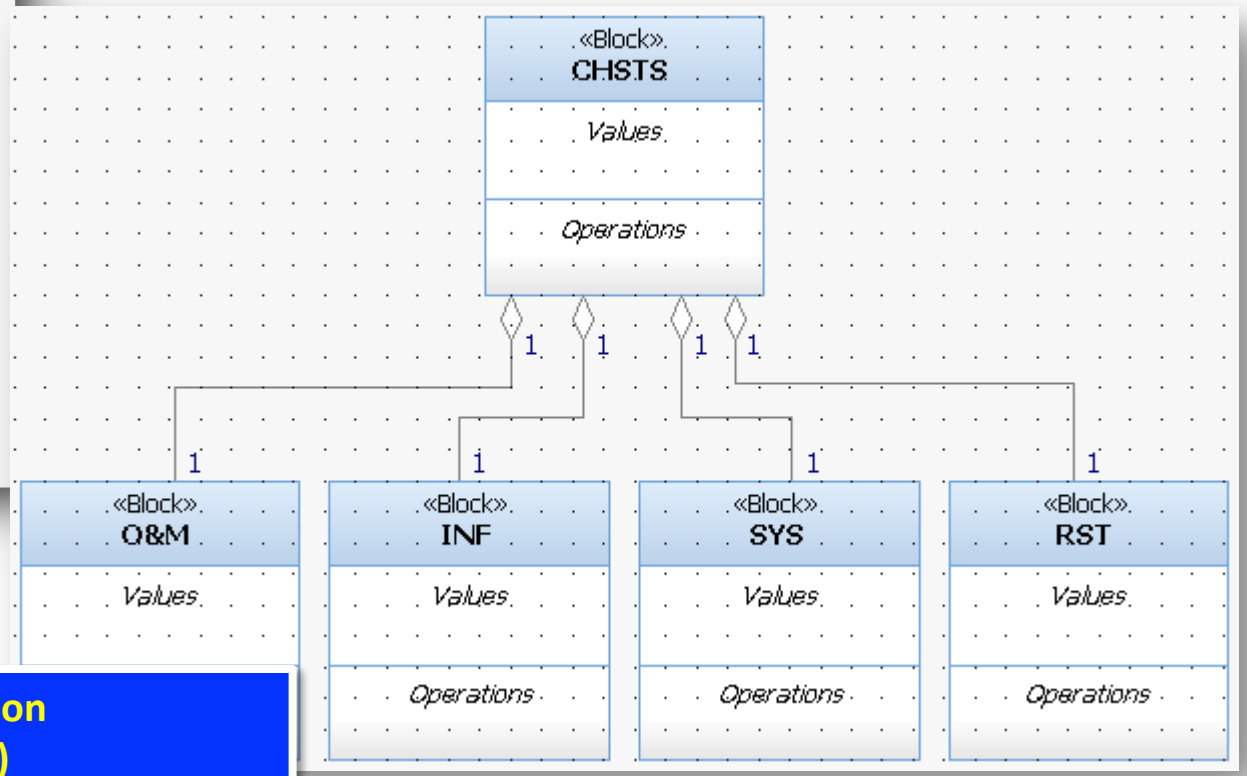
(3) TCC House Network Device processes intrusion alarm and forwards it to OCC via Wide Area Network.

(4) OCC Network Device processes intrusion alarm and forwards it to OCC Server / Database.

(5) OCC Server processes intrusion alarm and initiates audible and visual alarm on OCC Workstation(s).

THE IMPOSSIBLE
MODEL BASED SYSTEMS ENGINEERING (PLANNED)





- Systems Engineering Champion
- Communicate Clearly (WIIFY)
- Show Applicability
- Help Others Achieving Short-Term Results
- Just do it, Ask Forgiveness Later
- Early Adaptors

SUMMARY

JUST DO IT!

