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Characteristics of Single-Unit Truck Accidents Resulting in Injuries and Deaths: Study Overview

James Ritter

Office of Research and Engineering

Single-Unit Truck Characteristics

- Single-Unit Trucks
 - Cargo area typically does not detach from cab with engine
 - All axles are on the same frame
- DOT defines large trucks as those with gross vehicle weight ratings (GVWR) over 10,000 pounds
- This study examined single-unit trucks



Tractor-Trailer Characteristics

- Consist of a truck-tractor (a cab with engine) that pulls a semi-trailer (a trailer with no front axle)
- Separate frames for tractor and trailer
- Trailers carry cargo and can be dropped off and picked up



Why NTSB Undertook This Study

- Accidents involving large trucks pose a high risk of fatalities to other road users
- Single-unit trucks are excluded from certain safety regulations applicable to tractor-trailers
 - Conspicuity treatments
 - Rear underride guards
- Prior research suggested that single-unit trucks were undercounted in fatal accident databases
- Scope of non-fatal injuries is not well-documented
 - Medical/societal costs of pain, suffering, disability

Single-Unit Trucks are Diverse



Single-Unit Trucks: Background Information

- 8.22 million single-unit trucks
- 110.7 billion miles traveled
- Less interstate travel than tractor-trailers
- More urban/suburban travel and intersection accidents than tractor-trailers
- Subject of previous NTSB recommendations

Research Aims

- Estimate accident outcomes
 - fatal injuries
 - non-fatal injuries
 - inpatient hospitalizations
 - emergency department visits
- Compare accident characteristics for single-unit trucks versus tractor-trailers
- Identify safety problems and vehicle safety countermeasures for single-unit trucks

Methods Overview

- Multiple databases provided a more complete picture
 - Included state data systems that link hospital records with police reports
- Staff developed program to decode vehicle identification numbers
- Study used advanced statistical methods to address missing data

Data Sources

- Crash Outcome Data Evaluation System (CODES) for five states
- Trucks in Fatal Accidents (TIFA)
- Fatality Analysis Reporting System (FARS)
- Large Truck Crash Causation Study (LTCCS)
- National Automotive Sampling System/General Estimates System (GES)
- Case studies

The Major Issues Identified

- Vulnerable road users
- Underride (side, rear, front)
- Conspicuity
- Collision avoidance technologies
- Data quality and availability
- Invalid driver's licenses

NTSB Staff

Office of Research and Engineering

Elisa Braver

Robert Dodd

Amanda Magruder

Michael Diavolikos

Barbara Czech

Ivan Cheung

Nathan Doble

Kristin Poland

Shane Lack

Christy Spangler

Office of Highway Safety

Robert Squire

Michael Fox

Organizations Providing Data and Assistance

- National Highway Traffic Safety Administration (NHTSA)
- The University of Utah CODES Technical Center
- The National Study Center for Trauma & EMS at the University of Maryland, Baltimore
- Delaware Department of Health & Social Services
- Minnesota Department of Health
- Nebraska Department of Health & Human Services

Presentations

- Data Sources and Methods
- Analyses of Safety Issues



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Methods, Data Sources, and Data Issues

Ivan Cheung, Ph.D.

Office of Research and Engineering

Overview

- Overall approach and methods
- Data sources
- Topics
 - Misclassification of single-unit trucks
 - Commercial driver's licenses
 - Data-related issues
 - Location-based information and GIS

Analytical Methods

- Multiple data sources
- Descriptive statistics
- National estimates
- Comparison between single-unit truck and tractor-trailer accidents
- Case reviews

