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Motorcoach Collision With Crash Attenuator
in Gore Area, US Highway 101,
San Jose, California

January 19, 2016



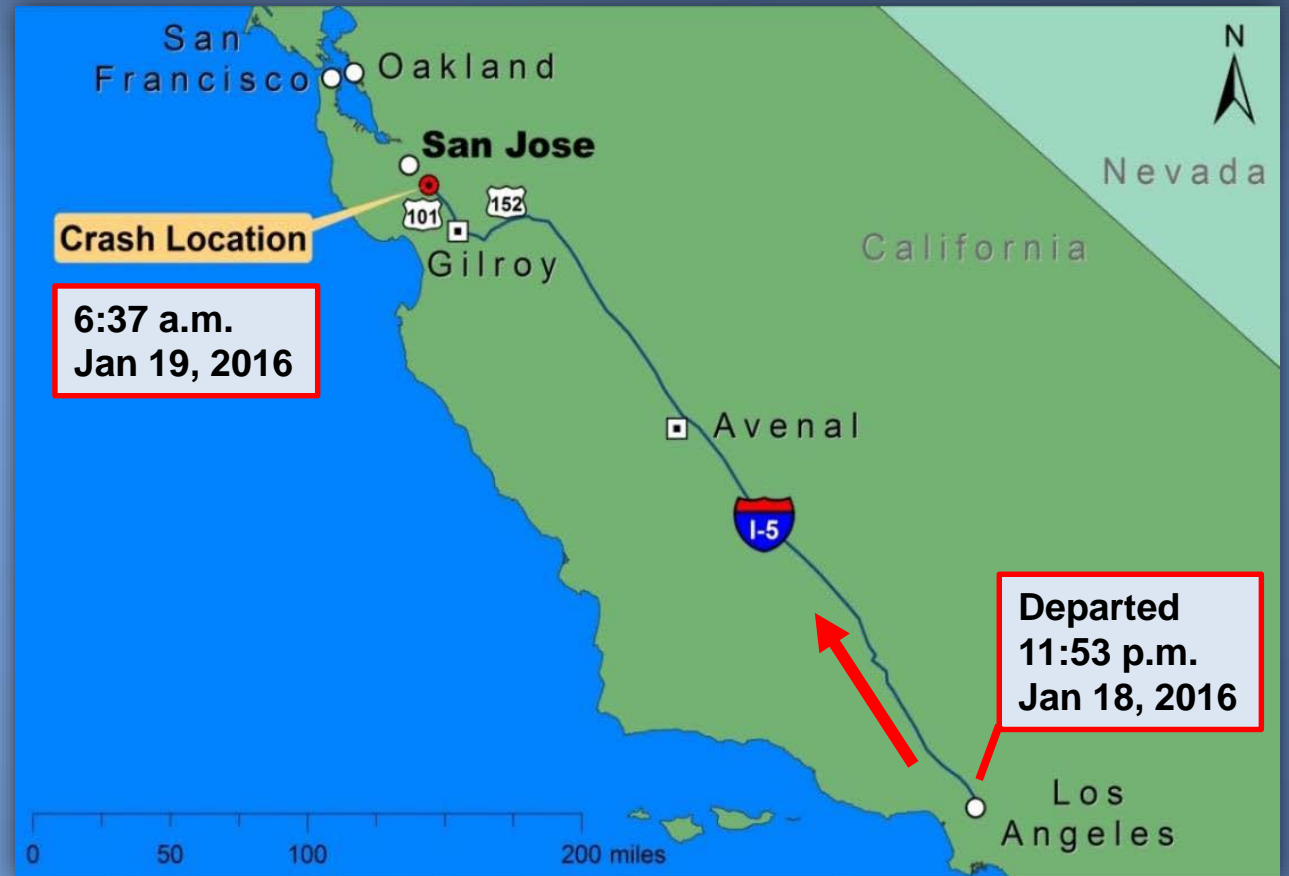
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Motorcoach Collision With Crash Attenuator San Jose, CA

