

# Injury Hazards in Road and Bridge Construction



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International Bridge Conference

Pittsburgh, PA

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# Injury Hazards in Road and Bridge Construction

- Background
- Road and Bridge Construction Facts
  - ◆ Citations, Nonfatal Injuries and Illnesses, Fatal Injuries
- Safely Working Around Trucks and Equipment
  - ◆ Blind Areas, Proximity Warning, Internal Traffic Control
- Road and Bridge Construction Hazards
  - ◆ Separating Workers from Traffic, Safe Entry and Exit



# NIOSH Role in the U.S. Occupational Safety and Health Framework

## Regulation/Enforcement

Department of Labor  
(DOL)

Mine Safety  
and Health  
Administration  
(MSHA)

Occupational  
Safety and Health  
Administration  
(OSHA)

## Research and Prevention Recommendations

Department of  
Health and Human Services  
(HHS)

Centers for Disease  
Control and Prevention  
(CDC)

National Institute for  
Occupational Safety  
and Health (NIOSH)





# The National Institute for Occupational Safety and Health

- The federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness.





# NIOSH Construction Program

Intramural  
Research

National  
Construction  
Center

Extramural  
Investigator  
Initiated Grants

CPWR

Center for Construction Research and Training

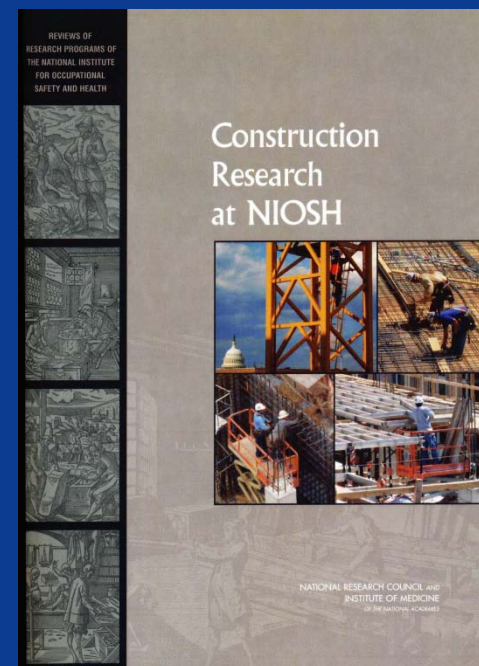




# NIOSH Construction Program Review

**THE NATIONAL ACADEMIES**  
*Advisers to the Nation on Science, Engineering, and Medicine*

- Performed by a National Academies Committee
  - Focused on work done over last 10 years
  - Provided recommendations for improving the program
- 
- Received score of **5/5** for **RELEVANCE**
  - Received score of **4/5** for **IMPACT**



**Report available at:**  
**<http://www.cdc.niosh/nas/>**



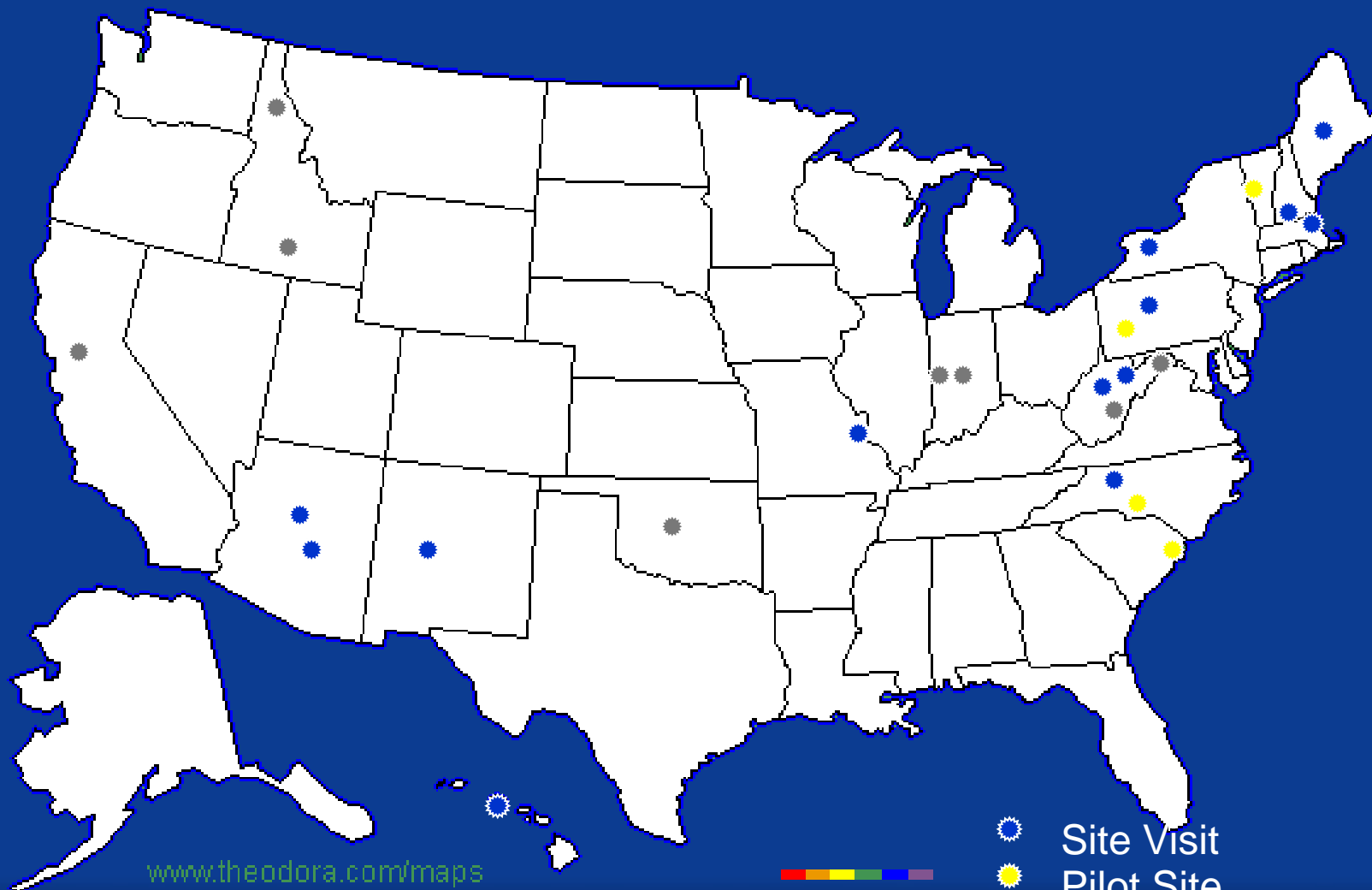


# Evaluating Roadway Work Zone Interventions

A Research Project Conducted by the  
National Institute for  
Occupational Safety and Health









# Roadway Work Zone Intervention Evaluations

Morgantown, WV

Pittsburgh, PA

Spokane, WA

Worker Exposure Measurement

HASARD

Proximity Warning Devices

Blind Area Determination

Work Zone Analysis System

Detection Zones

**State Transportation Departments**

**Construction Companies**

**Engineering Consultants**

**Labor Unions**

**Construction Trade Associations**

**Equipment Manufacturers**

**FHWA, OSHA**



# Work Zone Safety and Health Partners






# Acknowledgements (continued)

- James E. Bryden
- Steve Hubbard
- Michael Grey
- Michael Paylor
- Marv Sahlo







The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.



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# ROAD & BRIDGE CONSTRUCTION FACTS





# U.S. Infrastructure (2008)

- Road System Miles

- ◆ Urban ~1.1 trillion
- ◆ Rural ~ 3.0 trillion
- ◆ Total ~ 4 trillion

- Bridges

- ◆ Urban 153,407
- ◆ Rural 447,989
- ◆ Total 601,396

Source: U.S. Department of Transportation Statistics Highway Profile





# U.S. Infrastructure Condition (2008)

- Roads

- ◆ 65% paved

- Bridges

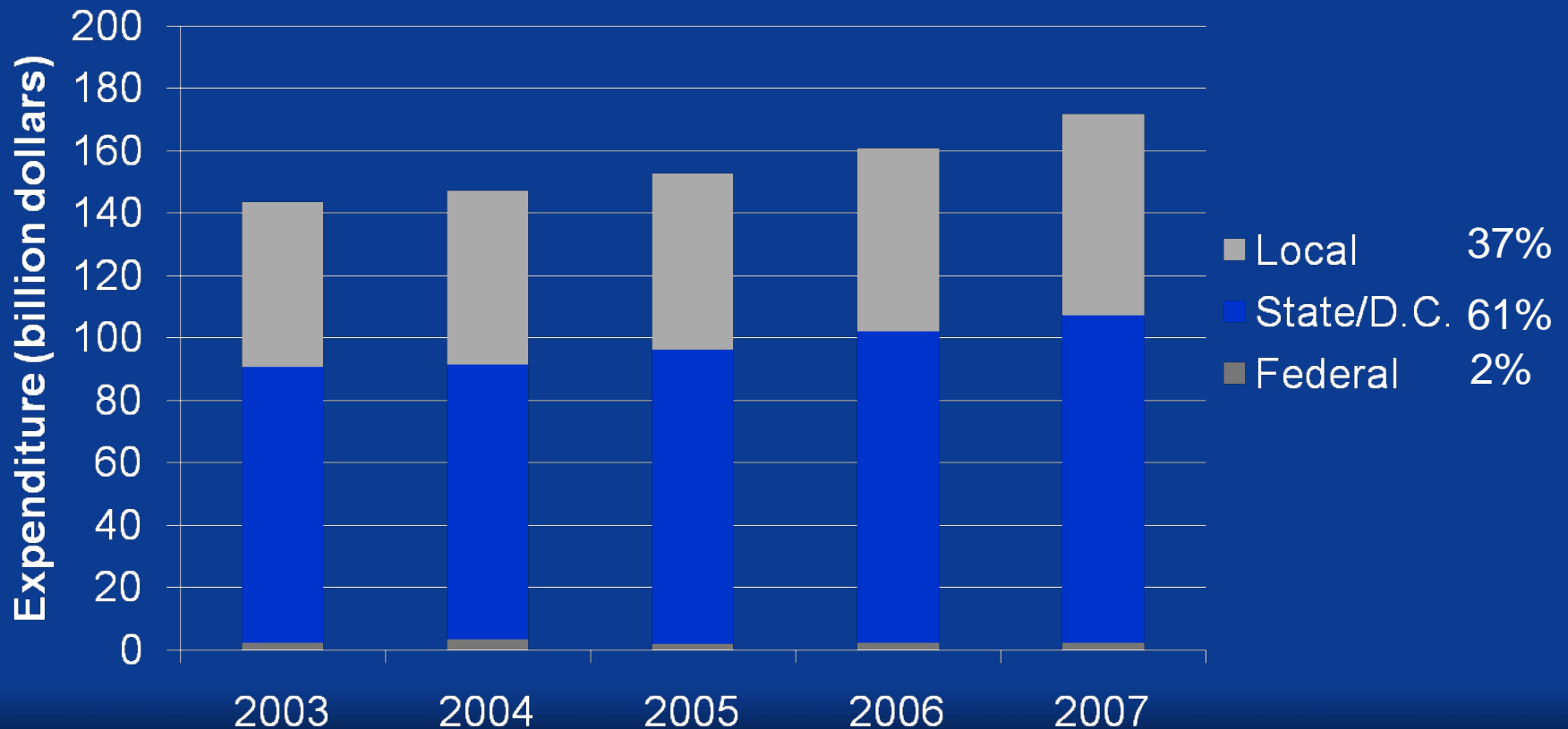
- ◆ 75% good repair
- ◆ 12% deficient
- ◆ 13% obsolete

Source: U.S. Department of Transportation Statistics Highway Profile





# Government Highway System Expenditures



Source: U.S. Department of Transportation Statistics Highway Profile



# The American Recovery and Reinvestment Act of 2009 (ARRA)

- More than 12,600 projects obligated
- More than 10,000 projects under construction
- More than 2,200 projects completed
- Total obligated funds for 50 states and the District of Columbia: \$26.6 billion

