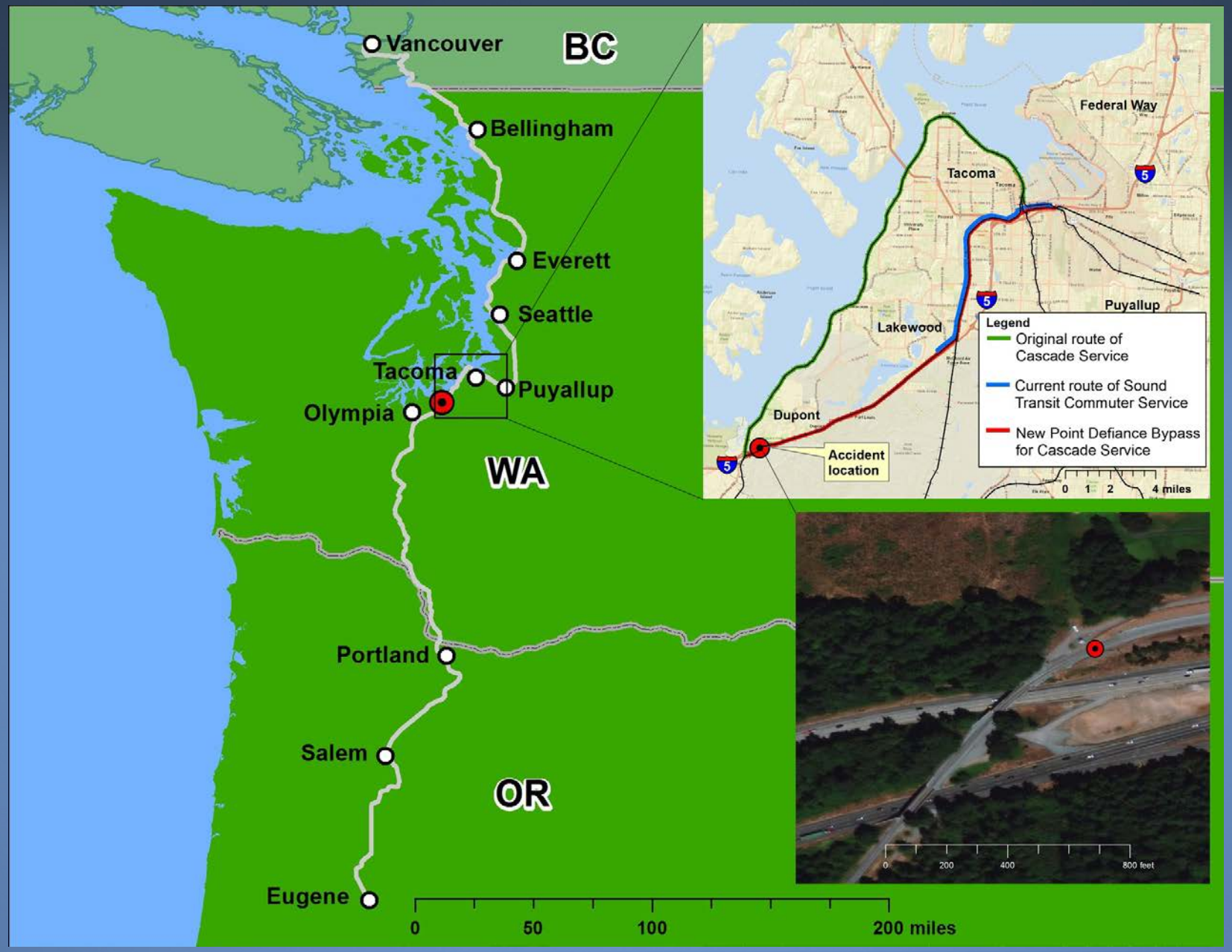
National Transportation Safety Board

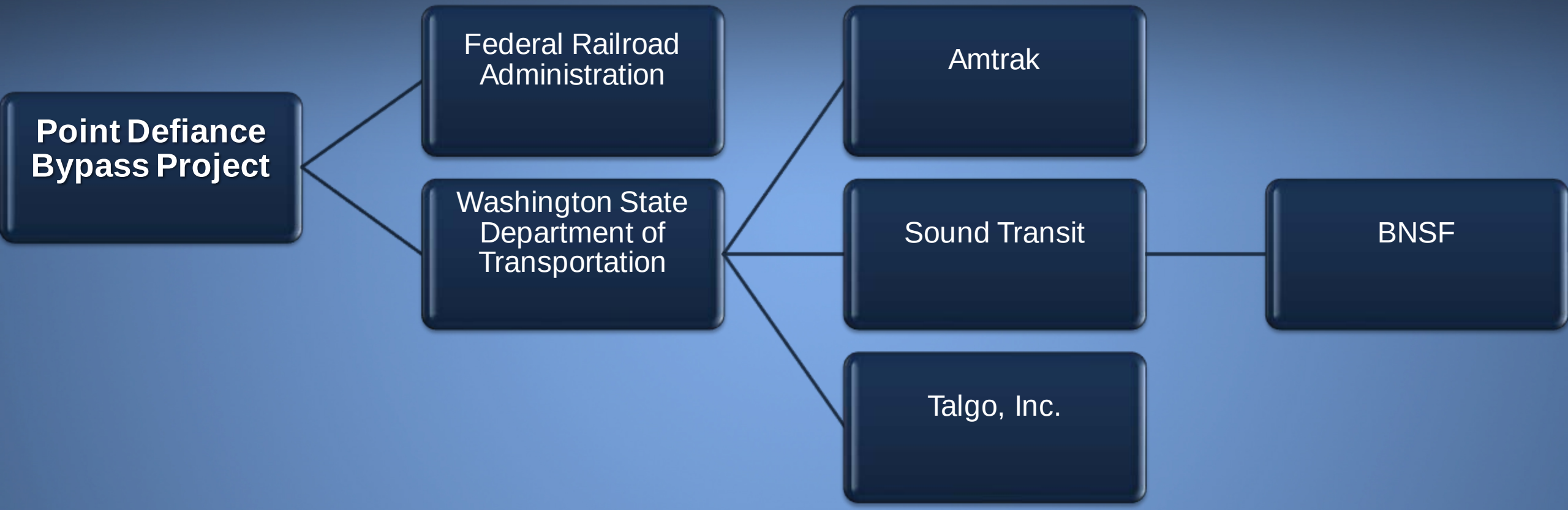
Amtrak Passenger Train 501 Derailment DuPont, Washington December 18, 2017

Michael Hiller


Vancouver
BC
Bellingham
Everett
Seattle
Tacoma
Puyallup
Olympia
WA
Portland
Salem
OR
Eugene
0
50
100
200 miles
Federal Way
Tacoma
Puyallup
Lakewood
Dupont
Accident location
Legend
Original route of Cascade Service
Current route of Sound Transit Commuter Service
New Point Defiance Bypass for Cascade Service
0 1 2 4 miles
0 200 400 800 feet

NTSB

NTSB


Point Defiance Bypass Project
Federal Railroad Administration
Washington State Department of Transportation
Amtrak
Sound Transit
Talgo, Inc.
BNSF

Investigation Team

- Bella Dinh-Zarr – Board Member-on-Scene
- Ted Turpin – IIC
- Mike Hiller – Asst. IIC
- Dennis Hogenson – Launch Support
- Ryan Frigo – Operations & System Safety
- Dr. Steve Jenner – Human Performance
- Joey Rhine – Mechanical
- Richard Hipskind – Track
- Tim DePaepe – Signals
- Sheryl Harley – Survival Factors
- Mike Hiller – Crashworthiness
- Charles Cates – Recorders

Staff

- Dave Bucher
- Dana Sanzo
- Mary Pat McKay
- Bob Beaton
- Mike Hamilton
- Jeff Marcus
- Mike Budinski
- Christy Spangler
- Ron Kaminski
- Matt Fox
- Ben Hsu
- Ivan Cheung
- Bill English
- Paul Suffern
- Eldridge Harding
- Gena Evans
- Joe Scott
- Joe Gordon
- Chris Wallace
- Stephanie Matonek
- Carl Perkins
- Pummy Bawa
- Terry Williams
- Ben Allen

Parties to the Investigation

- Amtrak
- Sound Transit
- Washington State Department of Transportation
- Washington Utilities and Transportation Commission
- Federal Railroad Administration
- Talgo, Inc.
- Siemens Industry, Inc.
- Brotherhood of Locomotive Engineers and Trainmen
- International Association of Sheet Metal, Air, Rail and Transportation Workers

Safety Issues

- Preparation for inaugural service
- Amtrak safety on a host railroad
- Training and qualifying operating crews
- Crashworthiness of the Talgo equipment
- Survival factors
- Multi-agency emergency response

National Transportation Safety Board

National Transportation Safety Board

Operations and Human Performance Investigation

Stephen M. Jenner, Ph.D.