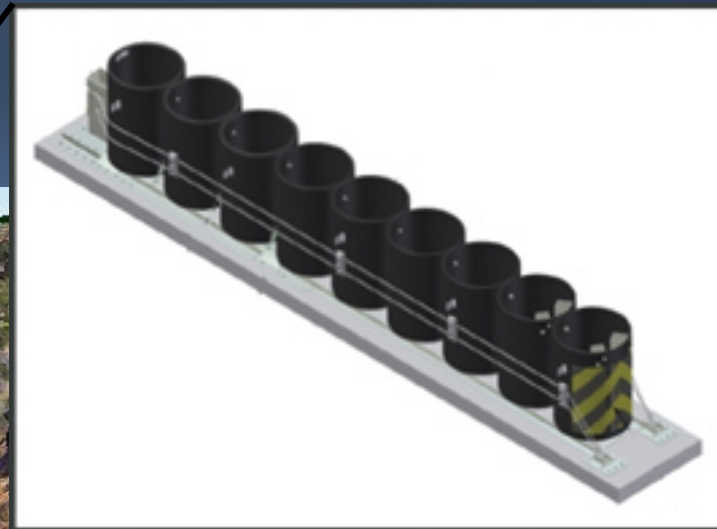
Jennifer Morrison
Investigator-in-Charge

Crash Overview

- Greyhound bus
 - Driver
 - 21 passengers
- Northbound from Los Angeles
- Crashed just south of San Jose
- Dark, rainy, windy



Crash Location



Source: Google Earth image dated March 28, 2015

Crash Location



Source: Google Earth image dated March 28, 2015

Final Rest



Source: California Highway Patrol

Postcrash Damage



On-Scene Staff

- David Rayburn, Highway Factors
- Rafael Marshall, PhD, Human Performance
- Michael Fox, Motor Carrier Operations
- Shawn Currie, Motor Carrier Operations
- Ronald Kaminski, Survival Factors
- David Pereira, Vehicle Factors
- Kristin Poland, PhD, Scene Scanning
- George Haralampopoulos, Recorders
- Jennifer Morrison, Investigator-in-Charge

Report Development Staff

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- Debbie Stocker, Writer-Editor
- Julie Perrot, Safety Recommendations
- Don Eick, Meteorology
- Christy Spangler, Graphics
- Ivan Cheung, PhD, Mapping Graphics
- Dr. Nick Webster, MD, Medical Factors
- Edward Kendall, Legal Counsel
- Katy Chisom, Transportation Disaster Assistance
- Eric Weiss, Media Relations

Parties to Investigation

- Federal Highway Administration
- Federal Motor Carrier Safety Administration
- California Highway Patrol
- Santa Clara Valley Transportation Authority
- Greyhound Lines, Inc.
- Trinity Industries, Inc.

Safety Issues

- Repair of traffic safety devices
- Signage and roadway markings
- Driver risk management
- Maintenance and use of passenger restraints on motorcoaches
- Collision avoidance systems



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Highway Factors and Traffic Guidance

David Rayburn

Overview

- Traffic metrics
- Accident history
- Inadequacies
 - Maintenance of traffic safety devices
 - Gore delineation
 - Guide signage noncompliance

Traffic Metrics for US 101

- Average daily traffic: 142,000 vehicles
- Truck and bus traffic accounted for 8.5% or 12,000 trucks and buses per day
- Posted speed limit: 65 mph
- Average speed of all traffic near time of crash: 56.6 mph

Accident History

- 8 crashes at crash site since 2008
 - 5 involved another vehicle striking crash attenuator
- 5 crashes since 2014

Traffic Safety Devices: Repair

- Crash on December 6, 2015
 - A vehicle struck the crash attenuator and displaced the retroreflective object marker
- Repair
 - Cleared the crash site