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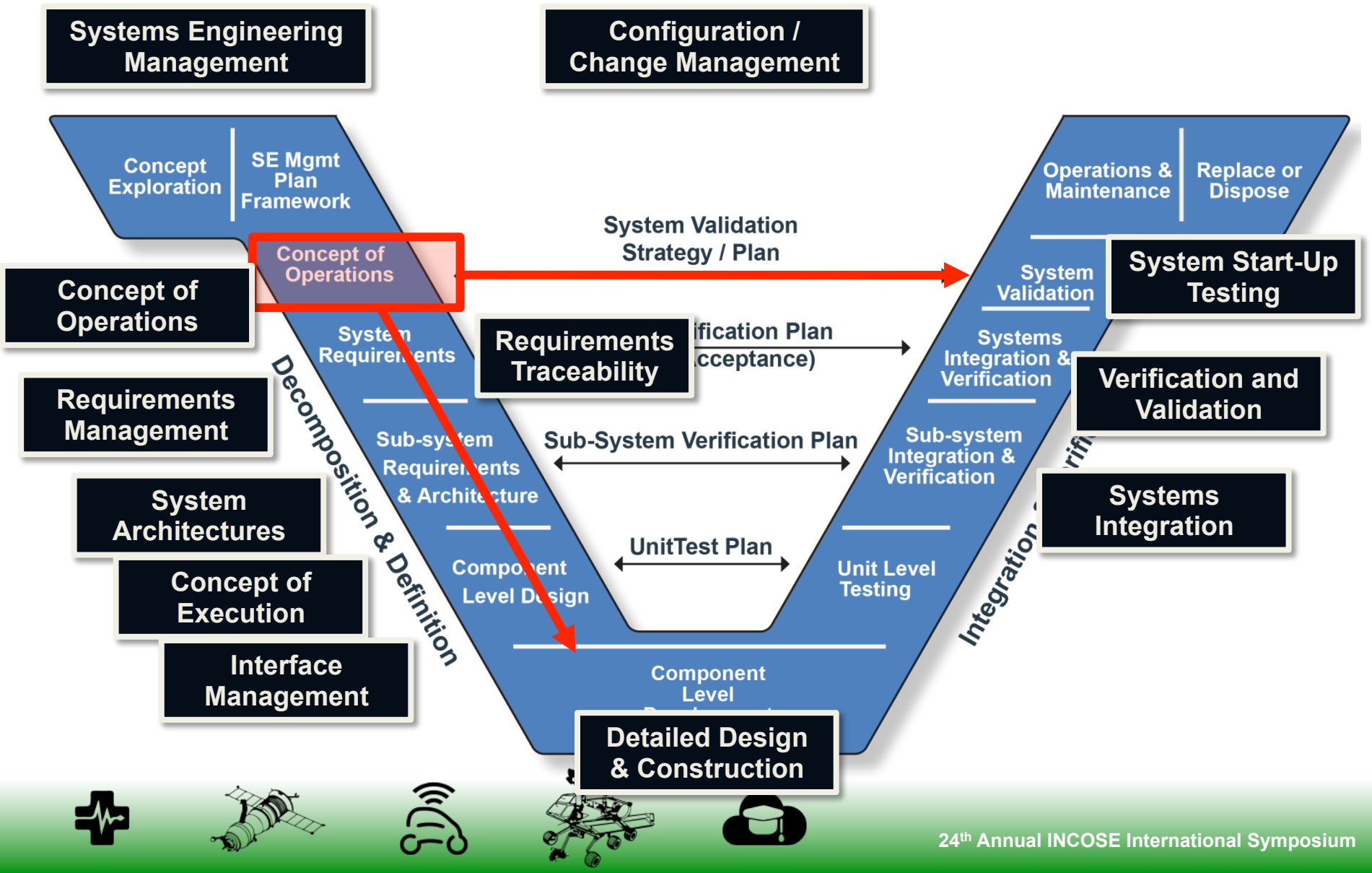
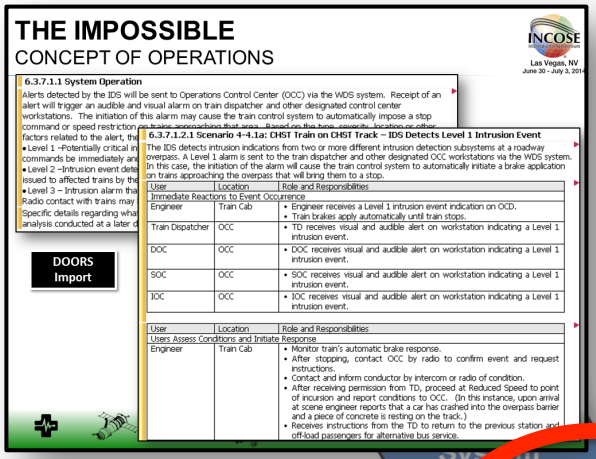
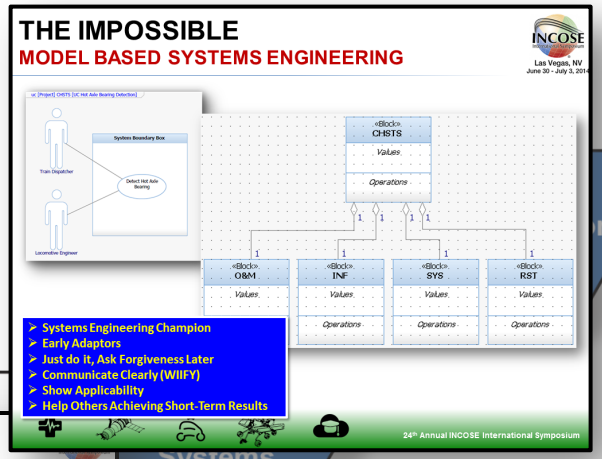