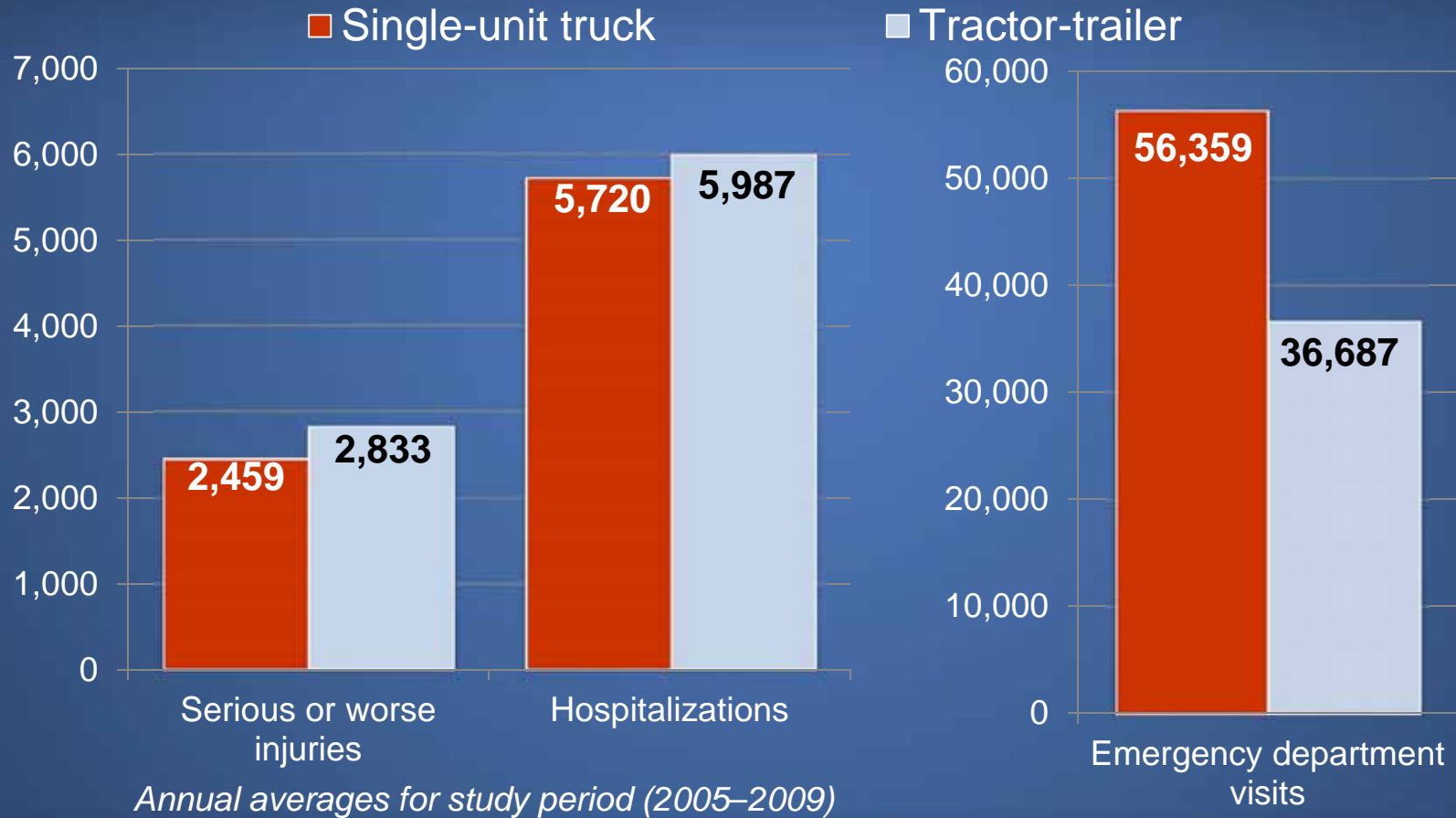
Data Sources

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Data Source: CODES

- Crash Outcome Data Evaluation System
 - Detailed medical outcomes
 - injury severity
 - hospitalizations
 - emergency department visits
 - Linked to police accident reports

Estimated Annual Injury Outcomes by Involved Large Truck Type, CODES



CODES Data Underestimates Injury Outcomes

- CODES data and derived national estimates underestimate the actual burden
 - e.g., about 10% of large trucks were of undefined types
- Best available data for non-fatal injuries and hospitalizations

Data Sources: FARS and TIFA

- Fatality Analysis Reporting System
 - a census of fatal motor vehicle accidents in the United States on public roads
- Trucks in Fatal Accidents
 - a supplement to FARS
 - improves the accuracy of FARS data on fatal large truck accidents
 - provides more information on large trucks, motor carriers, and accidents

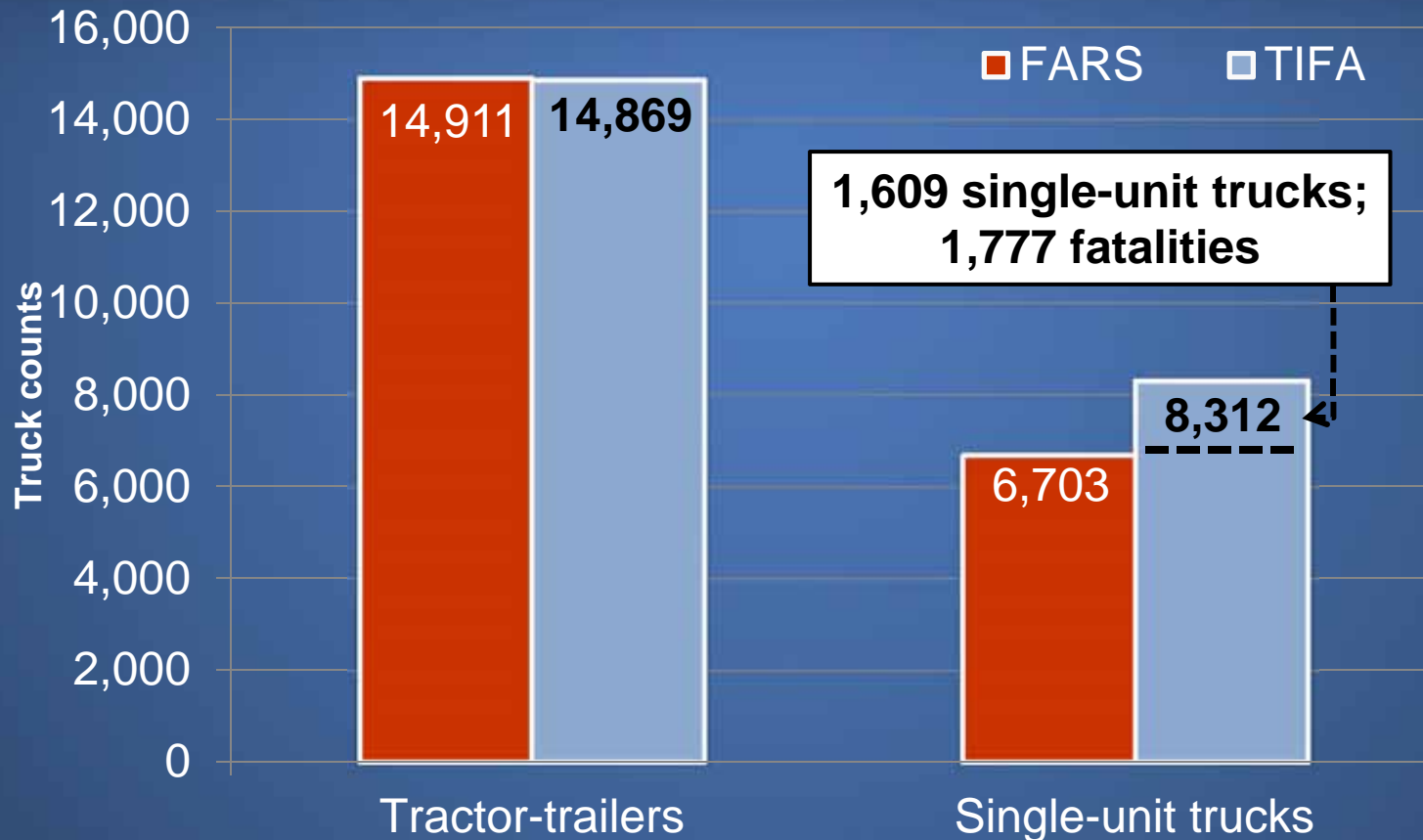
Vehicle Identification Number (VIN)