Traffic Safety Devices: Repair

- Repair
 - Cleared the crash site
 - Reset the cylinders



Traffic Safety Devices: Repair

- Repair
 - Cleared the crash site
 - Reset the cylinders
 - Placed temporary barricades
 - Did not replace the retroreflective object marker



Traffic Safety Devices: Repair

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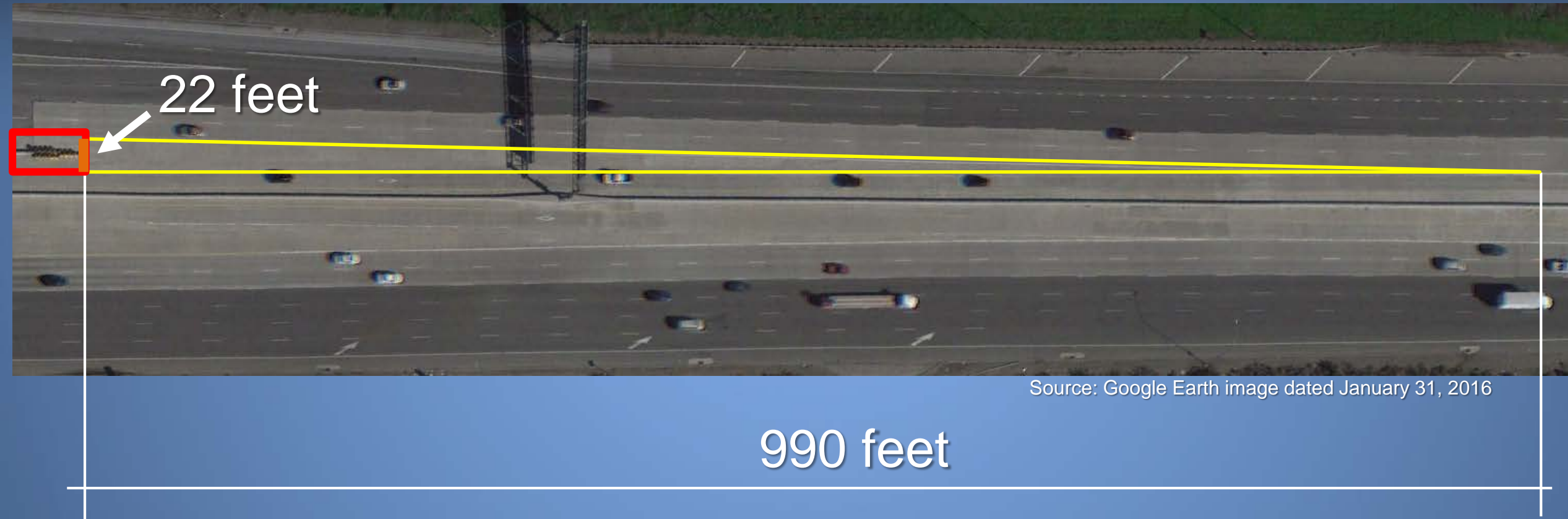
Traffic Safety Devices: Maintenance

- Caltrans policy requires clearing crash scene within 1 day
- Caltrans policy requires crash attenuators to be repaired within 7 days
- 44 days later, retroreflective object marker was still missing
- Unknown when temporary barriers were displaced