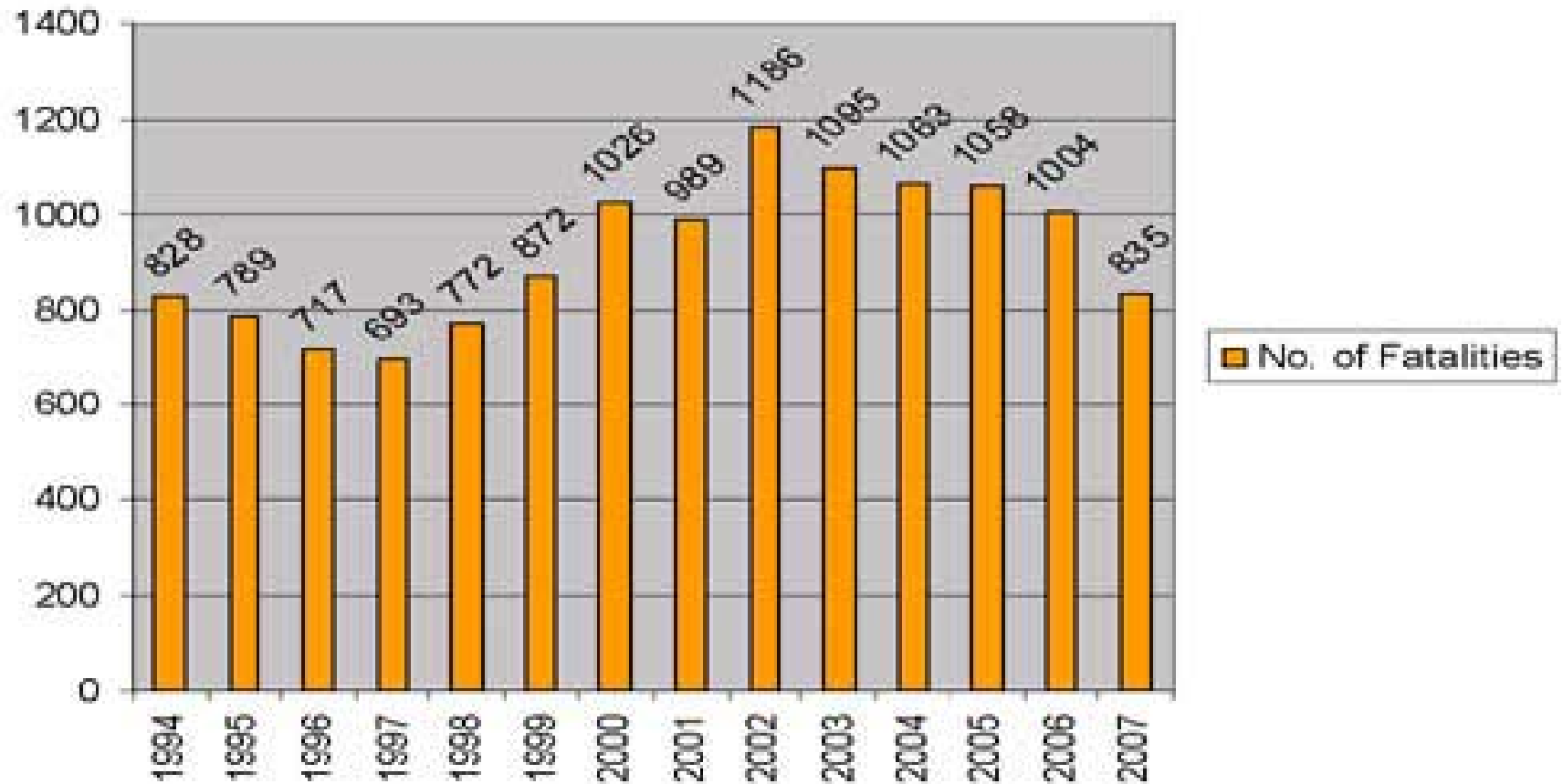


Source: U.S. Department of Transportation ARRA Website, June 1, 2010





## Work Zone Fatalities



Source: <http://www.fhwa.dot.gov/economicrecovery/workzones.htm>



# Highway, Street, and Bridge Construction:



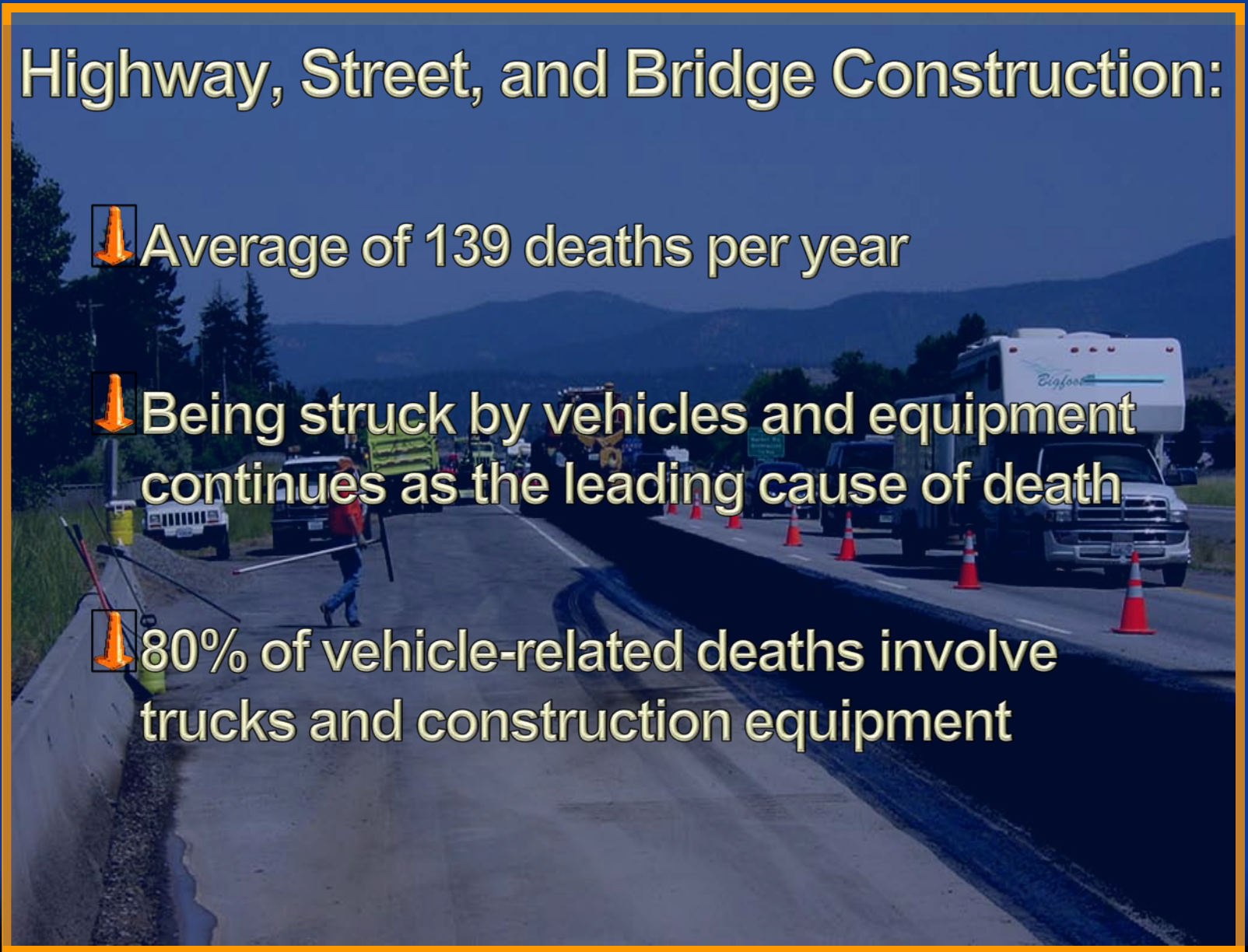
Average of 139 deaths per year



Being struck by vehicles and equipment continues as the leading cause of death



80% of vehicle-related deaths involve trucks and construction equipment





# Top 5 OSHA Citations

10/08-09/09

Bridge, Tunnel, and Elevated Highway Construction	Highway and Street Construction
Fall Protection (50)	Hazard Communication (60)
Cranes (43)	Excavation (60)
General (34)	Respiratory (45)
Lead (26)	Protective Systems (36)
Working /Over Near Water (23)	Signs and Tags (28)



# INJURIES AND ILLNESSES IN ROAD & BRIDGE CONSTRUCTION

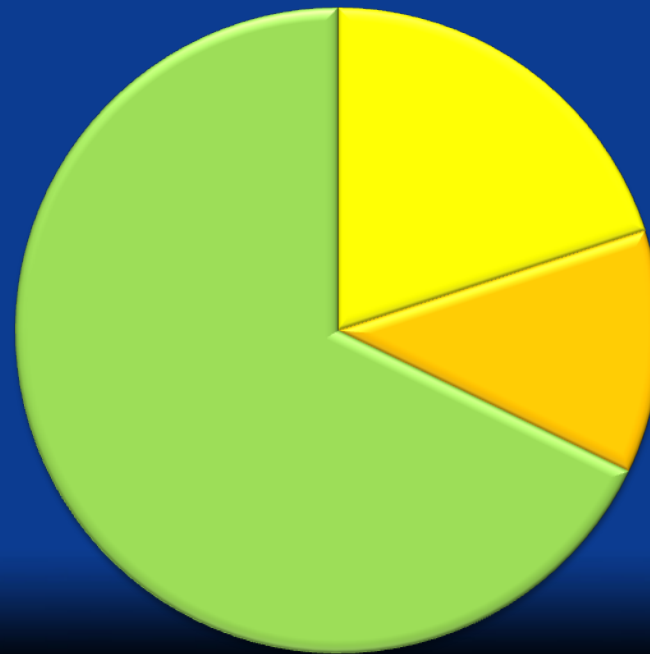




## Employment the Construction Industry



## Injuries and Illnesses in the Construction Industry 2003-2008



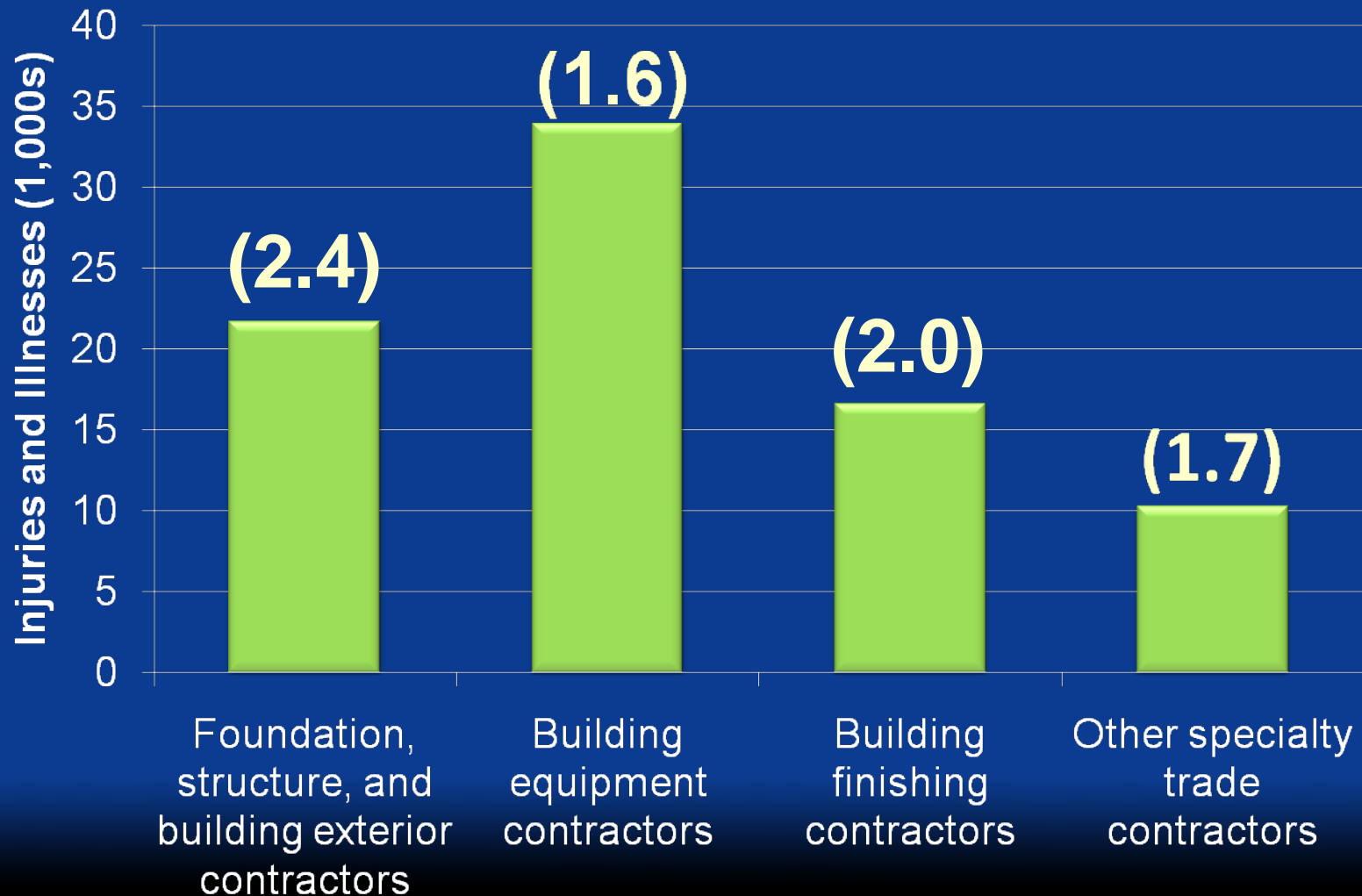
■ Construction  
of Buildings  
(NAICS 236)

■ Heavy and  
Civil  
Engineering  
Construction  
(NAICS 237)

■ Specialty  
Trade  
Contractors  
(NAICS 238)



## Specialty Trades Injuries and Illnesses by Subsector in 2008 (n=82,500) (Rate per 100 workers)



Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)





# Heavy & Civil Engineering Construction Injuries in 2008

DAFW due to  
Transportation

1,230

DAFW

21,900

Total Cases

40,700

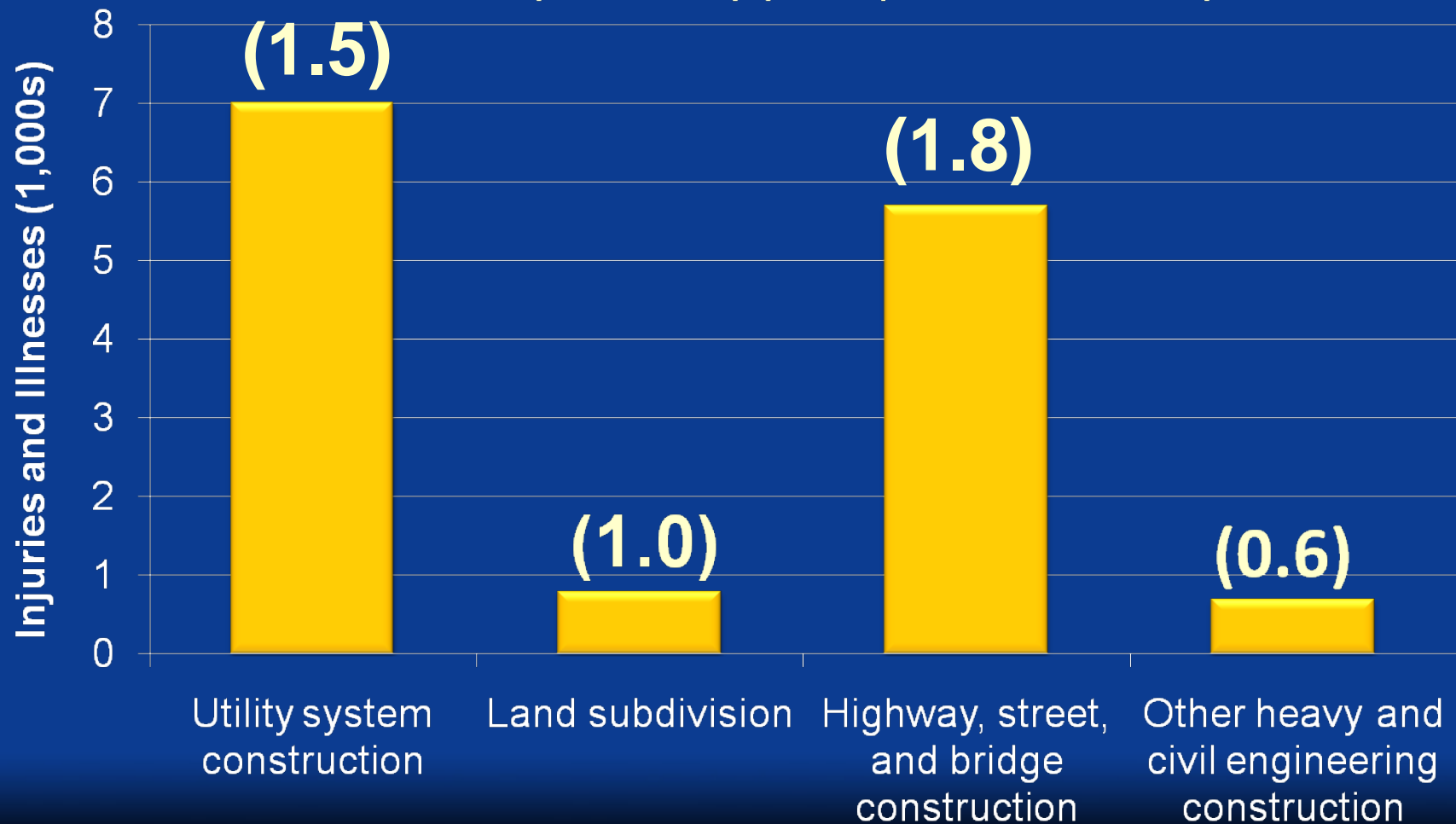
Close Calls

????????????????