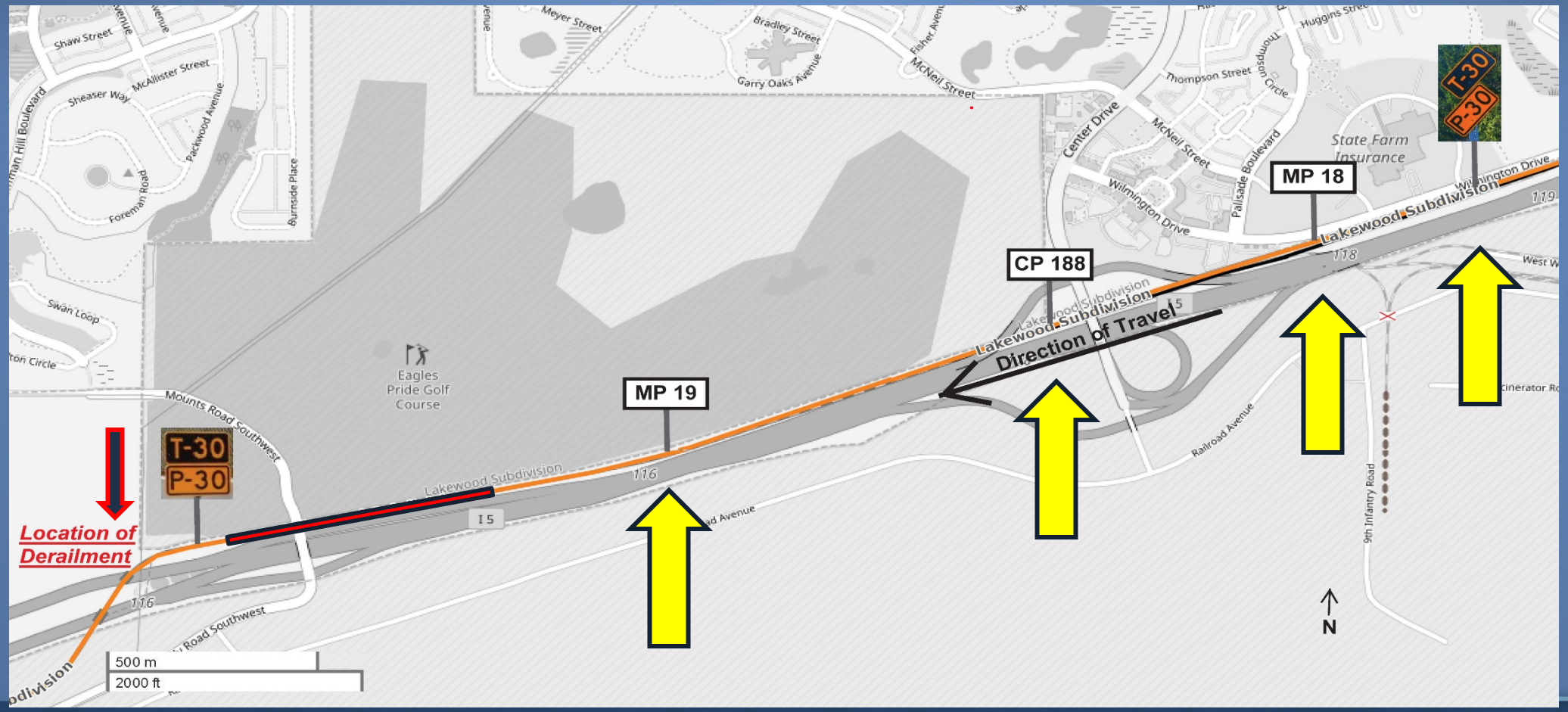
Focus of Operations and Human Performance Investigation

- Crew Performance
  - Failed to slow for curve at MP 19.8
- Training / Preparation
  - First trip in revenue service and unsupervised

Operating Crew

- Engineer
  - 4 years certified engineer
  - New territory
- Qualifying Conductor
  - 5 years certified conductor
  - Not qualified on territory / first trip
- Exclusions
- Inward-facing video

Amtrak 501 Accident Trip



NTSB

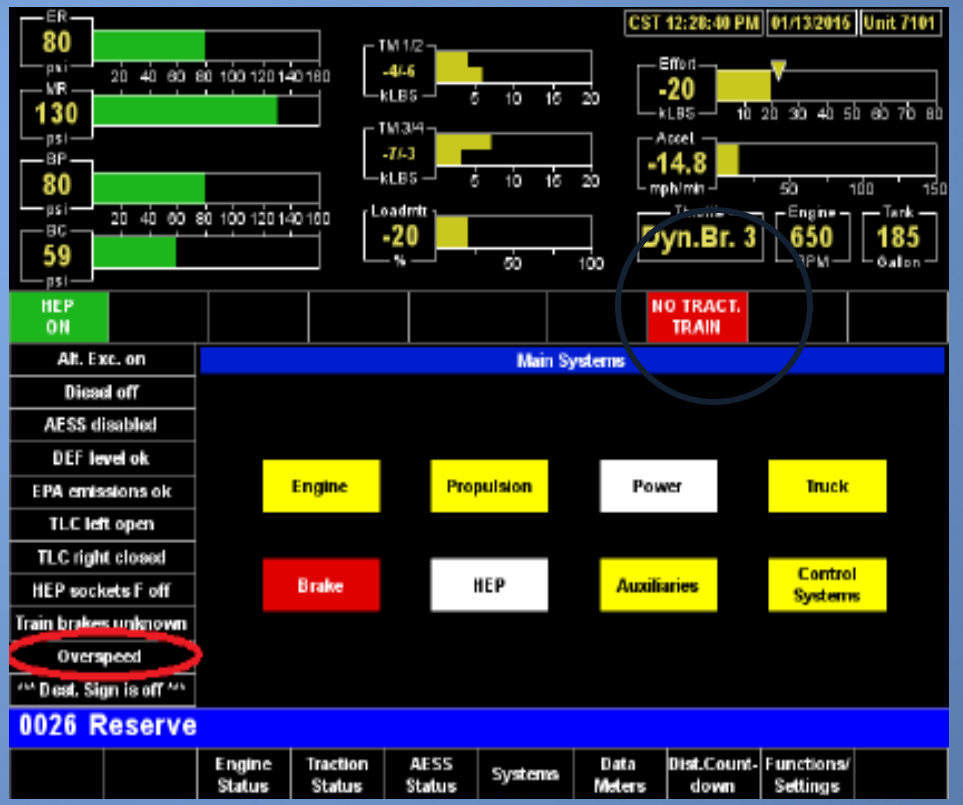
Safety Issue: Qualifying on New Territory