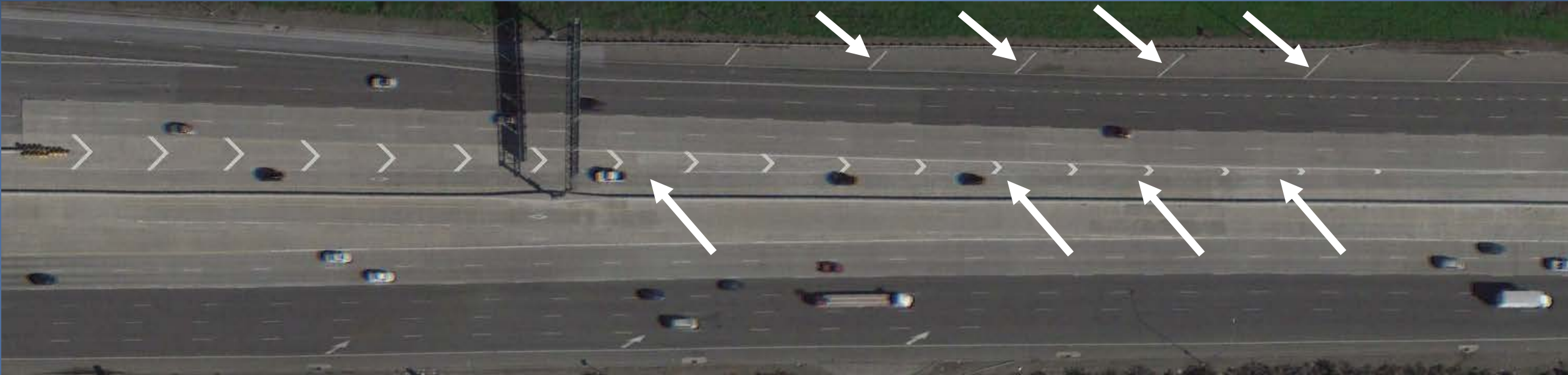
Traffic Safety Devices: Work Orders

- Integrated maintenance management system
 - Tracks initiation of work order
 - Does not indicate status of repair
 - Does not denote special orders
- Repair checklist for proprietary devices
 - Was never initiated

Gore Delineation

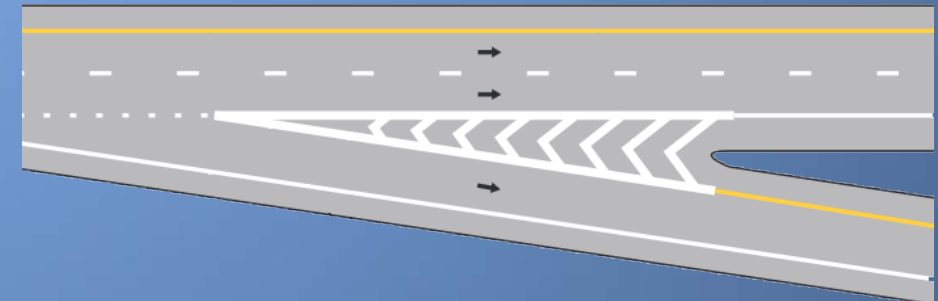
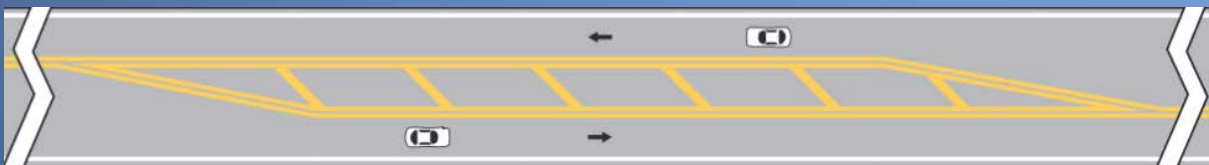


Gore Delineation



Source: Google Earth image dated January 31, 2016

- MUTCD guidance on gore delineation

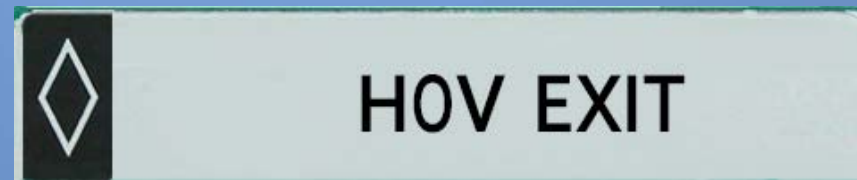


Guide Signage

- Three guide signs for left HOV exit
 - 2 advance signs and 1 exit direction sign
- At time of installation in 2008, signs were compliant with MUTCD standards
- At time of crash, signs were out of compliance with MUTCD standards