## Heavy Civil Engineering Injuries and Illnesses by Subsector in 2008 (n=14,150) (Rate per 100 workers)

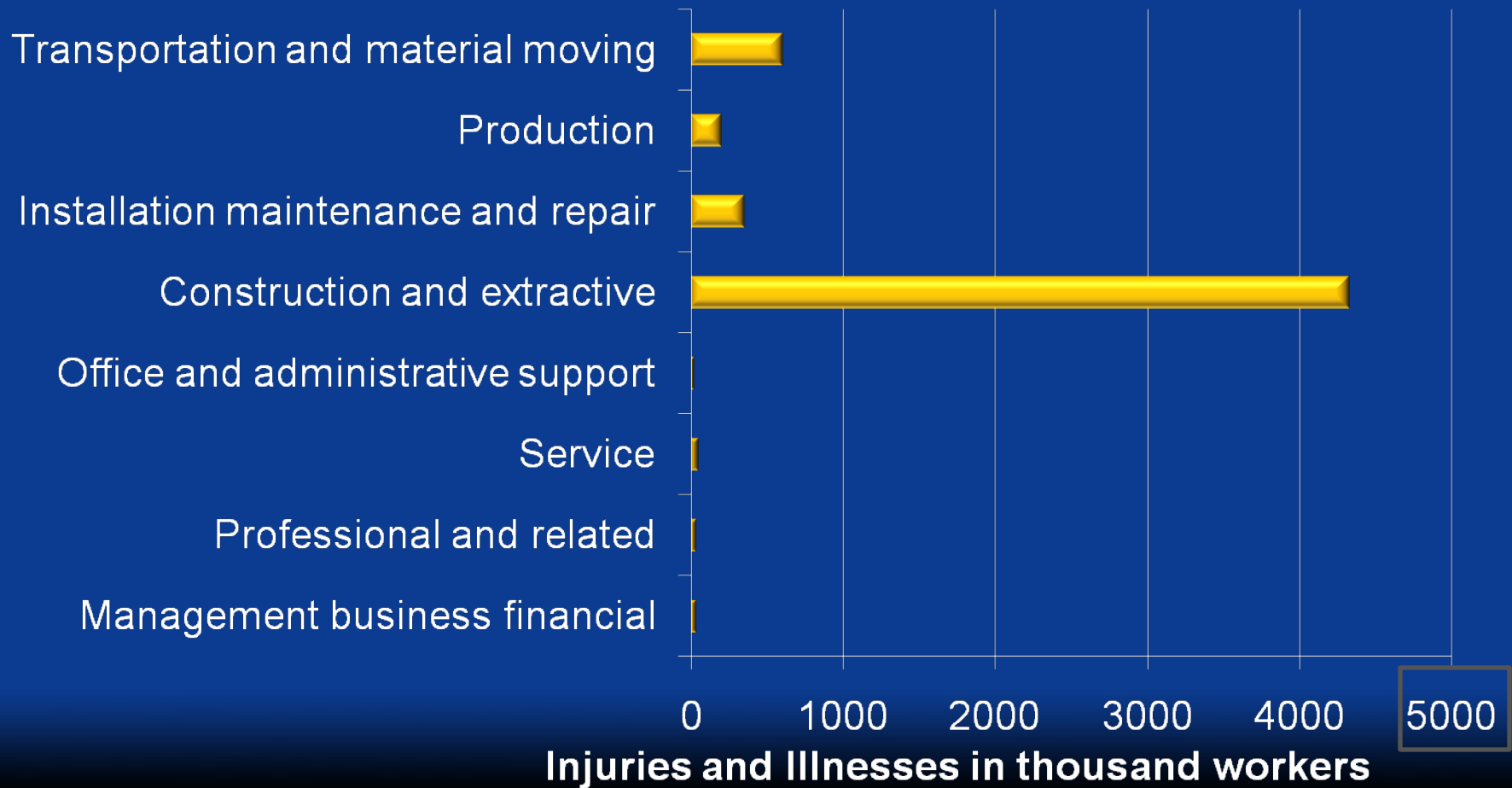


Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)





# Injuries and Illnesses by Occupation in Highway Street and Bridge Construction (n=5,690)



Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)





# Highway Street and Bridge Construction Days Away From Work Injuries and Illnesses by Event 2003-2008 (n=42,790)

**Contact with Objects or  
equipment 35%**



**Slips, Trips, or Falls  
20%**



**Overexertion  
15%**



**Transportation  
Incidents 12%**

**Exposure to  
Harmful Substances  
or Environments 5%**





# FATAL INJURIES IN ROAD & BRIDGE CONSTRUCTION



CDC

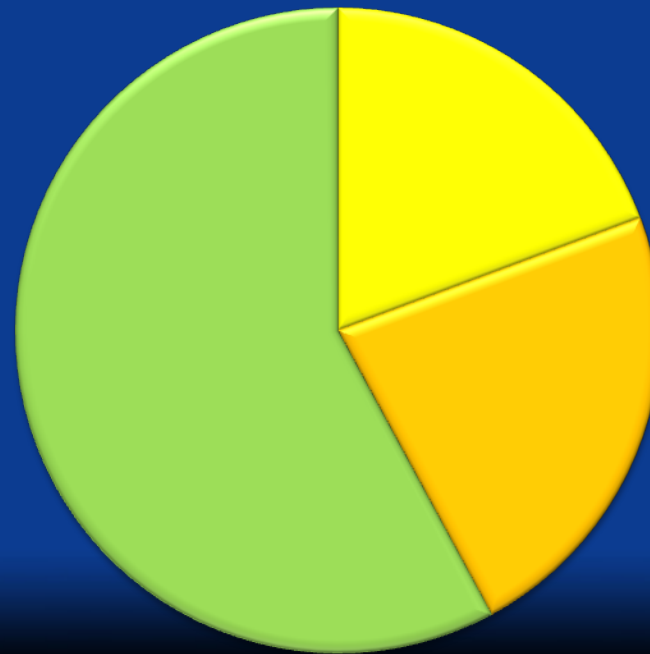
***NIOSH***



## Employment the Construction Industry



## Fatal Injuries in the Construction Industry 2003-2008



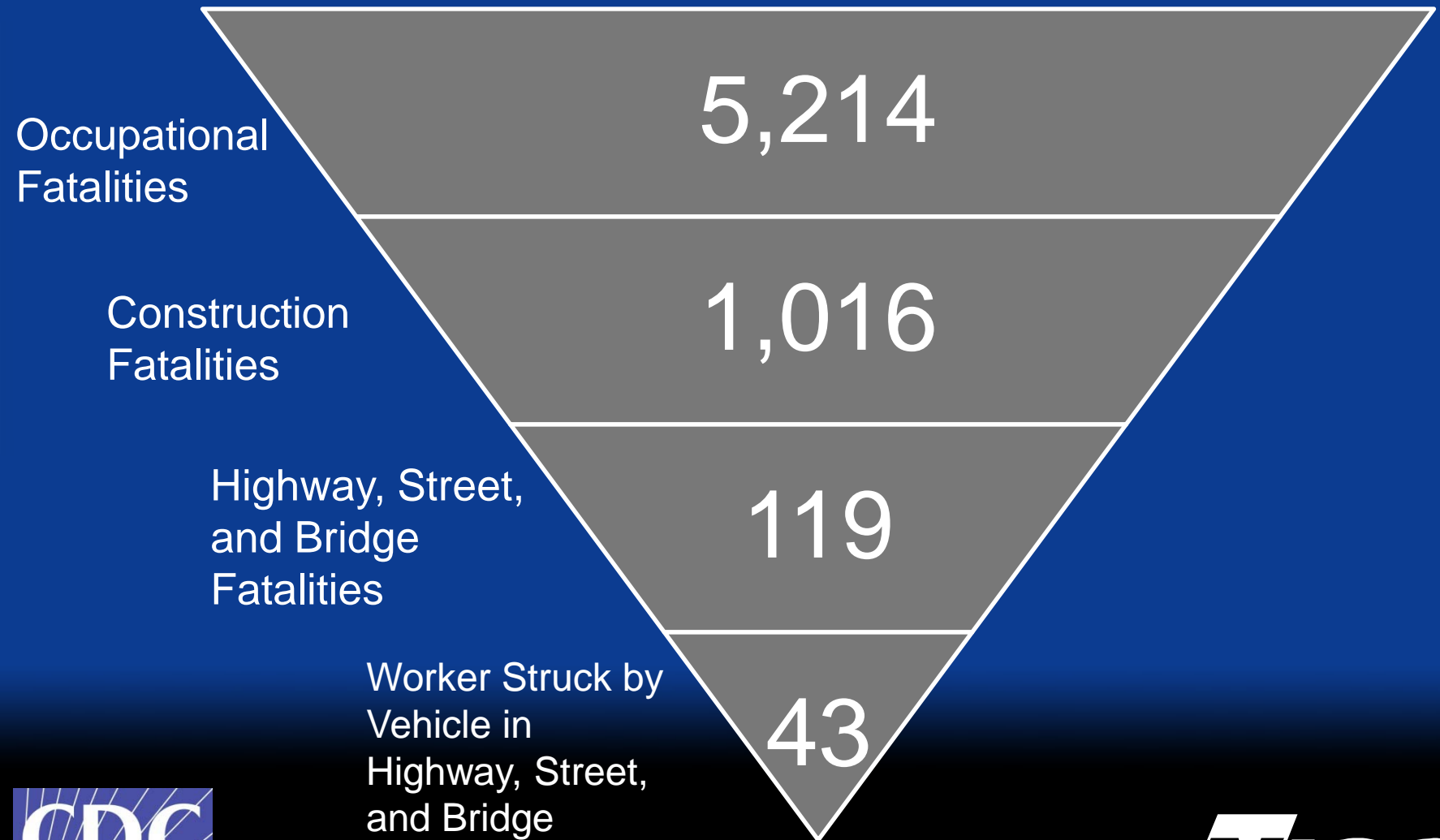
■ Construction  
of Buildings  
(NAICS 236)

■ Heavy and  
Civil  
Engineering  
Construction  
(NAICS 237)

■ Specialty  
Trade  
Contractors  
(NAICS 238)



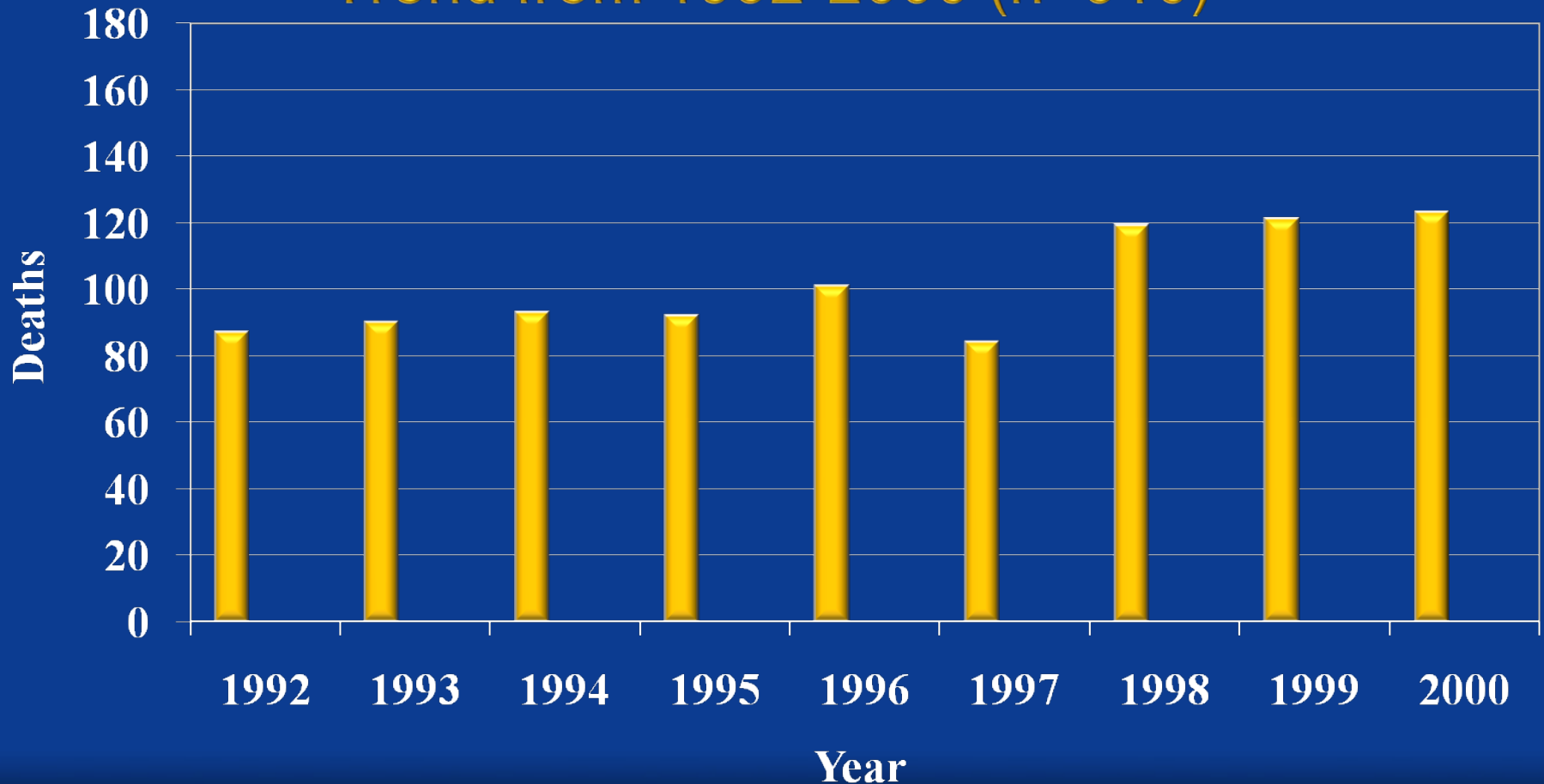
# Fatal Injuries in the United States in 2008