- Standardized 17-digit number
- VIN-derived information
 - Manufacturer, model year
 - Truck type
 - Gross Vehicle Weight Rating (GVWR)
- Collected in police accident reports
- Captured in databases

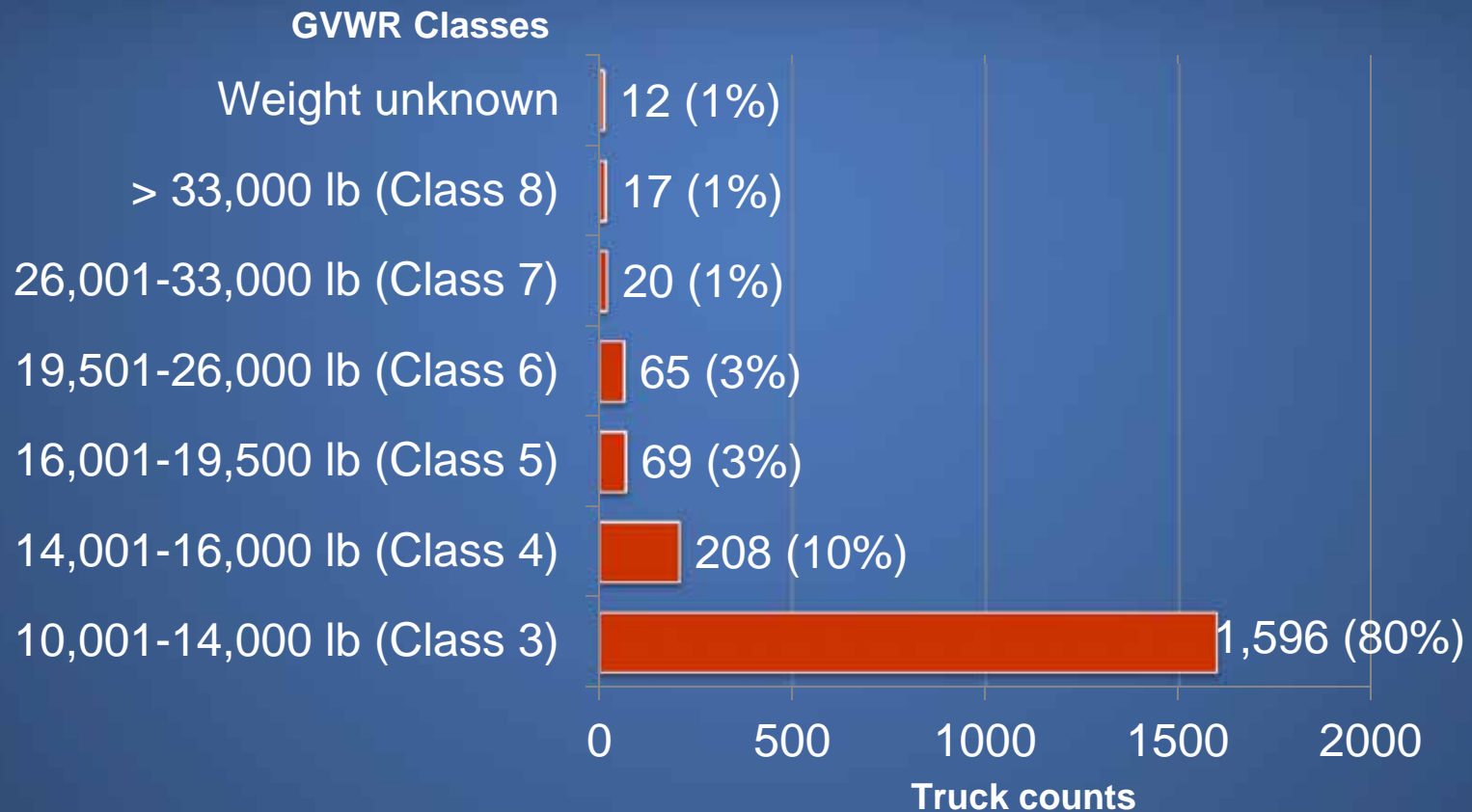
How FARS and States Classify Single-Unit Trucks

- Single-unit trucks in FARS are identified using
 - police reported vehicle body type
 - numbers of attached trailing units
- States use police-reported vehicle body type information