Guide Signage Compliance

- Recommendations from Atlanta, GA
- MUTCD revision in 2009
 - Requirement for left exit plaque; compliance date of December 31, 2014
 - Requirement for full border indicating HOV lane or exit; compliance required at end of useful life



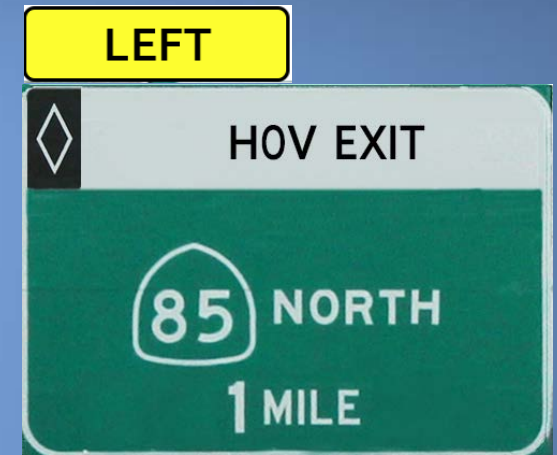
Guide Signage Compliance



Current sign
- out of compliance -



Compliant



Compliant, new

Summary

- Inadequate maintenance of safety devices
- Inadequate gore delineation
- Use of noncompliant guide signage



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Human Performance and Driver Perception

Rafael Marshall

Overview

- Bus driver background
- Factors that contributed to driver error
 - Incorrect driver expectations
 - Reduced visibility
 - Improper roadway signage and markings

Driver Background

- Experienced and properly licensed
 - 28 years driving for Greyhound
 - Class “B” commercial license
 - Passenger endorsement
 - Corrective lens restriction
 - Medical certificate good for 1 year due to medical conditions

Driver Perception

- Believed that gore was a travel lane
- Stayed in gore for 8 seconds before crash

Exclusions

- Licensure
- Overall driving experience
- Drug or alcohol use
- In-vehicle distractions
- Fatigue
- Medical condition

Driver Expectations: Route Familiarity



Source: Google Earth image dated January 26, 2016

Driver Expectations: Previous Trip



Source: Google Earth image dated March 28, 2015

Driving and Visibility Conditions

- Darkness
- Moderate/heavy traffic
- Moderate/heavy rain
- 28-mph wind gusts
- Poorly maintained pavement markings
- Absence of retroreflective object markers





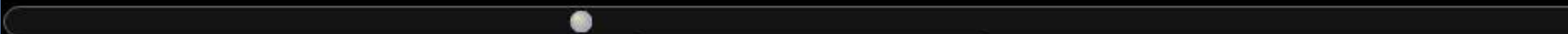
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LAT +0.00

Time -3.00

57 MPH GPS

Switch View



Export Video

Collapse Video



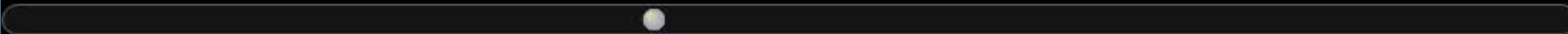
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LAT -0.02

Time -2.00

57 MPH GPS

Switch View



Export Video

Collapse Video



FWD -0.01

LAT +0.00

Time -1.00

56 MPH GPS

Switch View



Export Video

Collapse Video

Summary

- Bus driver may have expected HOV exit to have two travel lanes
- Bus driver would not have followed an incorrect travel path
 - Had visibility conditions been better
 - Had gore and crash attenuator been properly delineated



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Motor Carrier Factors and Managing Driver Risk

Michael Fox

Overview

- Motor carrier oversight and driver risk management issues:
 - Personnel files incomplete and missing data
 - Accident driver's disciplinary record
 - Greyhound had monitoring systems, but no procedures to maximize effectiveness

Greyhound Lines Inc.