# Worker Deaths in Roadway Construction

Trend from 1992-2000 (n=910)



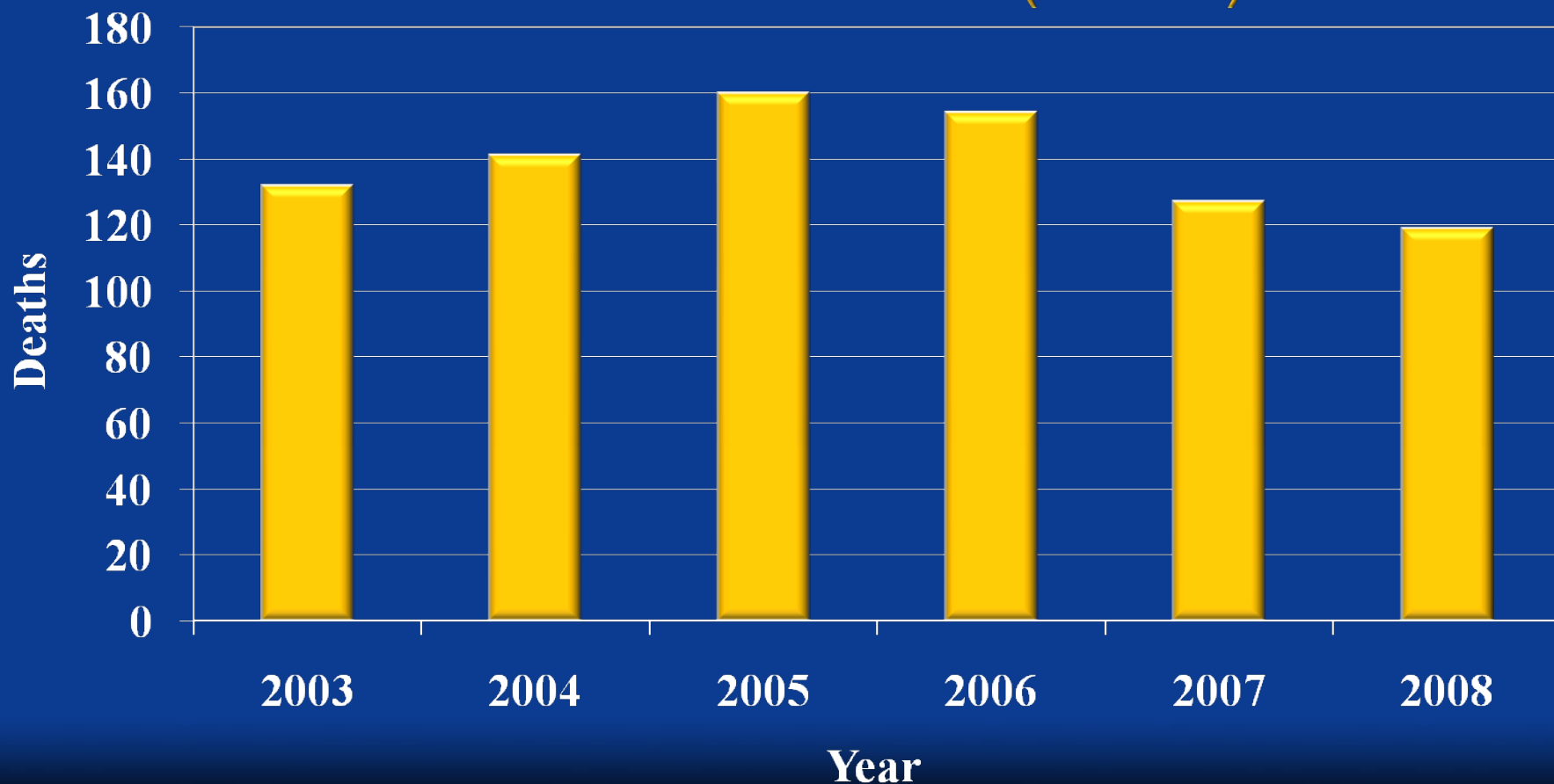
Source: Census of Fatal Occupational Injuries. This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data (excluding New York City). The views expressed here do not necessarily reflect the views of the BLS.





# Worker Deaths in Highway, Street, and Bridge Construction

Trend from 2003 - 2008 (n=833)



Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)





# Highway Street and Bridge Construction Fatalities by Event 2003-2008 (n=833)

Transportation Accidents  
70%



Contact with Objects or  
equipment 18%



Exposure to Harmful  
Substances or  
Environments 4%



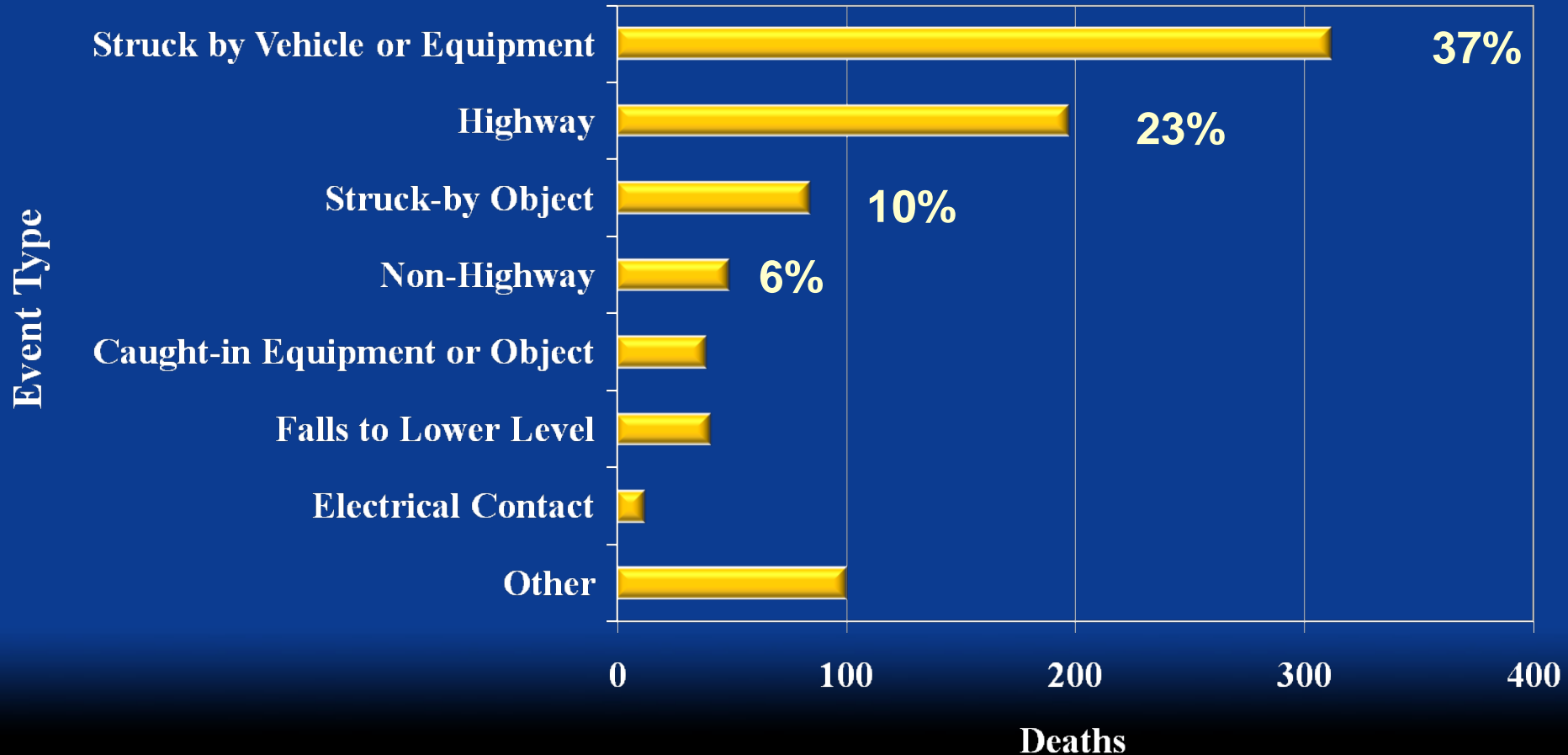
Slips, Trips, or  
Falls 4%





# Worker Deaths in Highway, Street, and Bridge Construction

Deaths by Event Type, 2003 - 2008 (n=833)



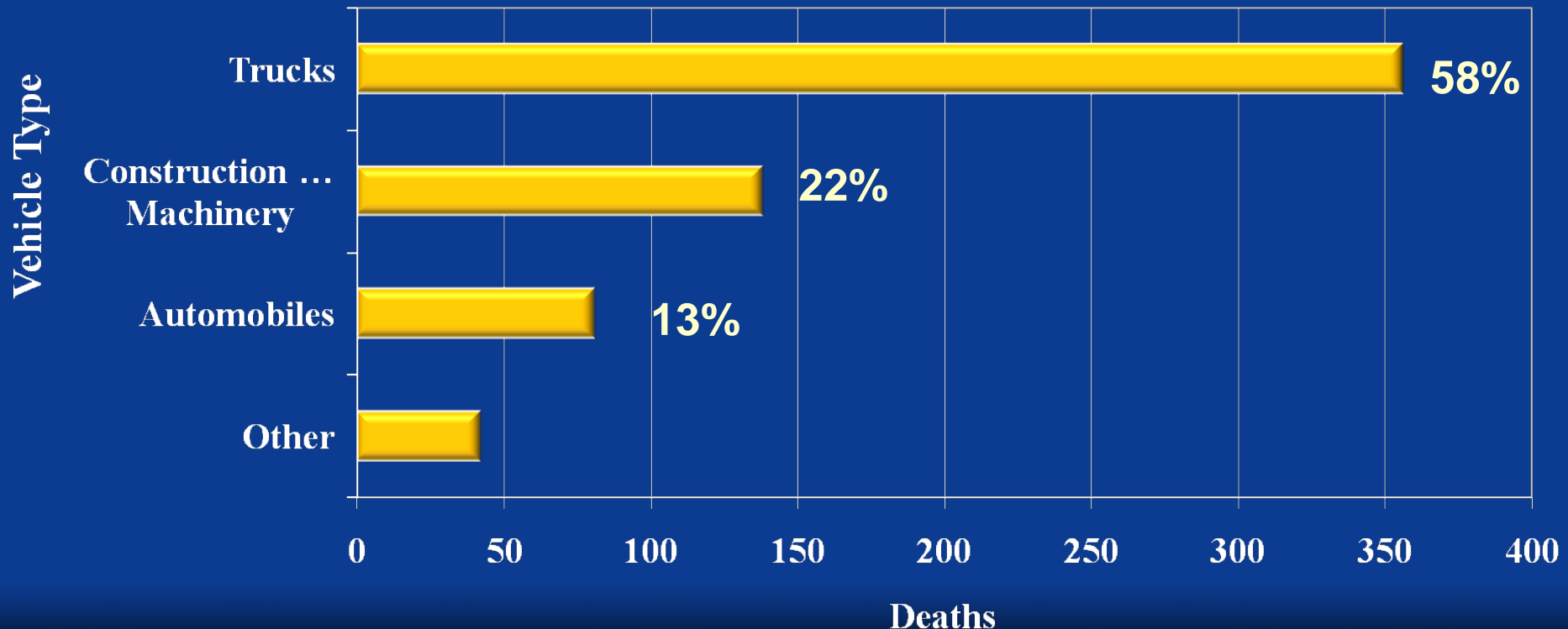
Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)





# Worker Deaths in Highway, Street, and Bridge Construction

Deaths by Vehicle Type, 2003 - 2008 (n=617)



Source: Census of Fatal Occupational Injuries [www.bls.gov/iif](http://www.bls.gov/iif)