Truck Identification Differences, TIFA and FARS, 2005–2009



Single-Unit Trucks Misclassified as Passenger Vehicles in FARS, by GVWR



Data Source: LTCCS

- Large Truck Crash Causation Study
 - Detailed accident investigations, including photographs
 - Focus on specific safety issues and provided cases for expert review

Commercial Driver's Licenses (CDL) for Single-Unit Truck Drivers

- 5% of drivers in two-vehicle accidents were cited for not having a valid CDL (LTCCS, 2001–2003)
- 6% of drivers involved in fatal accidents had invalid licenses (TIFA, 2005–2009)

Data Source: GES

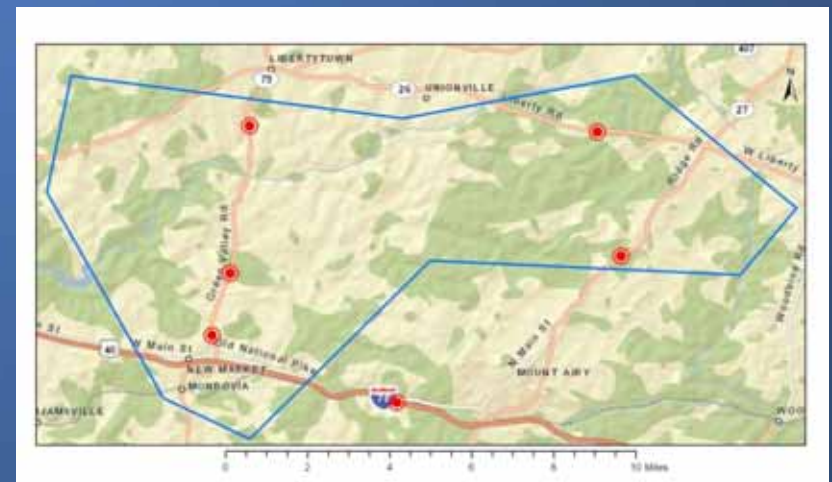
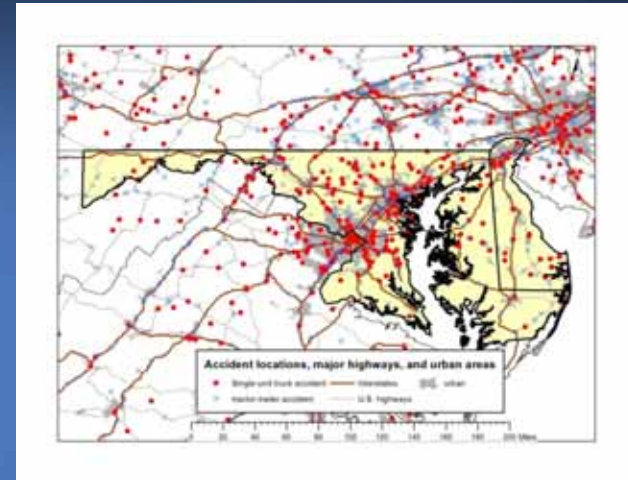
- National Automotive Sampling System/General Estimates System
 - Nationally representative sample
 - All severity levels
 - Provides national estimates of non-fatal injury by truck types

Data Source Summary

Data Source	National Scope	Detailed Injury Outcome	Accident Characteristics	Risk Ratio	Truck Misclassification
TIFA	✓		✓		✓
FARS	✓		✓		✓
GES	✓				
CODES	✓	✓	✓	✓	✓
LTCCS		✓	✓		

Potential Use of GIS and Location-based Data

- Location-based information is available in FARS
- No national location-based information for non-fatal accident database
- GIS helps illustrate certain safety issues, identify hotspots of accidents, and identify effective countermeasures



Annual Single-Unit Truck Accident Burden

Outcome	Involving Single-Unit Trucks
Fatalities	1,817
Serious or worse injuries	2,459
Hospitalizations	5,720
Emergency department visits	56,359

Annual averages for study period (2005–2009)