- Engineer did not observe critical signs
- Training
  - Observation rides
    - All taken at night
  - Throttle time
    - 3 total trips (2 north, 1 south)

Safety Issue: New Equipment Familiarization

- Engineer not completely familiar with locomotive features
- Training
  - Classroom
  - Qualification trips
  - Not exposed to overspeed alarm

Control Screens and Overspeed Alarm



NTSB

Safety Issue: Systematic Training

- Formalize approach to training
  - Identify and address all challenges
    - New equipment, territory, limited combined experience
  - Devise strategic plan

Safety Issue: Maximize Crew Resources

- Trip had new challenges for both crewmembers
- Need for active participation even from inexperienced crewmembers
- Apply Crew Resource Management (CRM) principles:
  - Help identify signs; recognize clues that safety may be compromised; intervene if necessary

Safety Issue: Enhanced Signage

Advance Warning Sign – 2 miles from curve

NTSB

Enhanced Signage

- Greater advantage to freight trains than passenger trains
- Supplemental signs / plaques
- Safety recommendation proposed

National Transportation Safety Board

National Transportation Safety Board

System Safety

Ryan J. Frigo

Overview

- Washington State Department of Transportation (WSDOT)
- Sound Transit
- Amtrak
- Federal Railroad Administration (FRA)

Operations Planning

- Sounder Commuter Rail Timetable
  - Timetable #1 (2015)
    - Crew focus zone at MP 3.4
  - Timetable #2 (2017)
    - Crew focus zone at MP 19.8 not included

Operations Planning

- Amtrak
  - Speed limit action plan
    - Crew focus zone
    - Did not include Lakewood subdivision

Sound Transit Project Safety Management Process

- Safety and Security Management Plan (SSMP)
  - Hazard management process for safety risk
    - Identify
    - Mitigate
    - Resolve

Preliminary Hazard Analysis

- Derailment in curves
  - Proposed mitigations (2015):
    - Ensure curves and speed limitations meet federal regulations
    - Develop inspection and maintenance procedures to meet federal regulations
    - Implement positive train control (PTC) [future]

Integrated Testing

- Prerevenue operations testing incomplete
  - Simulated operations at track speeds
  - Conducted under various operating conditions
- Operating hazard analysis incomplete
  - Validated the effectiveness of mitigations

Safety Certification Verification Report

- Certifiable items list (CIL)
  - Mitigations developed through hazard management
  - Final verification tool
  - Timetable as a procedural control

Safety Certification Verification Report

- No operating hazard analysis
- No prerevenue operations testing
- Hazard of overspeed derailment in curves erroneously classified as “completed accepted”

WSDOT Project Oversight

- Review of safety and security verification report
  - Limited role in safety oversight
  - Lack of formalized process to validate Sound Transit's safety certification activities

Federal Railroad Administration Oversight

- Grant oversight
  - SSMP required
- Safety oversight
  - No regulatory authority to approve or require changes to an SSMP
  - 34 field and compliance inspections
  - Missed opportunity

Amtrak Responsibility

- Operations on host railroads
  - Traditional acceptance of risk
- Risk assessments on host railroads
  - Proactive management of risk

Amtrak Safety Management

- System safety program plan
- Safety management system
  - National implementation
  - Beyond current minimum standards

Federal Railroad Administration System Safety Plan

- Failure of FRA to issue final rule
  - Six extensions since 2016
  - Continued postponement has led to delayed safety improvements

Summary

- Inconsistent permanent speed reduction location mitigations
- Coordination of prerevenue activities
- Initiation of operations prior to the completion of PTC
- Use of out-of-date operating documents
- Acceptance of high risk
- Continued delay to Part 270

National Transportation Safety Board

National Transportation Safety Board

Crashworthiness of Talgo Series VI Passenger Trainset

Michael Hiller

Overview

- Overview of the derailment kinematics
- Discussion of severely damaged cars and released rolling assemblies
- Talgo Series VI / crashworthiness design
- US passenger equipment safety requirements
- Grandfathering the Talgo Series VI
- Performance
- Safety issues