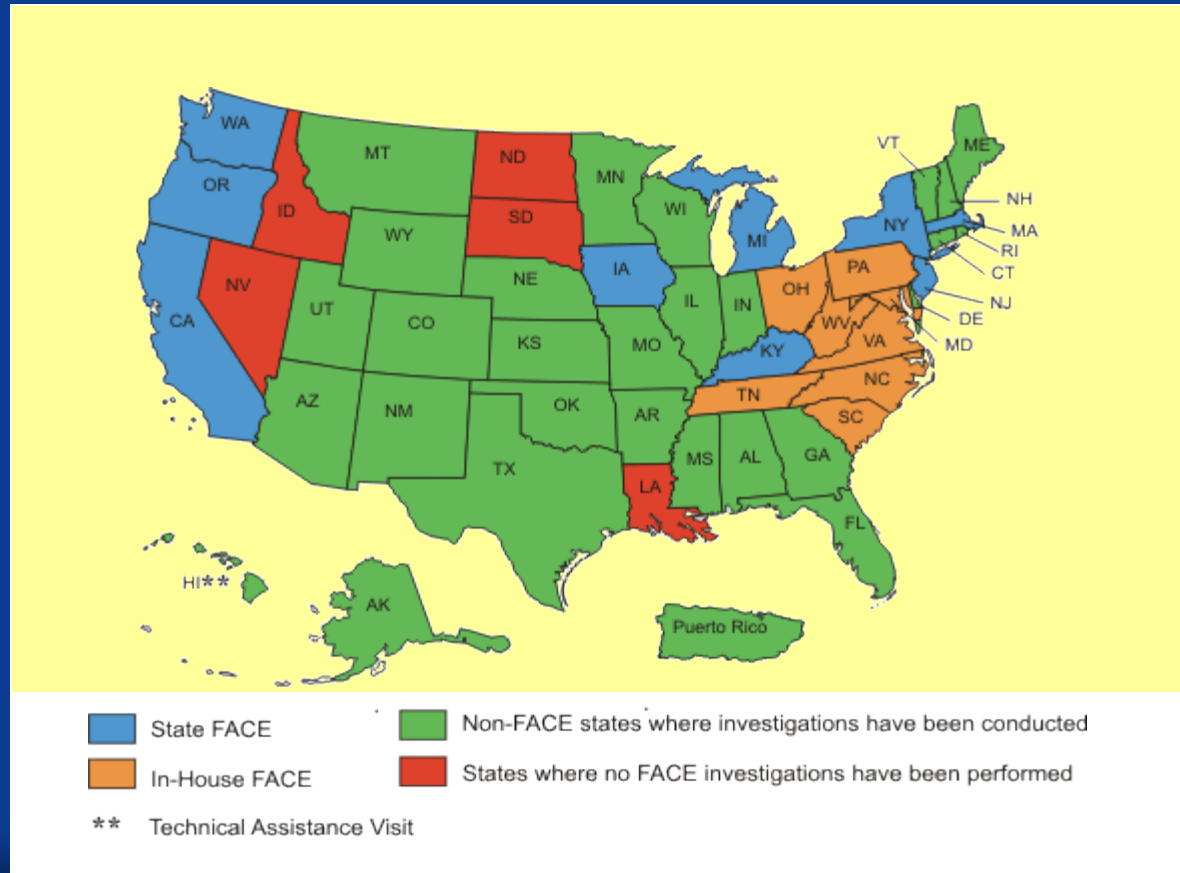


# SAFELY WORKING AROUND TRUCKS AND EQUIPMENT





# Fatality Assessment and Control Evaluation States Participating in the Program



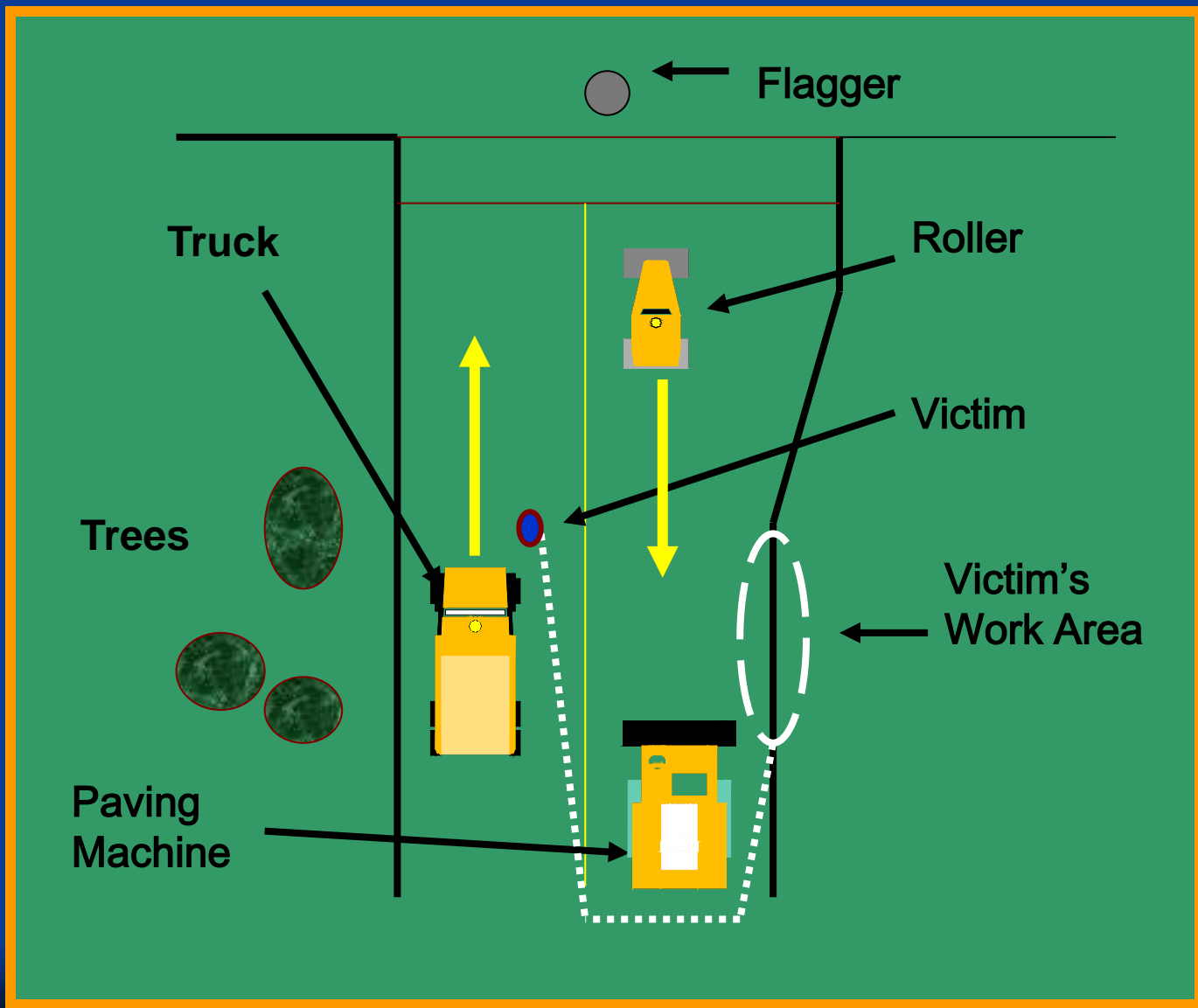


# Laborer Run Over by Dump Truck at Roadway Resurfacing Operation in Virginia



Two-lane County Road Intersection with  
Four-lane State Highway





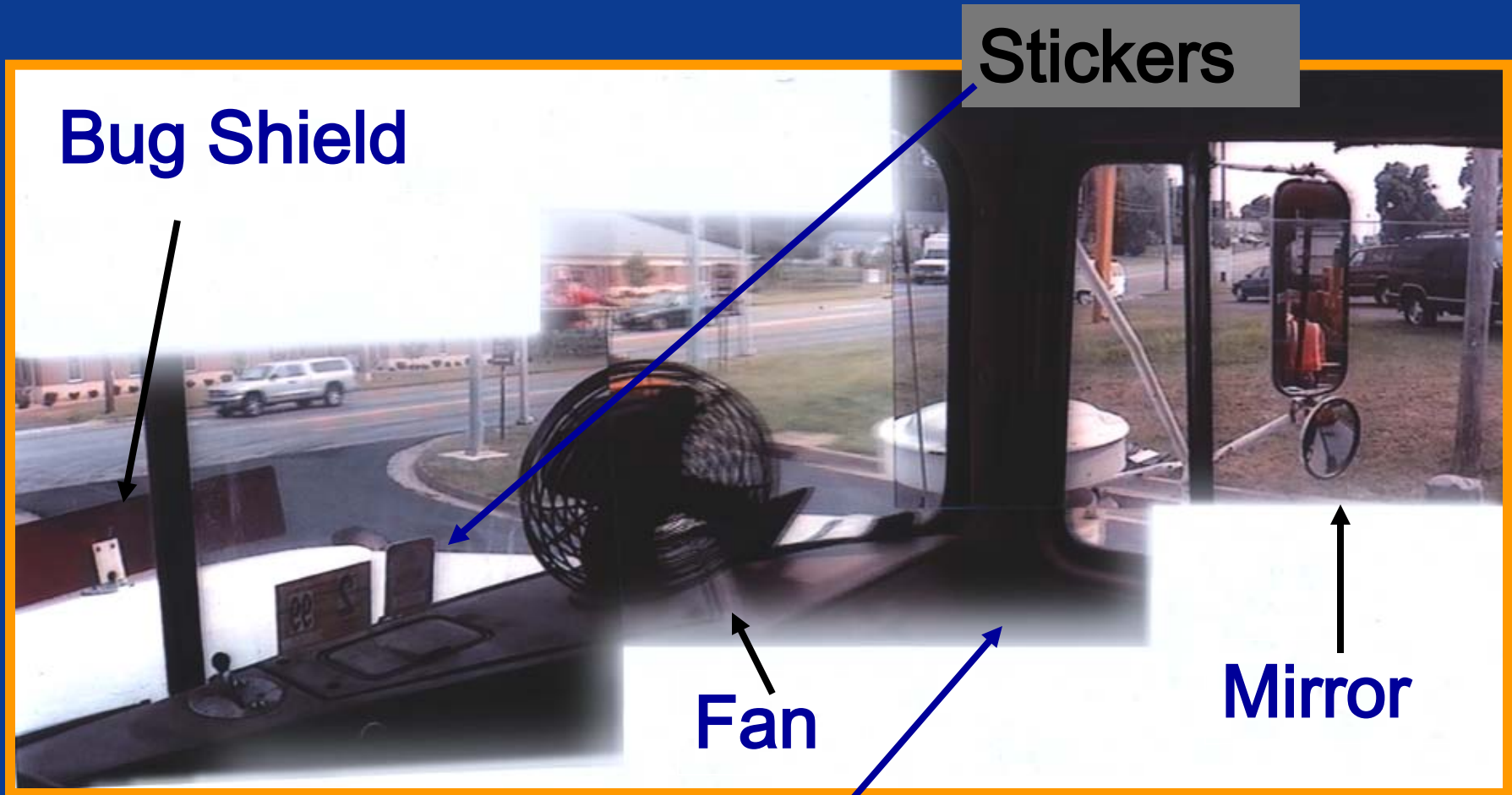


# View from the Street



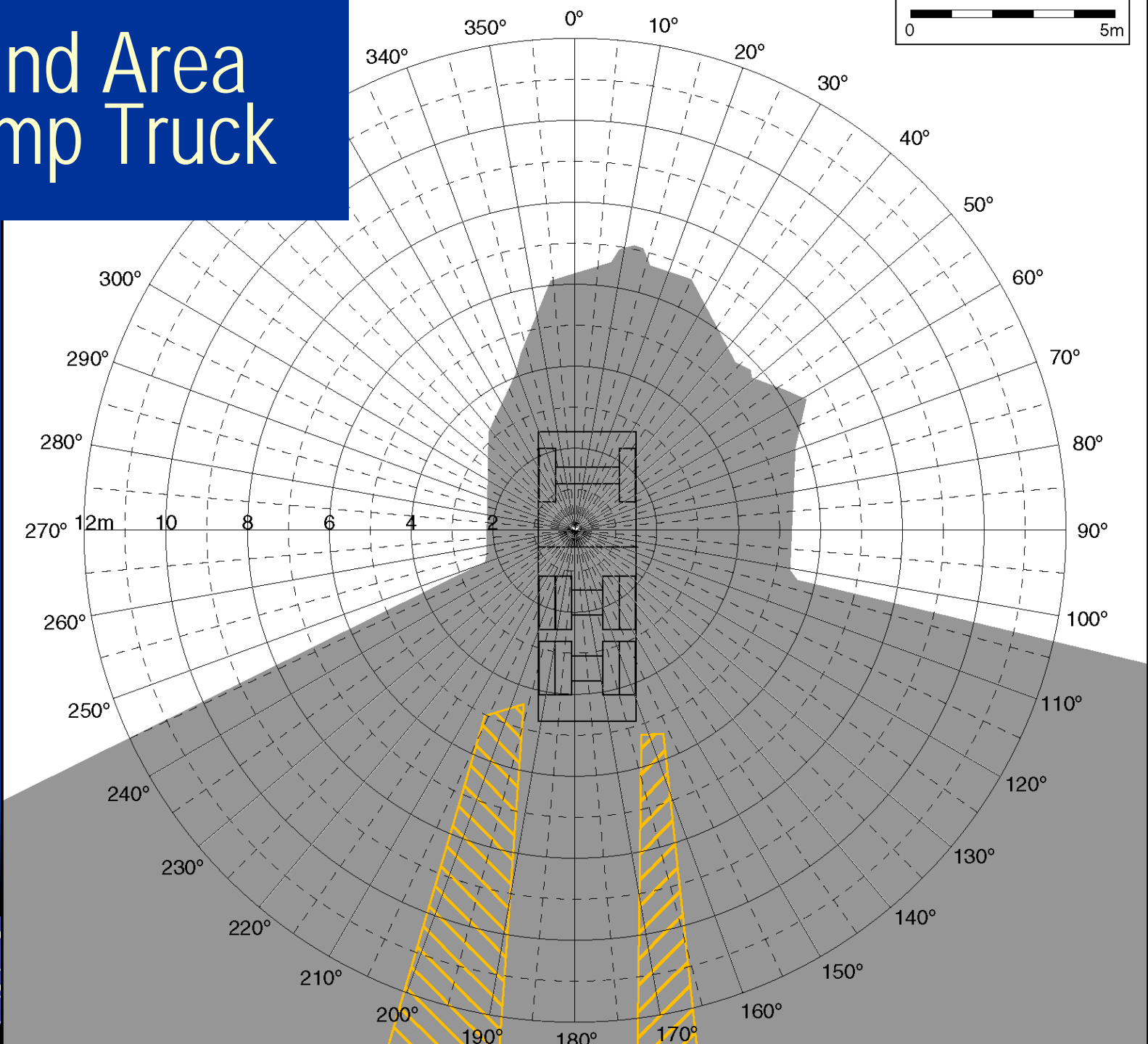


# View from Inside the Cab





# Blind Area Dump Truck





http://isx-morg1/DSR/cvg1/external/BAD/default.html

File Edit View Favorites Tools Help

Highway Work Zones - Construction Equipment Visibilit...

CDC Home CDC Search CDC Health Topics A-Z

**CDC** **NIOSH** National Institute for Occupational Safety and Health

Search NIOSH | NIOSH Home | NIOSH Topics | Site Index | Databases and Information Resources | NIOSH Products | Contact Us

## NIOSH Safety and Health Topic: Highway Work Zone Safety

### Construction Equipment Visibility

Studies show that highway and street construction workers are at a significant risk of fatal and serious nonfatal injuries while working in and around a street/highway construction jobsite. In addition to the risk of injury from passing motor vehicle traffic outside the work zone, there is an equally hazardous risk of injury from movement of construction vehicles and equipment within the work zone. In analyzing the data collected on fatalities and serious nonfatal injuries occurring from 1992-1998, researchers from the National Institute for Occupational Safety and Health (NIOSH) have concluded that "safety efforts must also protect construction workers within work zones who are working on foot around moving vehicles and equipment..." [Pratt et al., 2001]. Collision occurrences have been attributed in part to limited visibility around the equipment.