- Largest motorcoach company in US and Canada
- Based in Dallas, TX
- 82 terminals
- 1,200 buses
- 792 fixed US routes
- Employs 2,200 drivers



Greyhound Driver Files

- Employed since 1988, 28 years
- Paper system kept at Los Angeles terminal
- Files incomplete and missing 5 years of data
- Prevented timely and adequate oversight
- Need to modernize record keeping to better manage risk

Driver Disciplinary Record

- From 2001 – 2015:
 - 27 disciplinary actions
 - 4 preventable accidents
 - 19 suspensions totaling 58 days
 - Repeat infractions
 - Reprimanded 5 times for hours-of-service violations
 - Suspended 9 times for speeding violations
- No means to track or assess driver performance due to record keeping limitations

Greyhound Risk Management Systems

- Recommendations from Burnt Cabins, PA
- Fatigue management program
- Cadec fleet management system
- DriveCam system introduced to address at-risk behavior:
 - Driver had 18 critical events
 - On Top 20 list for worst offenders

Managing Driver Risk

- Greyhound
 - No policy to address repeat infractions
 - No established threshold for suspensions before termination
- Industry best practices
 - Risk assessments
 - Established thresholds

Summary

- Files incomplete and missing data
- Extensive disciplinary record
- Greyhound had proactive monitoring systems, but no policies to maximize effectiveness



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Survival Factors and Occupant Protection

Ronald Kaminski

Overview

- Seat belt use by bus passengers
- Pretrip safety briefings not required
- Seat belt use laws

Occupant Injuries

- Driver was partially ejected, lap belted only, sustained minor injuries
- Passengers
 - 2 fatal, ejected
 - 2 serious
 - 11 minor
 - 3 not injured, 2 of whom were belted

3-D Laser Scan Video



Seat Belt Use



- Seat belts were available
- NHTSA statistics
 - 75% of ejected are fatalities
 - Restraints reduce fatalities by 77%
- Improvements to maximize benefits
 - Maintenance and inspection
 - Pretrip safety briefings

Seat Belt Maintenance and Inspection



Pretrip Safety Briefings

- Pretrip briefing to inform and educate
- Originally recommended in 1999
- Recommendation from Orland, CA
 - Added printed instructions to reinforce seat belt use
- Greyhound pretrip safety briefings
 - Script developed
 - Not required

Seat Belts Use Laws

- Primary enforcement
 - Increased usage
 - 34 states with primary enforcement, average use rate of 92 percent (vs 83 percent)
- NTSB has advocated use of seat belts for 50 years
- Recommendations from Davis, OK
- California considering seat belt enforcement bill

Summary

- Increasing seat belt use
- Requirement for pretrip safety briefings
- Primary enforcement of mandatory seat belt use laws for all vehicles



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Vehicle Factors and Collision Avoidance Systems

David Pereira

Overview

- Mechanical systems inspection
- Collision avoidance testing
- Collision avoidance history

Exclusions

- Major mechanical systems inspected, excluded
 - Steering
 - Suspension
 - Brake
 - Electrical
 - Tires & wheels



Commercial Vehicle Collision Avoidance Systems

- 2014 motorcoach not equipped with collision avoidance system
- Collision avoidance systems
 - Not required
 - No performance standards
- About 20% of Greyhound buses equipped with collision avoidance system

Collision Avoidance Testing

- Testing conducted at Transportation Research Center Inc., East Liberty, Ohio
 - Greyhound
 - Meritor WABCO
 - Trinity Industries, Inc.



Collision Avoidance Testing

- Test findings:
 - 18 of 19 trials detected crash attenuator
 - Technology capable of detecting stationary hazard
 - Collision avoidance system effective in preventing or mitigating crash severity

Recommendation History

- Collision avoidance systems are life-saving technologies
- NTSB has advocated for collision avoidance technologies for more than 20 years
- 2015 Special Investigation Report
- Most Wanted List

Summary

- Mechanical condition of bus was excluded as contributing to collision
- Collision avoidance technology could have alerted driver of forward hazard and mitigated severity of crash



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