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Analyses of Safety Issues

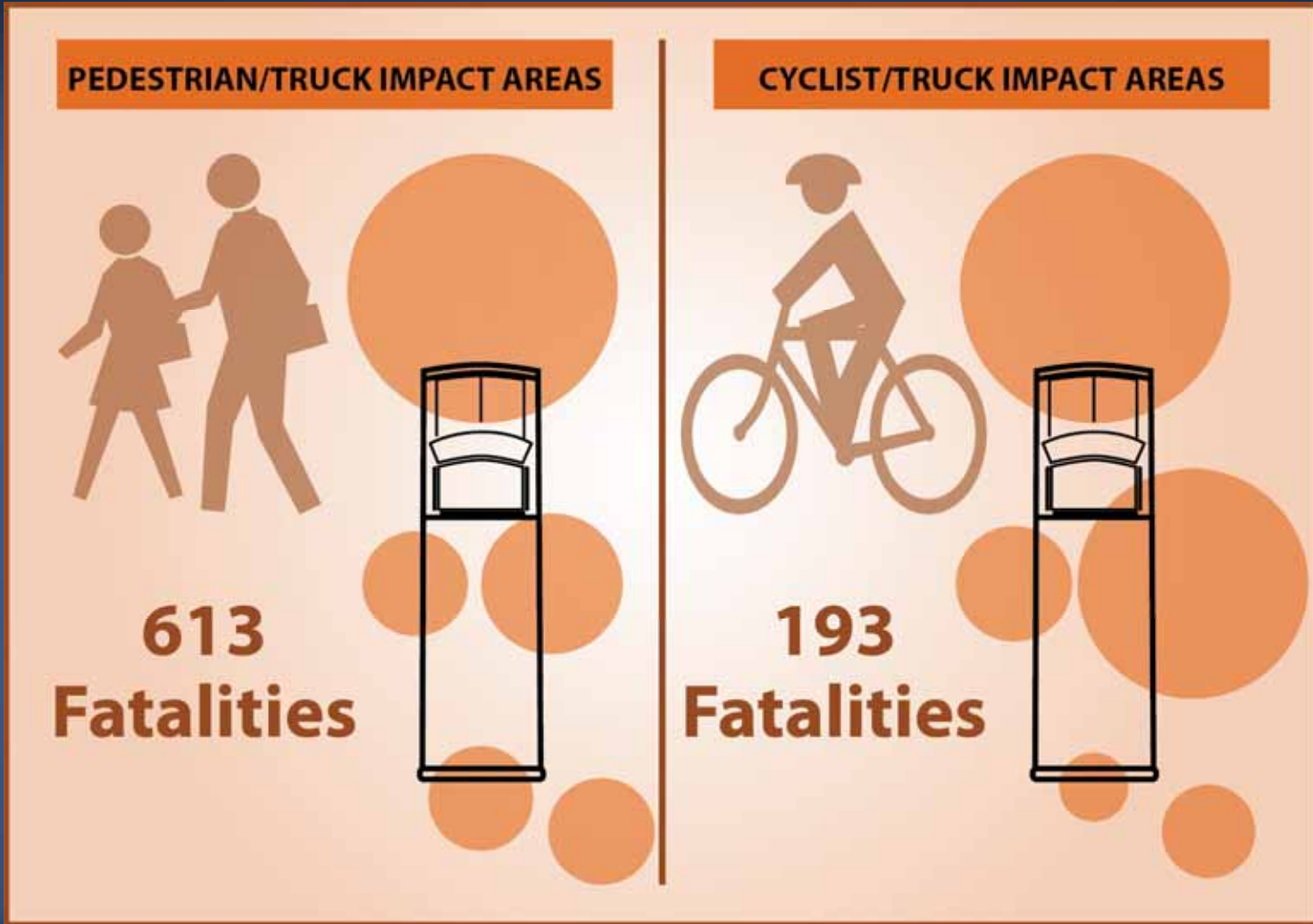
Elisa Braver, Ph.D.

Office of Research and Engineering

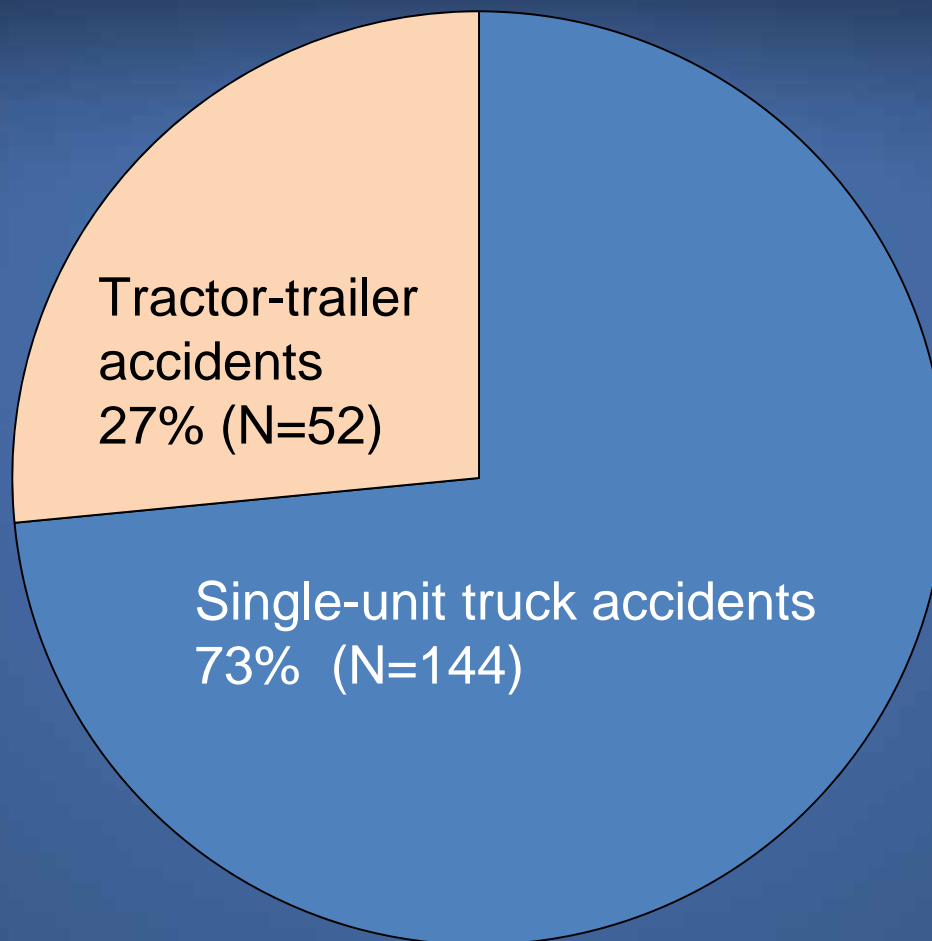
Overview of Safety Topics

- Pedestrians and cyclists (vulnerable road users)
- Underride collisions (side and rear)
- Conspicuity
- Previous NTSB recommendations
 - Front underride
 - Collision avoidance technologies