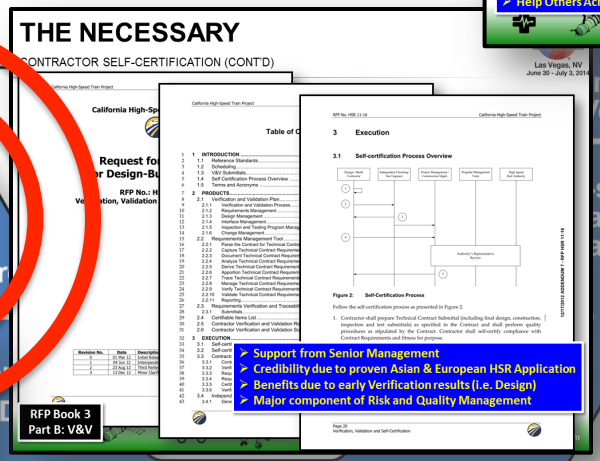
SUMMARY

DO NOT GIVE UP!





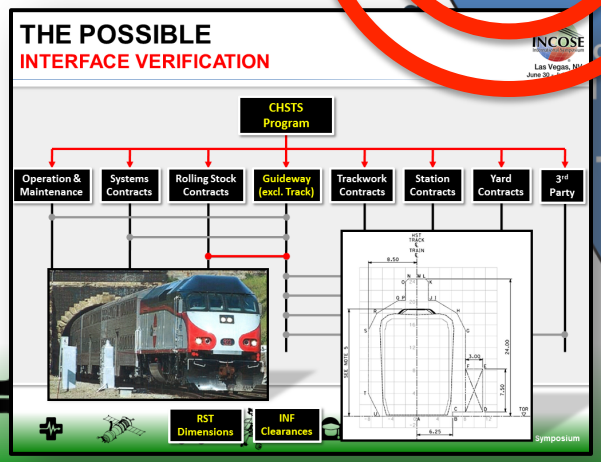
System Validation Strategy / Plan



We are Here
= Sweet Spot

Integration & Verification

Component Level Development



QUESTIONS & ANSWERS

REMEMBER THE WIIFY

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