Within this web site you will find detailed diagrams to assist in visualizing the areas around various construction vehicles and equipment that are unable to be seen from the operator's position. These areas are commonly referred to as *Blind Areas*. For each construction vehicle, three different Blind Area Diagrams are available to represent the ability of the operator to see an object at three different elevations: ground level, 900 mm (3'), and 1500 mm (4' 11"). The 900 mm plane represents the average height of a channelizing device, e.g. construction barrel, commonly used in road construction. The 1500 mm plane corresponds to the height of a 5th percentile female. NIOSH provides this information to safety personnel and instructors as a training aid to develop awareness about hazardous areas around construction vehicles and equipment due to limited visibility.

The test procedure for developing the Blind Area Diagrams are also given within this web site by selecting the appropriate link located on the right side of the page. This information is provided in the event safety personnel or instructors would like to develop their own Blind Area Diagrams.

#### Highway Work Zone Safety



#### Topic Index:

- [Highway Work Zones](#)
- [Highway Work Zones Fatality Investigation Reports](#)
- [In-house Reports](#)
- [State-based Reports](#)
- [Construction Equipment Visibility](#)

#### Topic Area Index:

Local intranet 100%

start Le... ph... W... CO... De... IT... Co... FY... BA... Hig... 4:05 PM

WWW.CDC.GOV/  
NIOSH/TOPICS/  
HIGHWAYWORKZ  
ONES





# Efficacy of Site Safety?

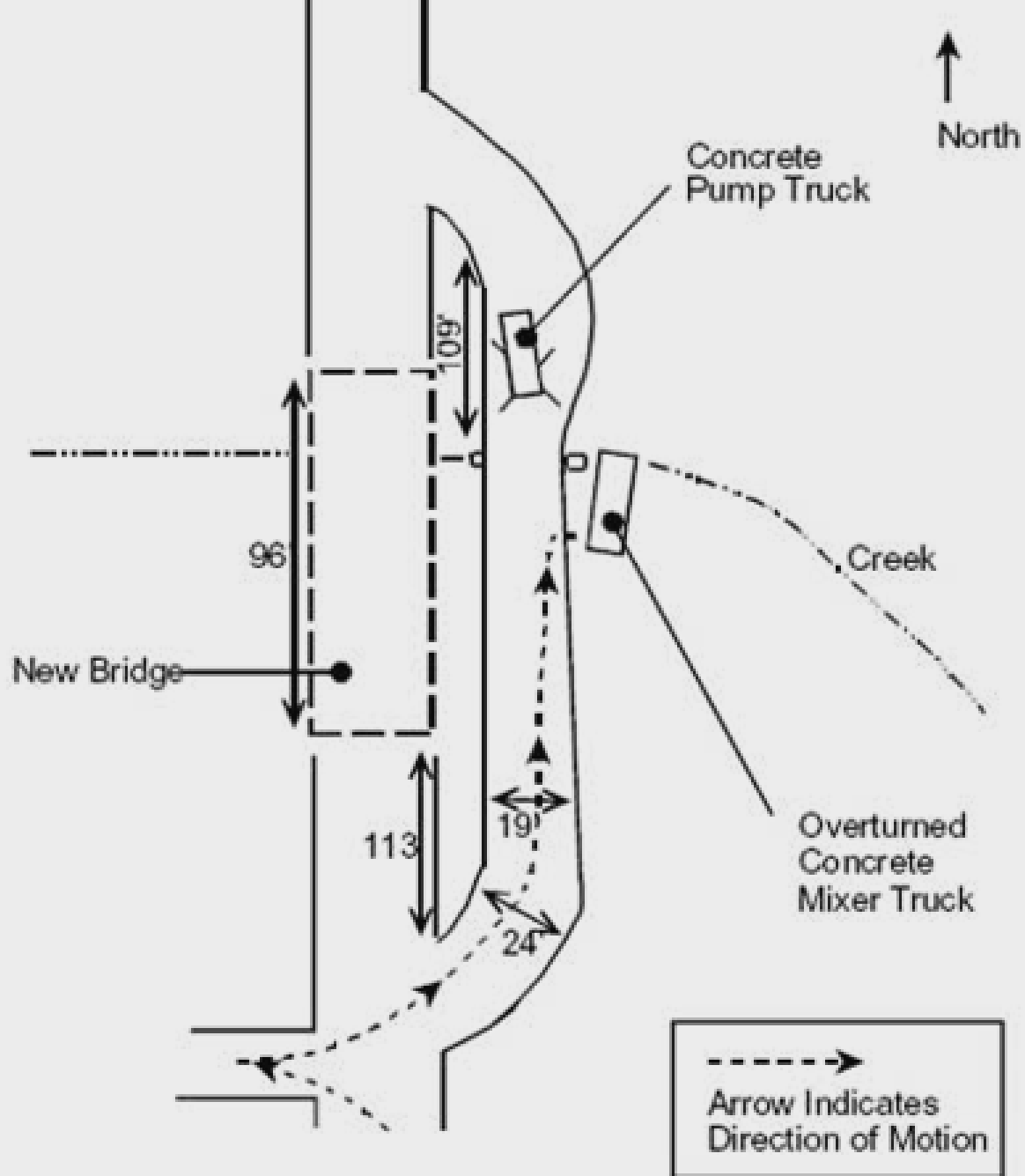




# Driver Died When Mixer Truck Overturned





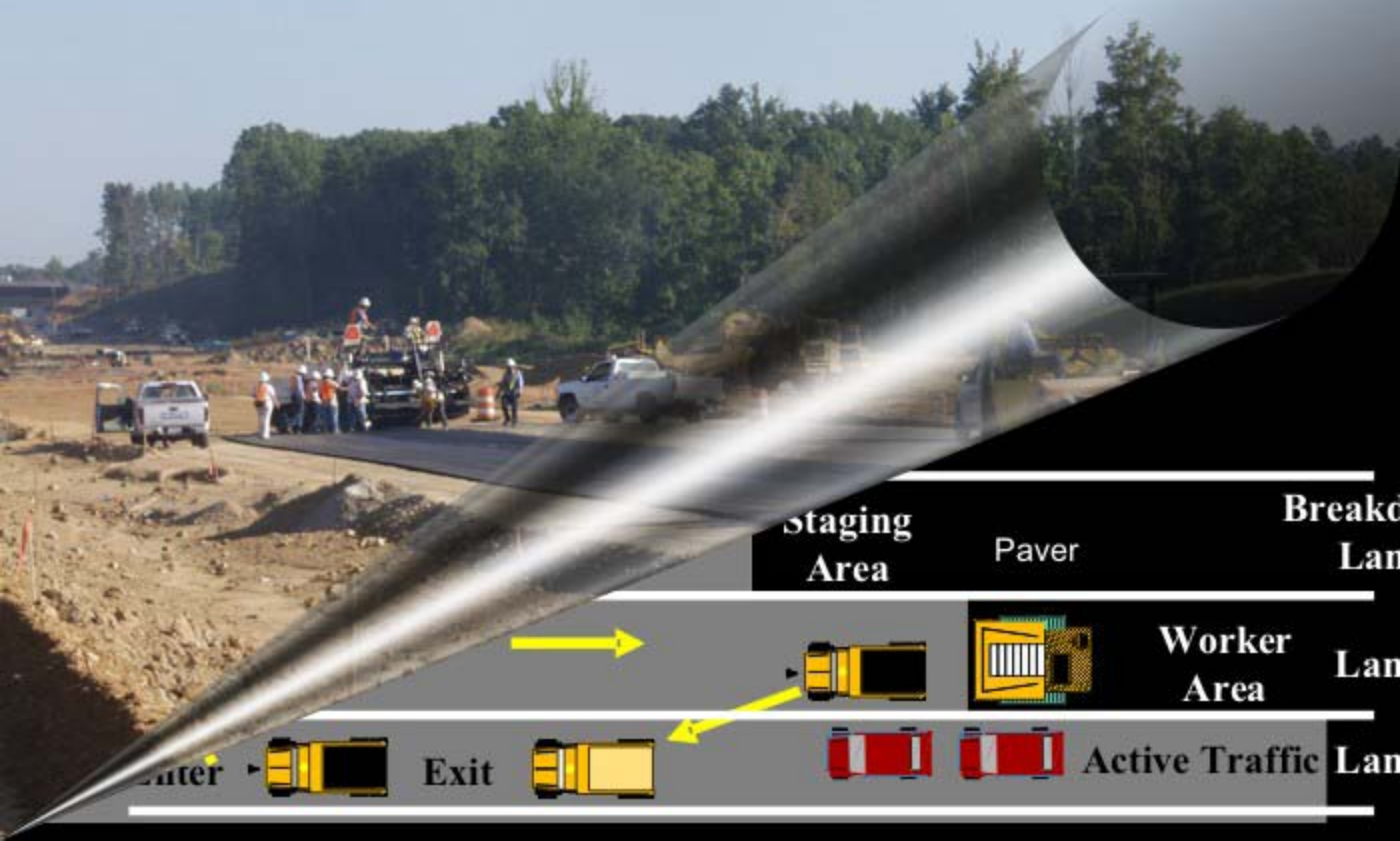








# Internal Traffic Control Plans



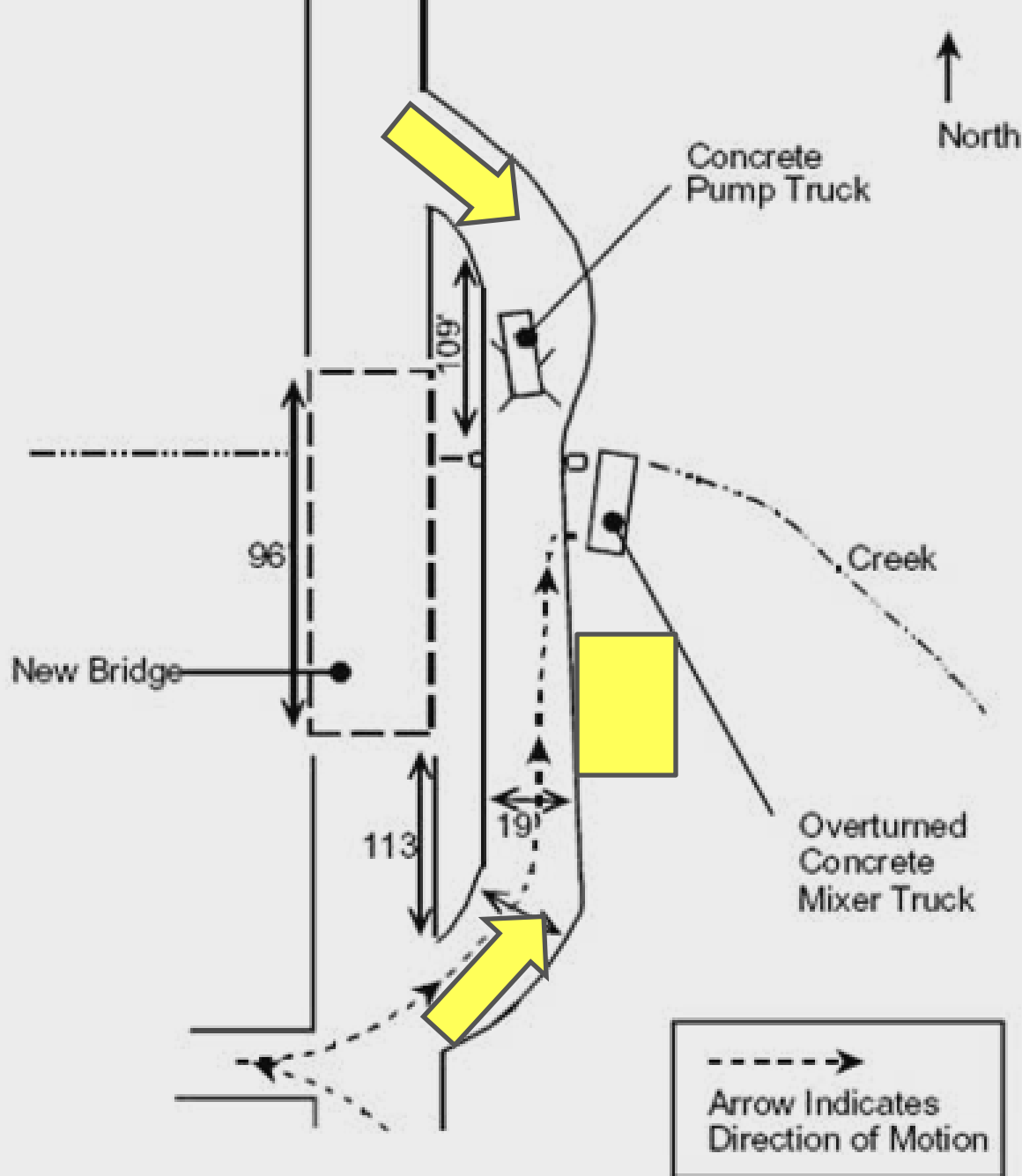


# ITCP Key Principles

Key Principles of an ITCP are:

- Limit access points to the work zone
- Reduce the need to back up equipment
- Coordinate truck and equipment movements
- Establish worker-free zones
- Inform workers of the ITCP







# ITCP Recommendations

## Integrate

- **Company**
- **State employees**
- **Trucking company**
- **Sub-contractors**

## Inform

- **Irregular personnel**
- **Truck drivers**
- **Sub-contractors**

## Implement

- **Parking**
- **Take Timeout**
- **Revise**
- **Re-communicate**



10 MPH is faster  
than you think!!!

A Dump Truck  
Backing at 10 MPH  
Covers 14.7 Feet  
In 1 Second!!!!!!!!!!