Fatalities, Single-Unit Trucks, TIFA, 2005–2009 (One-Vehicle Accidents)

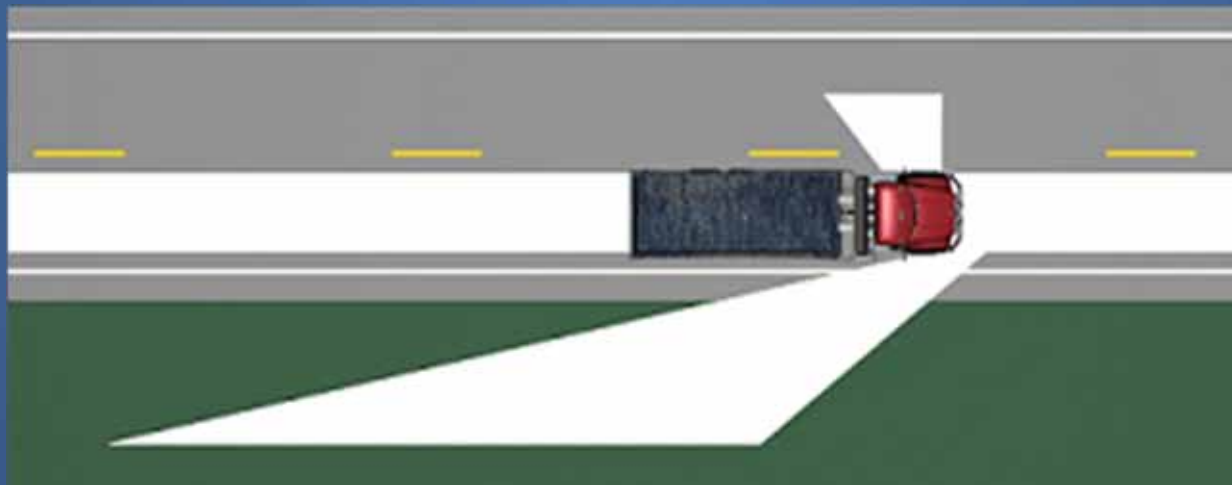


Annual Averages of Pedestrians and Cyclists in Large Truck Accidents, CODES



Vulnerable Road Users

Blind spots on a single-unit truck



NTSB, 2013

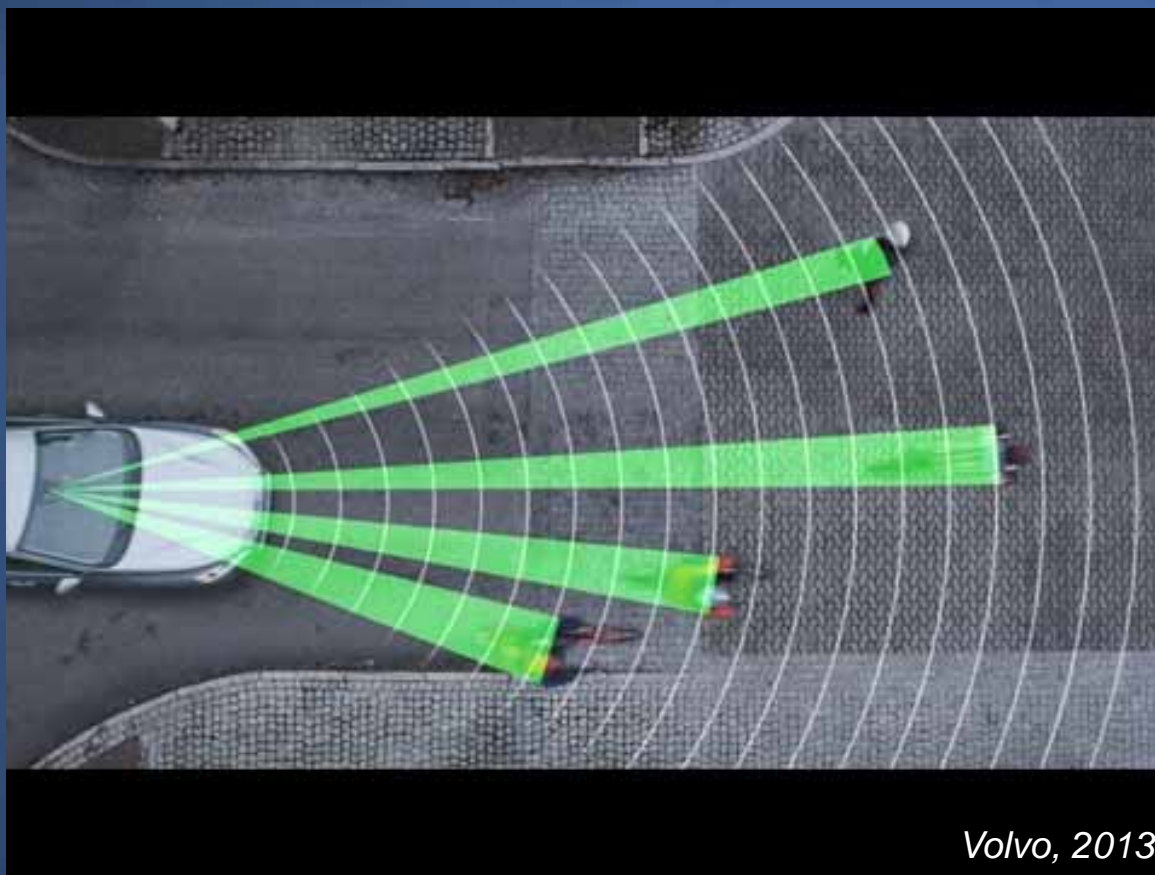
Vulnerable Road Users: Addressing Blind Spots