WDTX 1402(1)	AMTK 7903(2)	AMTK 7454(3)	AMTK 7554(4)	AMTK 7804(5)	AMTK 7303(6)	AMTK 7504(7)	AMTK 7424(8)	AMTK 7423(9)	AMTK 7422(10)	AMTK 7421(11)	AMTK 7420(12)	AMTK 7102(13)	AMTK 181(14)

NTSB

Damage Description-AMTK 7424 (8)

NTSB

Damage Description-AMTK 7504 (7)

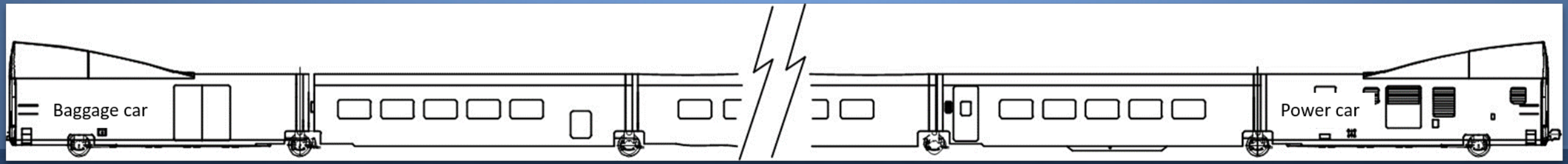
NTSB

Rolling Assembly Detachment

NTSB

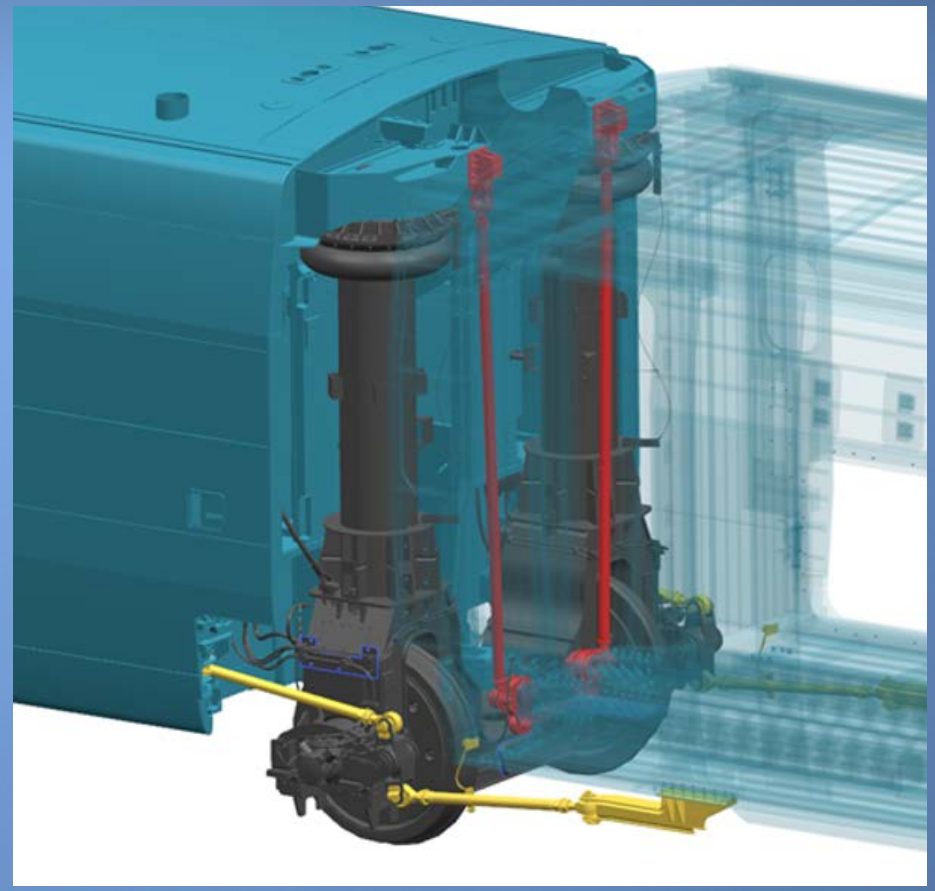
Talgo Series VI

- Talgo, Inc. (Talgo Series VI)
- Introduced in the US for service in WA, 1998
- Introduced into service before CFR Part 238, Passenger Equipment Safety Standards
- Semi-permanently coupled to adjacent cars
- One rolling assembly between each car except the baggage car



Talgo Series VI

- Wheels mounted in a frame (rolling assembly)
- Towers include air suspension at top
- Rolling assembly attached to one end of the car
- Adjacent car is attached with weight bearing bars
- Guidance bars are primary attachment to the car body



Talgo Series VI Crashworthiness Design

- Designed to UIC-566, January 1990
- Static end strength 450,000 lbs.
- No structural strength requirement for anti-collision pillars at the car ends
- No collision or corner post on individual passenger cars