MPH	Feet in 1.0 Second	Feet in 2.5 Seconds
10	15	37
20	29	74
30	44	110
40	59	147
50	74	184
60	88	220
70	103	257
80	118	294

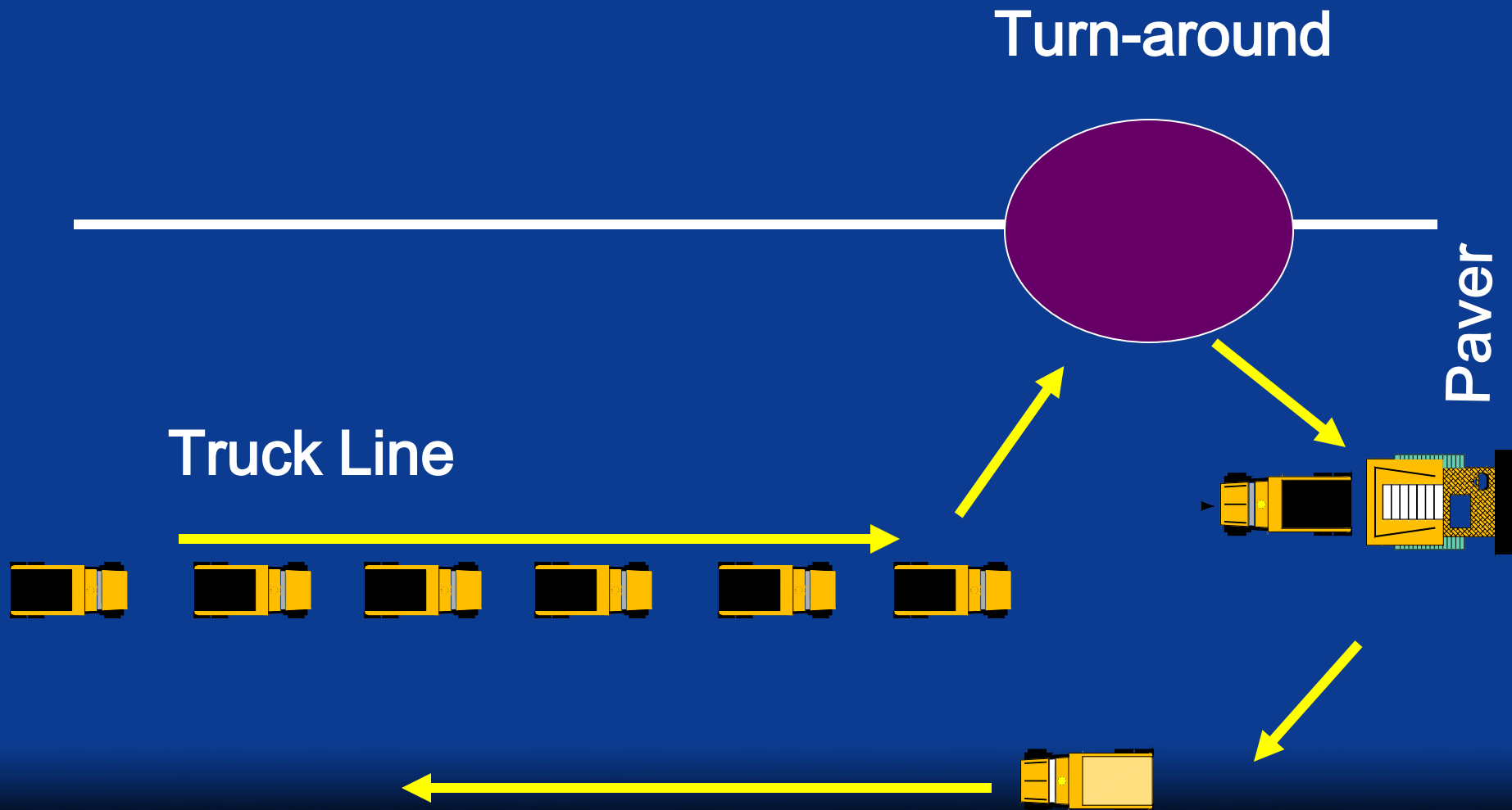


# Worker Dies After Being Backed Over By a Rear End Dump Truck



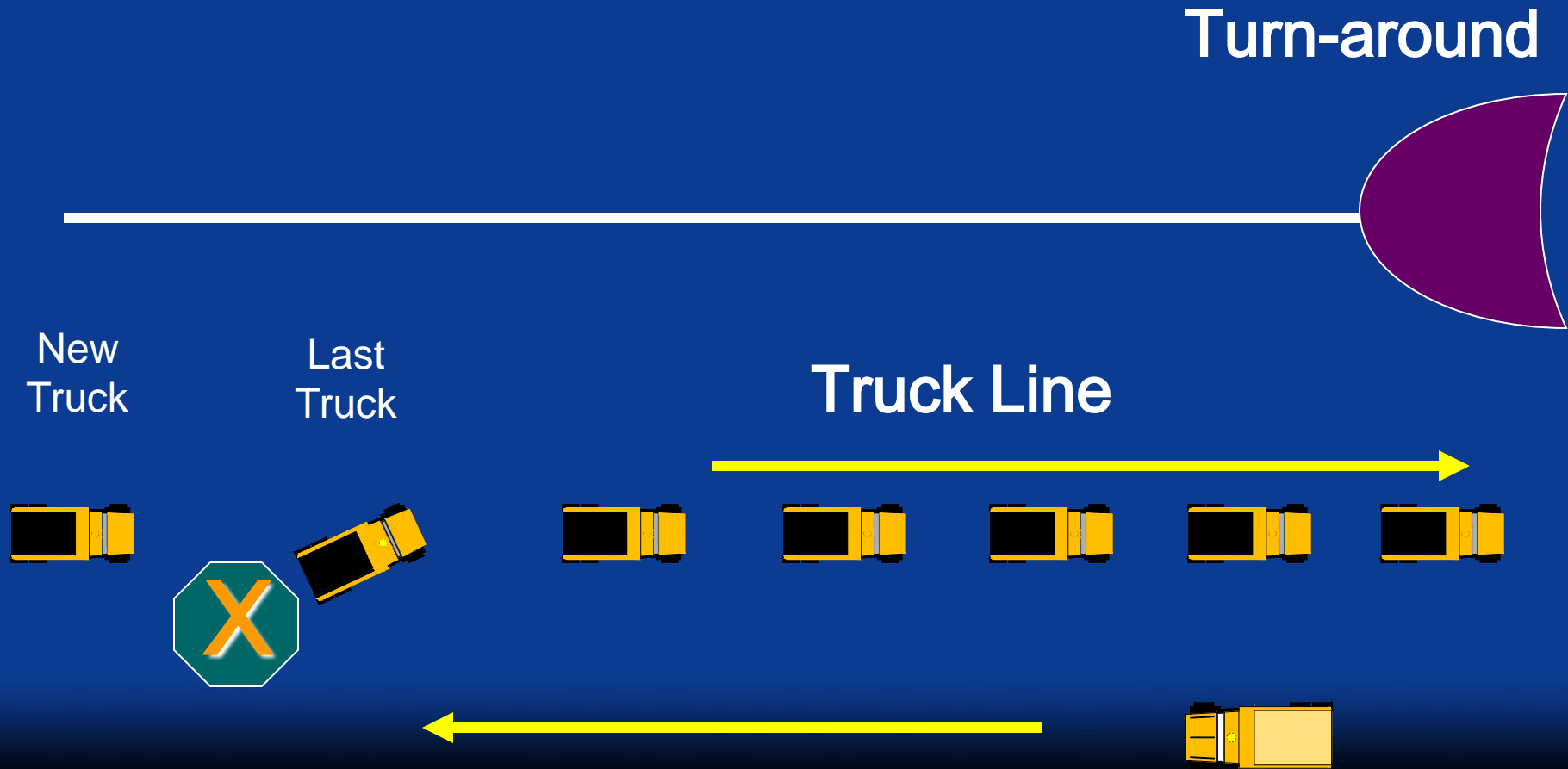


# Concrete Paving Operation Layout





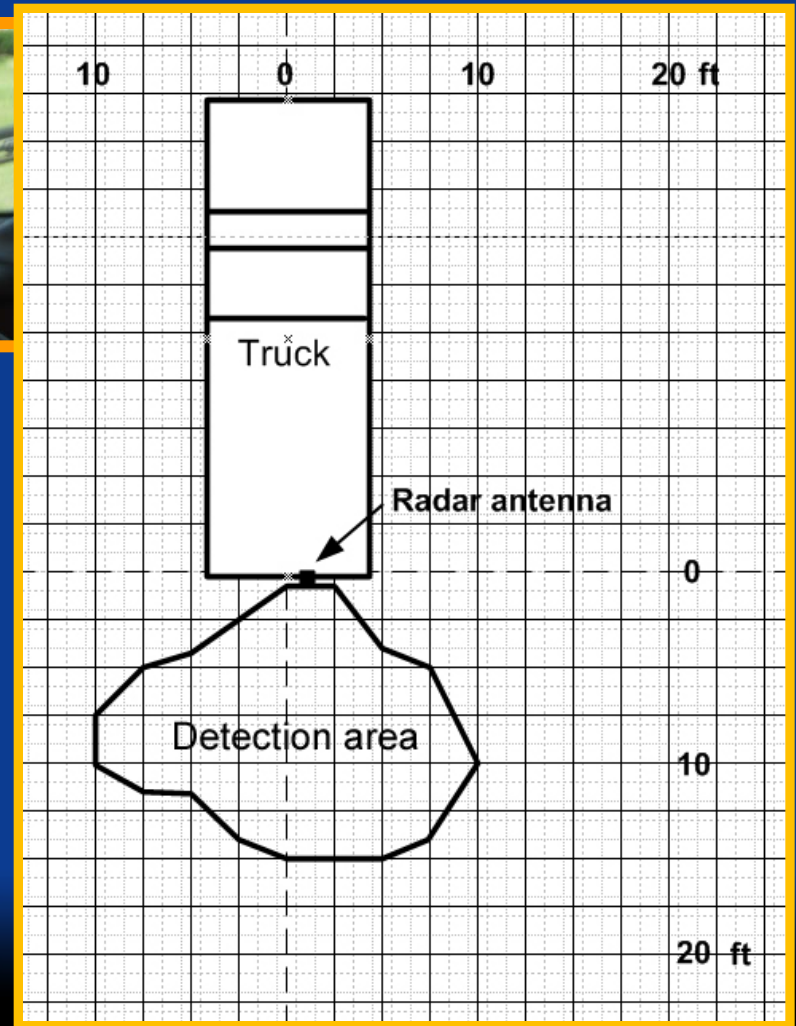
# Truck Queue Repositioning





# Proximity Warning Systems

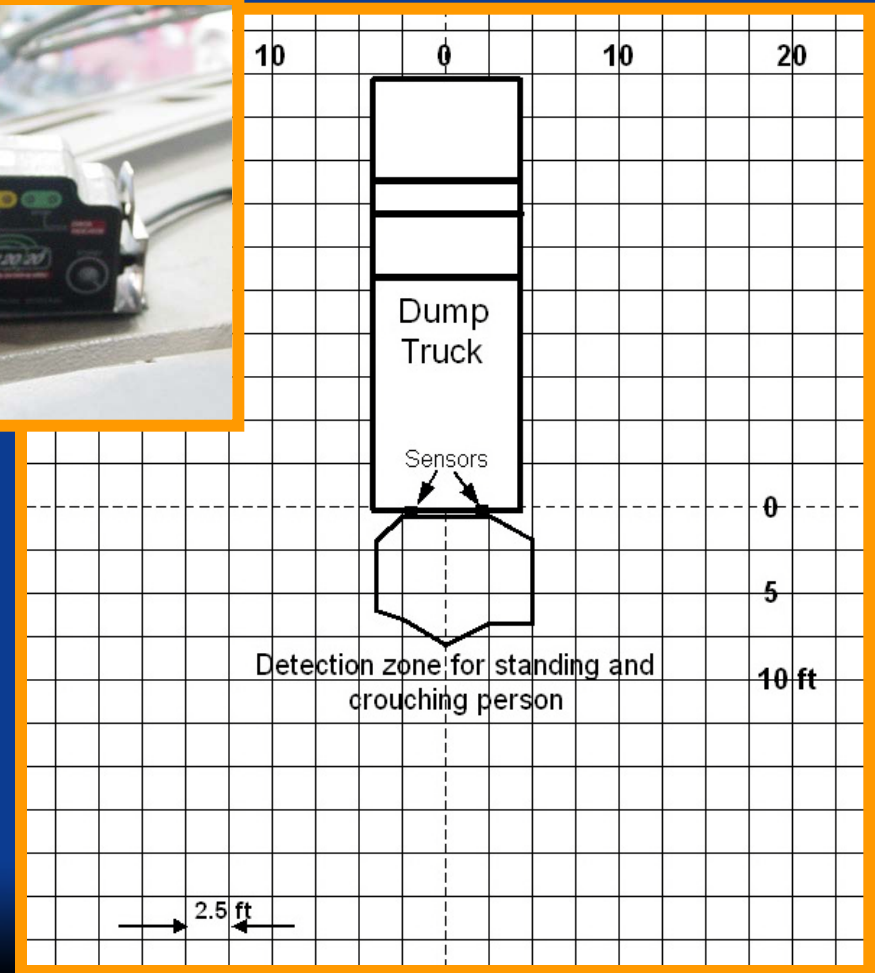
- Preco Preview





# Proximity Warning Systems

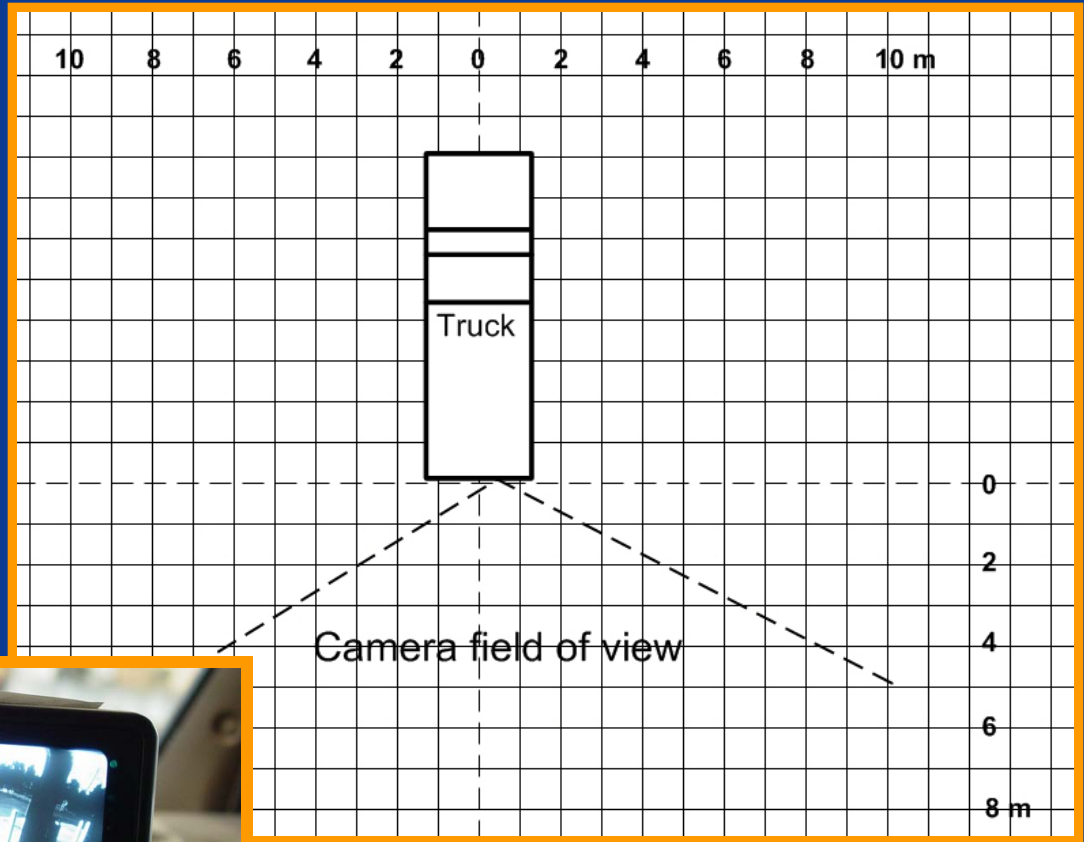
- Hindsight 20/20





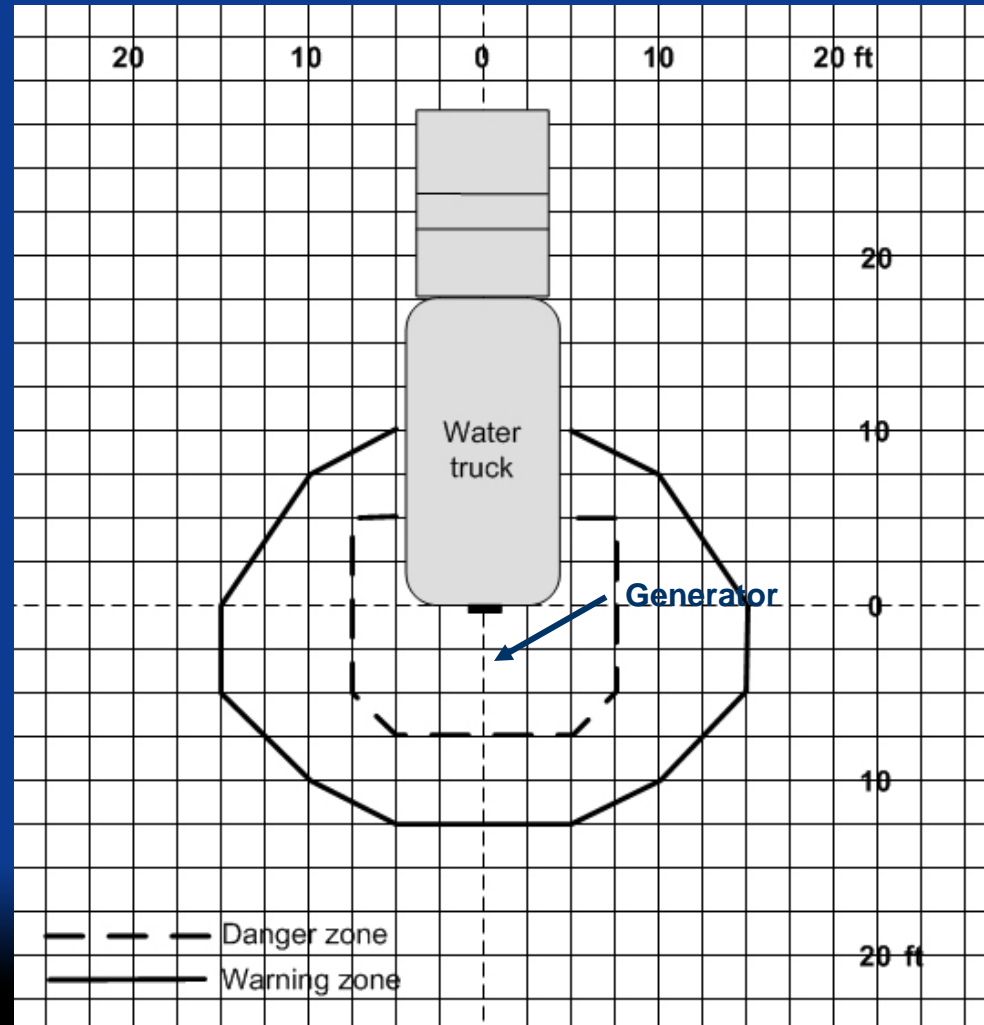