Simple, inexpensive technologies, such as enhanced mirrors (crossover convex and others)



Vulnerable Road Users: Addressing Blind Spots

Pedestrian and cyclist sensing technologies



Volvo, 2013

- Radar
- Camera(s)
- Automatic braking

Underride Collisions

- Passenger vehicles stop beneath a taller vehicle, such as a large truck
- Catastrophic intrusion can occur
- Underride can defeat safety features of passenger vehicles (airbags, crush space)

Single-Unit Truck Side Impacts

- Passenger vehicle collisions with the sides of single-unit trucks are common
 - Average of 810 two-vehicle collisions each year in 5 participating CODES states
- Rates of serious injury and hospitalization: twice as high for single-unit truck side impacts compared with all accident types

Side Underride

LTCCS Side Underride



- Underride occurred in about 50% of passenger vehicle collisions with the sides of single-unit trucks (in accidents resulting in death or injury)

Side Underride Guards



Kumar et al, 2009



Krone Safe Liner

Rear Underride Accident



Rear Underride

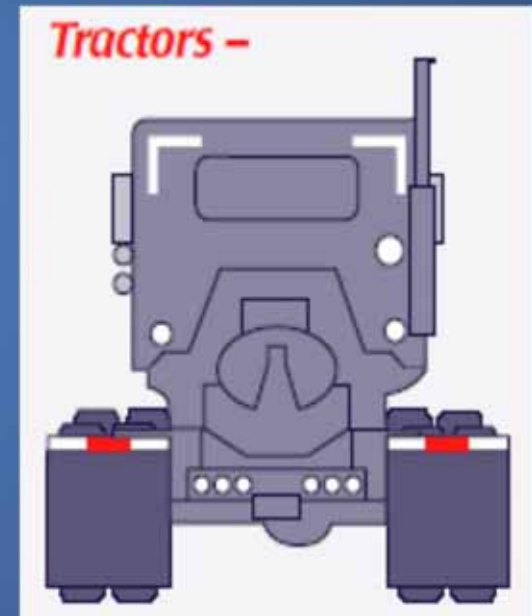
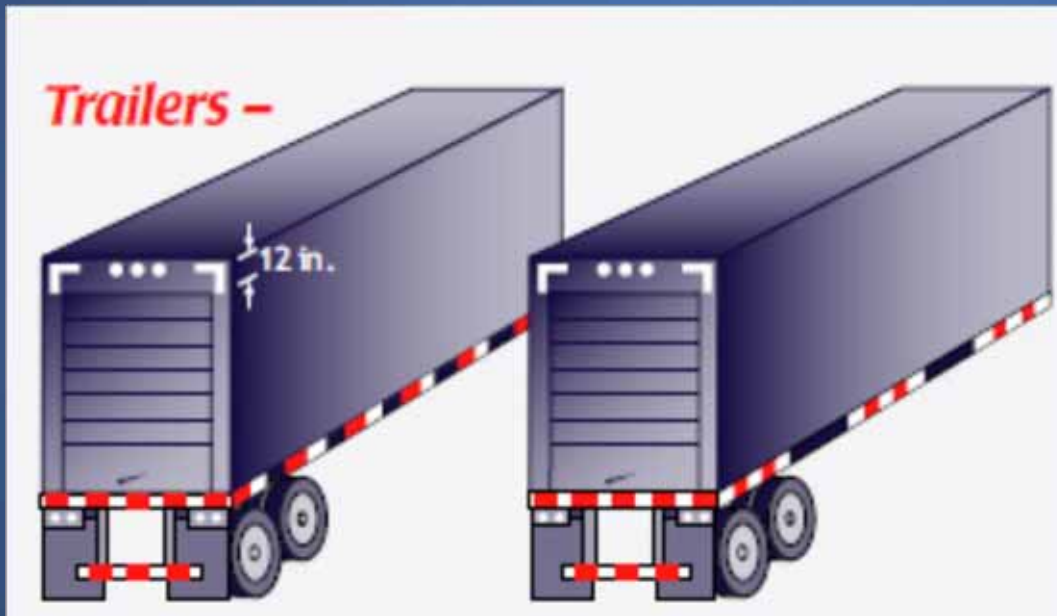
- Passenger vehicle collisions with the rears of single-unit trucks are common and can result in serious injury
 - In CODES states: about 30 hospitalizations and 340 emergency department visits each year from truck rear impacts
- Underrides occur in 70% or more of collisions between passenger vehicles with the rears of single-unit trucks (in accidents resulting in death or injury)