US Crashworthiness Passenger Safety Requirements 1999

- Static end strength-800,000 lbs.
- Full height collision posts
- Full height corner posts
- Anti-climbing mechanism
- Truck to carbody retention strength
- Car to car coupler strength

US Crashworthiness Passenger Safety Requirements 1999

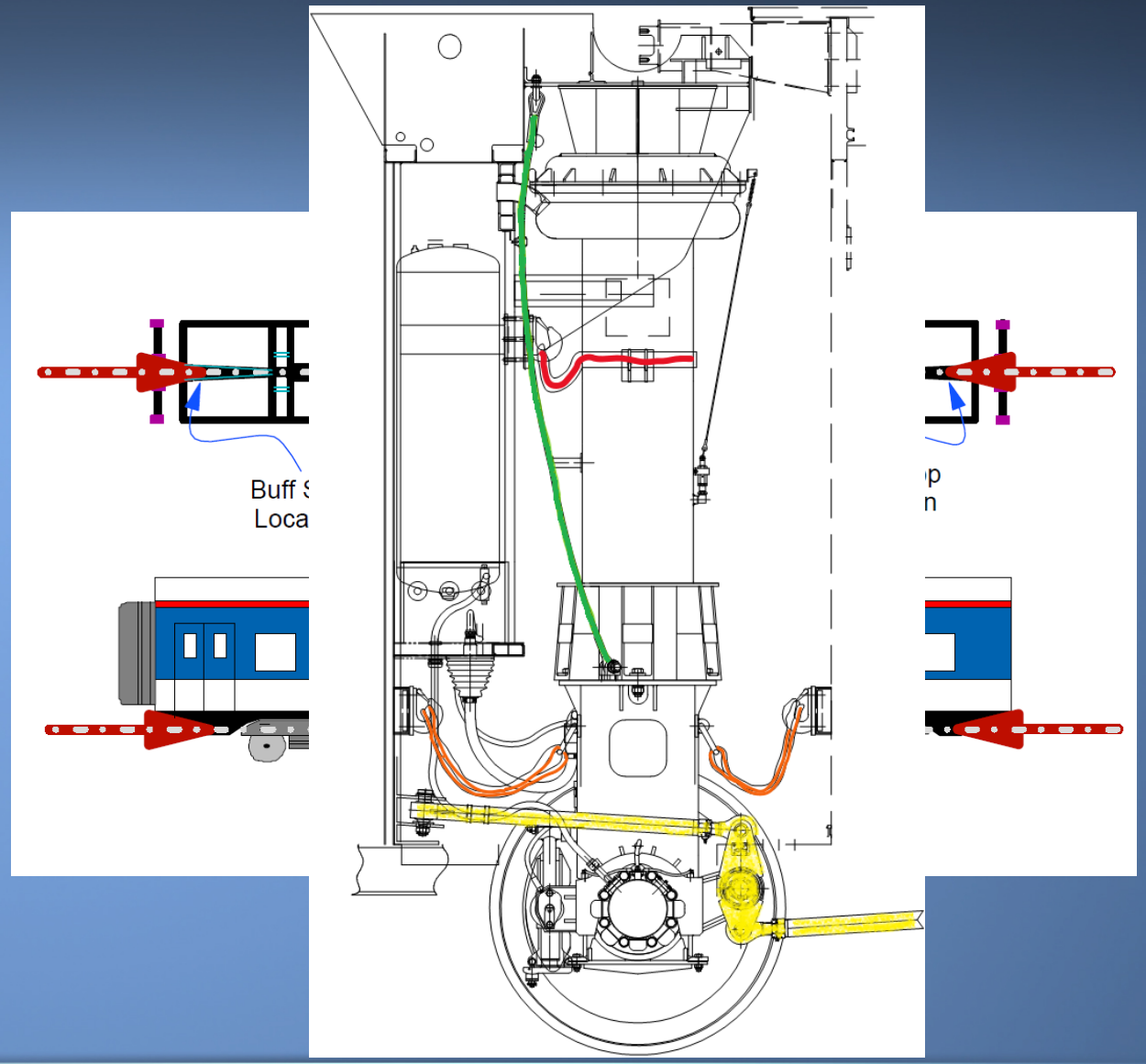
- FRA concerned with European passenger equipment structural standards
- Codifying assured high level of safety

Title 49 CFR 238.203(d) Grandfathering

- Permitted non-compliant equipment for passenger service
- Petition required (summarized)
  - Drawings
  - Specifications
  - Engineering analysis

FRA's Grandfathering Approval

- Amtrak petitioned the FRA for approval
- Preliminary approval in September 2000
- Selected conditions required:
  - Install safety cables between cars
  - Install safety cables on rolling assembly tower assemblies



FRA's Grandfathering Approval

- In the public interest and consistent with railroad safety
- Ensure adequate compatibility among units in the general railway system
- Concerned with performance in high energy event
  - Articulated connections were expected to fail
  - Unsupported car bodies fall to track with unknown result
  - Greater lateral displacement than conventional equipment

Performance of the Talgo Series VI

- Failure of the articulated connection in a high energy event
- Complex and uncontrolled behavior and secondary collisions with surrounding terrain with severe results
- Rolling assemblies prone to separation after the articulated coupler fails

Safety Issues

- Talgo Series VI trainset does not provide adequate protections to passengers in a high energy event
- Talgo Series VI trainset lacks structural protections proven to preserve survivable space
- Grandfathering is not in the public interest or consistent with railroad safety

National Transportation Safety Board

National Transportation Safety Board

Survival Factors

Sheryl Harley

Overview

- Train occupancy and injury
- Occupant protection-compartmentalization
- Seat rotation and seat latching mechanism
- Emergency lighting/HPPL signage
- Highway user injuries and causation
- Emergency response-communications

Train Occupants

- Total number of occupants: crew and passengers 83
- Injuries
  - Fatal 3
  - Serious 32
  - Minor 10
  - Not injured 31
  - Injury Severity Unknown 7
- Ejections
  - Full 7
  - Partial 3

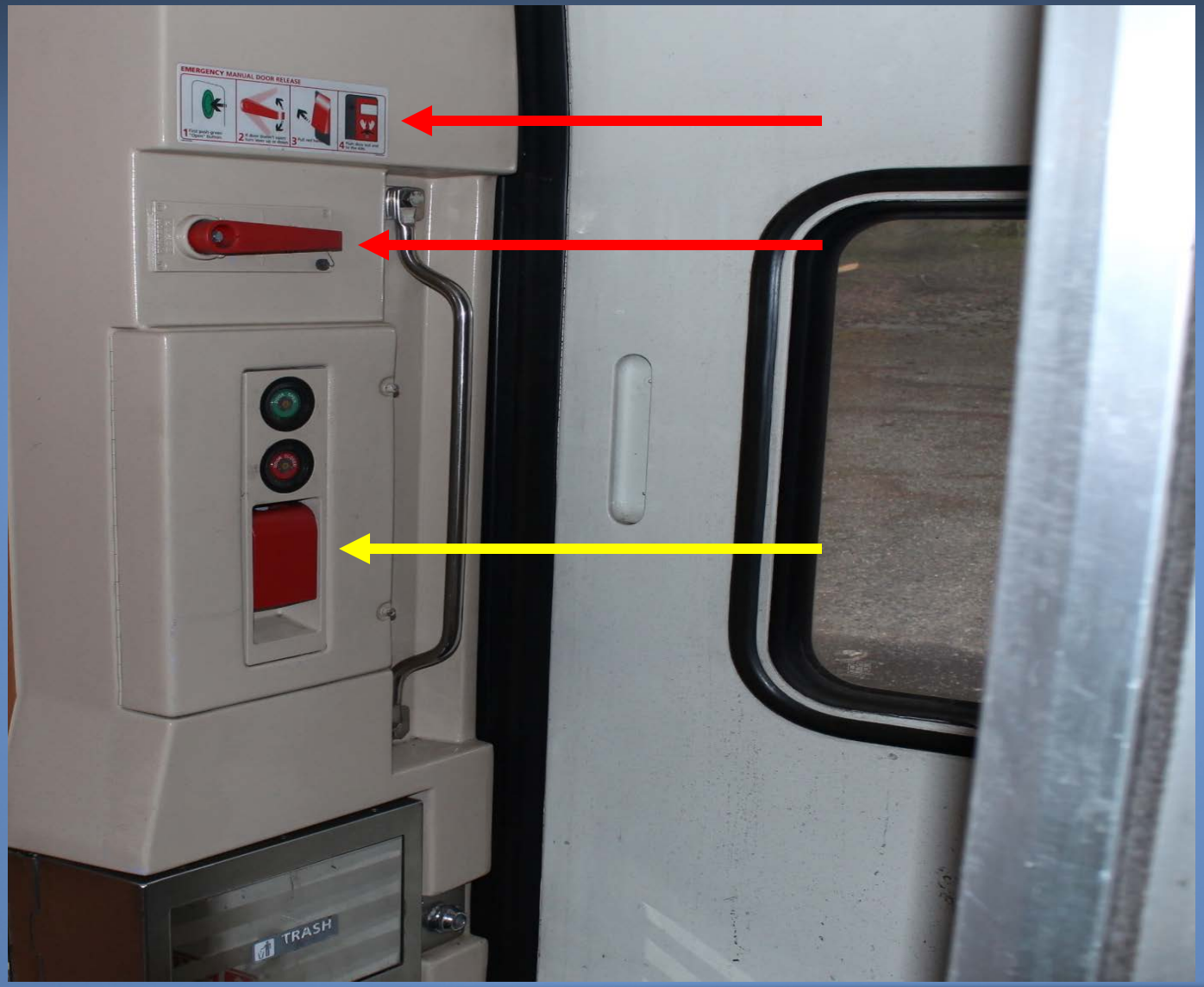
Occupant Protection

Compartmentalization and Seat Securement

NTSB

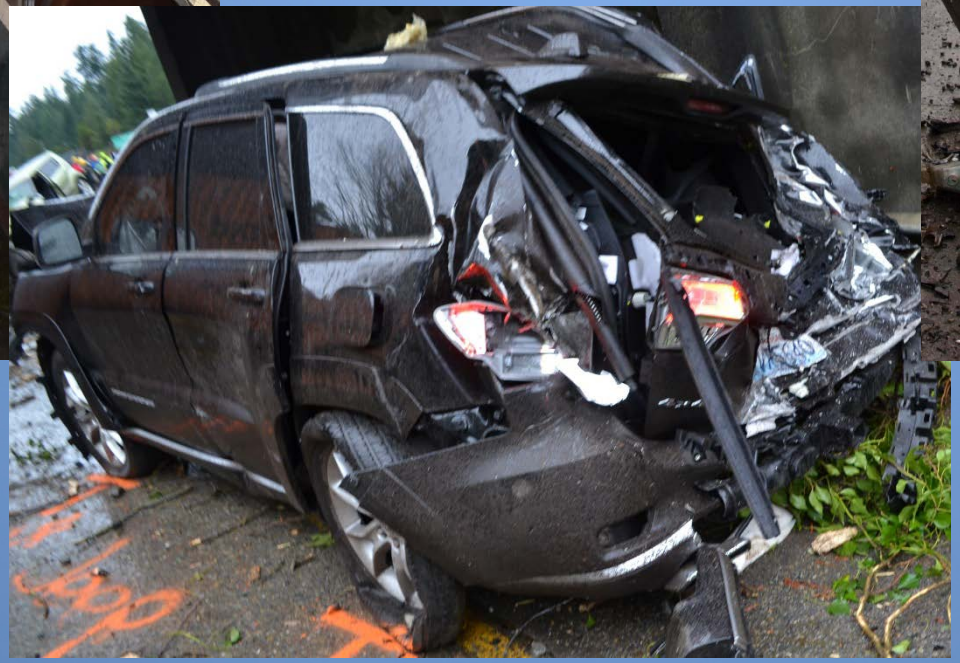
Compartmentalization and Seat Securement

Emergency Lighting and Signage



NTSB

Highway Users



Highway Users

- Vehicles involved 8
  - 2 Truck tractor in combination with semi-trailers
  - 6 passenger cars
- Occupants in vehicles 10
- Injuries
  - Serious 2
  - Minor 2
  - Not Injured 4
  - Injury Severity Unknown 2

Emergency Response

NTSB

Emergency Response

- Fire/Rescue-EMS Agencies
  - Joint Base Lewis McChord
  - Pierce County Fire Department
  - Thurston County Fire Department
  - EMS - Madigan Army Hospital, American Medical Response and Faulk Ambulance Services
- Law Enforcement Agencies
  - Pierce County Sheriff's Department