Rear Underride Protection



Insurance Institute for Highway Safety, 2013

Conspicuity Standards for Trailers and Tractors

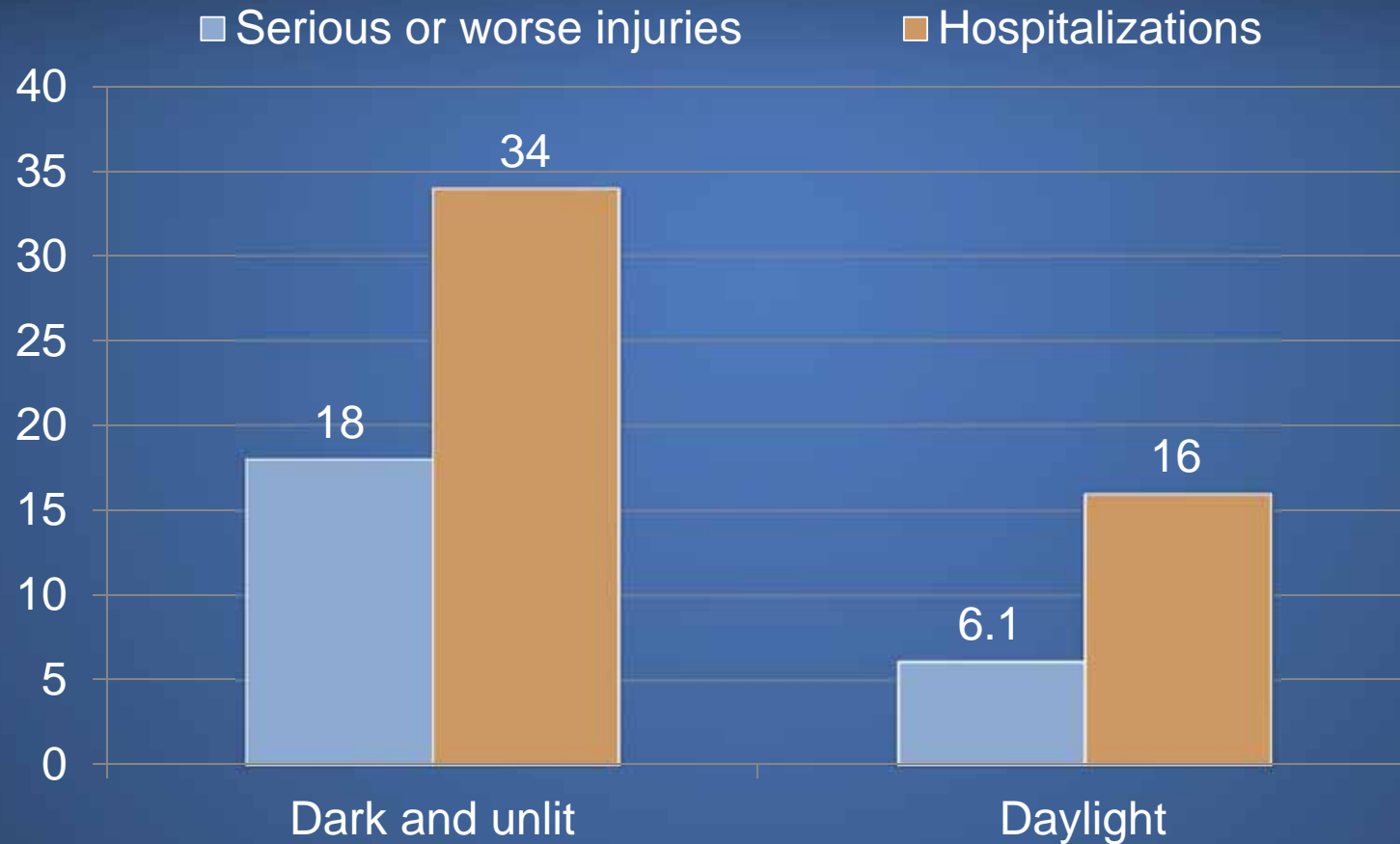


FMCSA, 3M

Conspicuity: Dark and Unlit Roads

- National estimate: 5,921 single-unit trucks involved in accidents on dark and unlit roads during 2005–2009
 - 6% of single-unit truck involvements
- State data
 - 21% for dump trucks (rear-end impacts)
- High-risk accidents

Serious injury and hospitalization rates per 1,000 passenger vehicle occupants, collisions with sides/rears of single-unit trucks by light conditions, CODES, 2005–2009



Conspicuity

- Dark and unlit roads: 41% reduction in accidents involving sides and rears of trailers with retroreflective tape



Previous Recommendation Topics

- **Front underride protection systems on large trucks**
 - Majority of fatal large truck accidents involve fronts of trucks
 - 70% of passenger vehicle collisions with fronts of single-unit trucks recorded as front underride
- **Electronic stability control**
 - 1,000 rollovers (single-unit trucks, 2005–2009)
 - 8,900 single-unit run-off road accidents

Previous Recommendation Topics

- **Adaptive cruise control and collision warning systems**
 - Truck frontal impacts: high risk of death and injury
 - NTSB case reviews and prior research indicated that these systems could be beneficial for large trucks, including single-unit trucks
- **Lane departure warning systems**
 - Sideswipe accidents: high risk of death and injury
 - Prior research indicated value of lane departure warning systems

What We Learned

- **Single-unit trucks are involved in a disproportionate share of passenger vehicle occupant deaths in multivehicle accidents**
 - 9% of deaths vs. 4% of miles and 3% of registered vehicles
- **Considerable societal impacts**
 - Fatalities, injuries, hospitalizations, emergency department visits
- **Rear underride guards and conspicuity-enhancing treatments should be required for single-unit trucks**

What We Learned

- **Additional vehicle-based countermeasures are needed**
- **Adverse effects of single-unit truck accidents have been underestimated, but this problem can be addressed by using VINs**
- **Multiple data sources needed**
 - TIFA
 - CODES



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