  - Lakewood City Police Department
  - DuPont Police Department
  - Washington State Patrol
  - Steilacoom Police Department
  - Puyallup Police Department
- Emergency Management Agencies
  - Pierce County Emergency Management Agency
  - Pierce County Incident Management Team

Emergency Response Operations

- Agency Communications Center and Operating Frequency
  - JBLM- DoD radio frequency 450 MHz
  - Fire/Rescue and Law Enforcement 800 MHz
  - Pierce County Emergency Management Agency 700 MHz
- Incident Communications
  - Radio frequency incompatibility and lack of interoperability
  - Required face to face and runners to deliver communications
  - Effected timely and efficient communications between agencies

Summary

- Effectiveness of compartmentalization for occupant protection
- Securement of train seats designed to rotate
- Development of procedures for the safe transportation of children in car seats
- Adequacy of emergency lighting
- Improvement to interoperability of communications between DoD and civilian agencies

National Transportation Safety Board

Figure 6. Risk Assessment Matrix

HAZARD RISK INDICES					
Frequency of Occurrence	Hazard Category				
	1 Catastrophic	2 Critical	3 Major	4 Marginal	5 Insignificant
(A) Frequent	1A	2A	3A	4A	5A
(B) Probable	1B	2B	3B	4B	5B
(C) Occasional	1C	2C	3C	4C	5C
(D) Remote	1D	2D	3D	4D	5D
(E) Improbable	1E	2E	3E	4E	5E

Each hazard category in the Risk Assessment Matrix in *Table 5* requires a specific level of action. *Table 5* represents the decision authority for each category.

Table 5: Hazard Decision Matrix

Hazard Risk Index	Risk Decision Criteria
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable (Un)
1D, 2C, 2D, 3B, 3C, 4A, 4B, 5A	Undesirable (Ud) ELTR/SOAP concurrence required
1E, 2E, 3D, 3E, 4C, 4D, 5B, 5C	Acceptable with SSDCC review (Ar)
4E, 5D, 5E	Acceptable without further review (Ac)

NTSB

NTSB