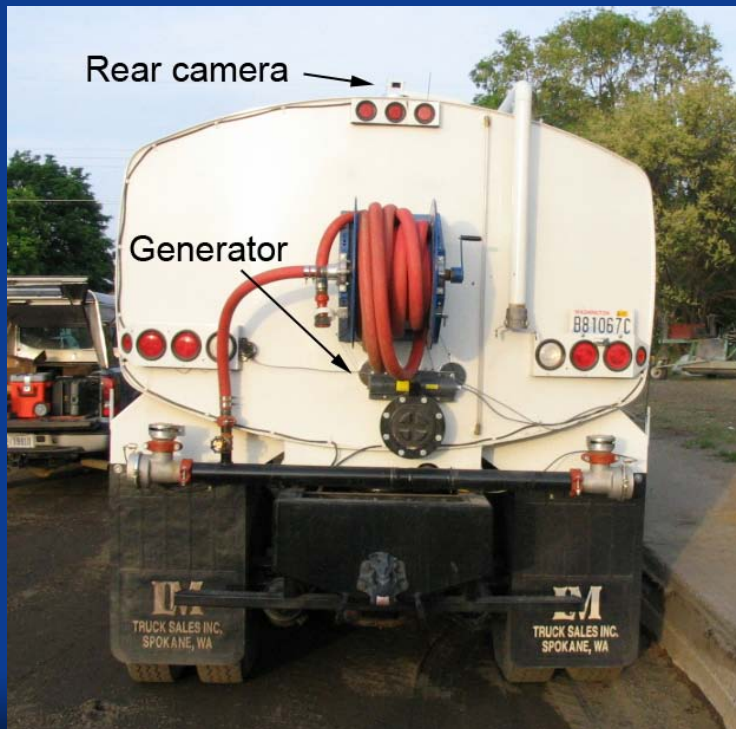
# Proximity Warning Systems

- Intec Camera





# Detection Zones





# PWS Recommendations

## Sonar

- Flush mount
- Short range
- Nuisance alarms
- Dirt/water

## Radar

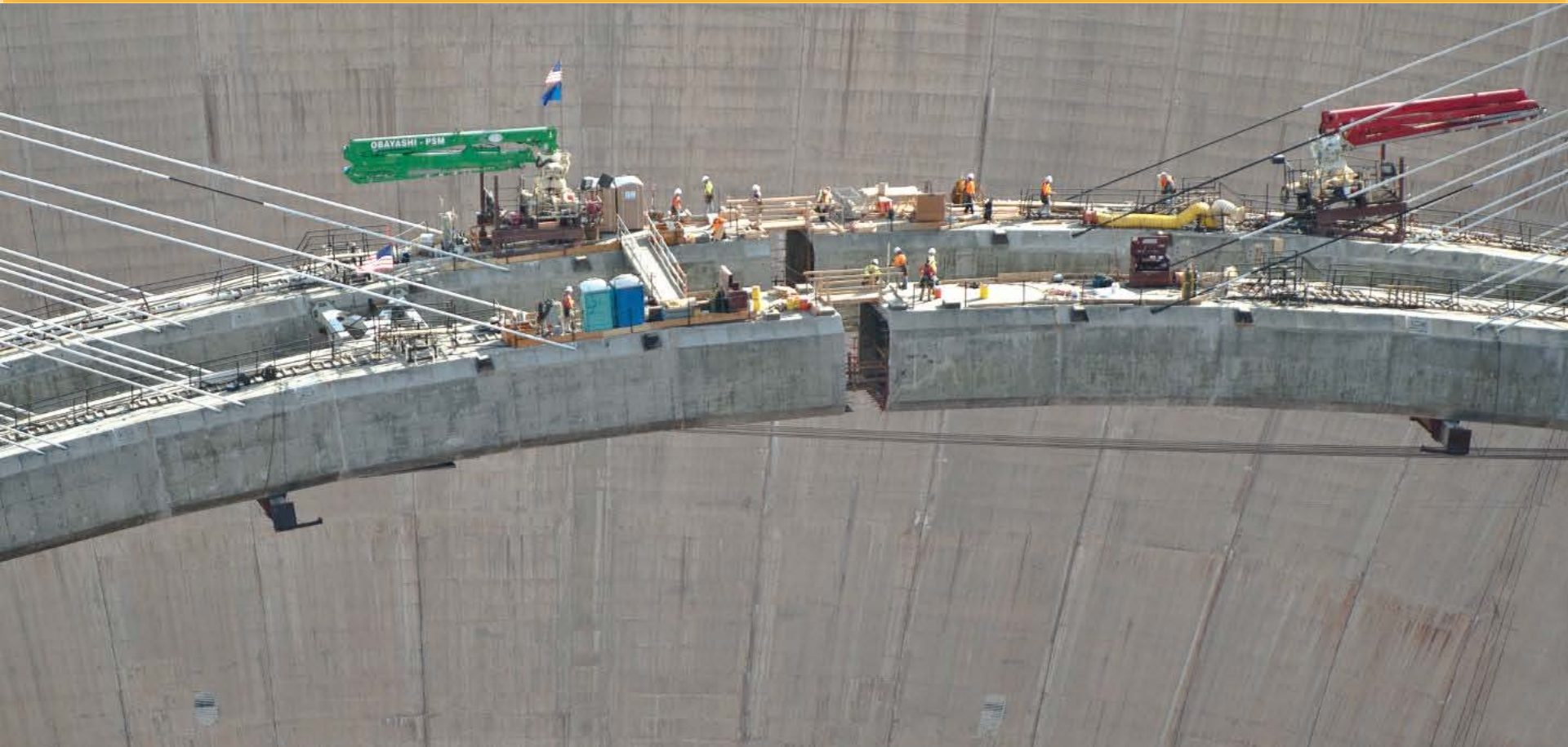
- Good range
- Operates when dirty/wet
- Nuisance alarms

## Camera

- View of blind area
- No alarm
- Requires daily maintenance



# ROAD & BRIDGE CONSTRUCTION HAZARDS



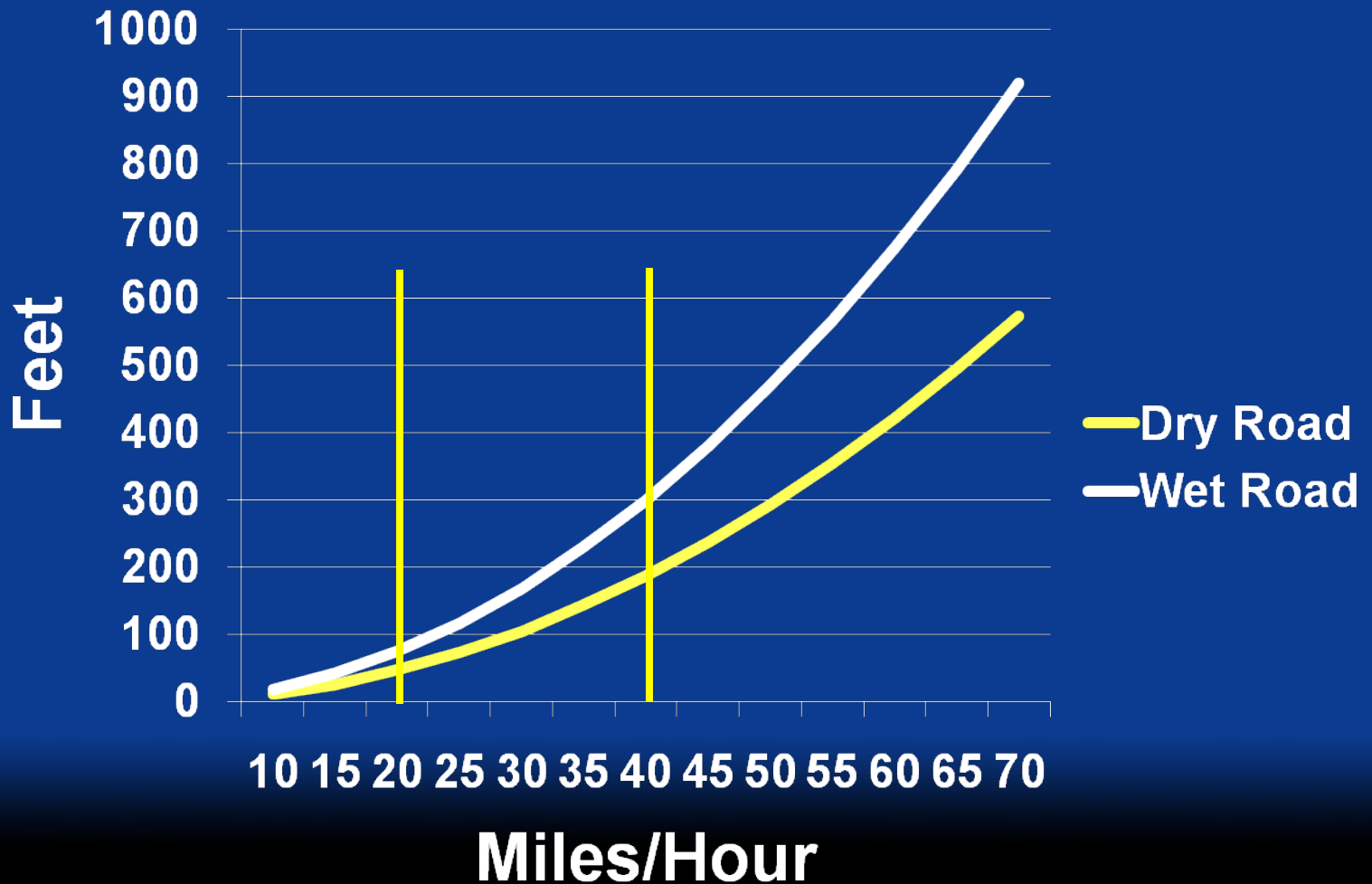


# Efficacy of Channelizing Devices?





# Stopping Distance = $f(\text{Vehicle Speed, Surface Condition})$





# SEPARATING WORKERS FROM TRAFFIC





# Subpart K: Temporary Traffic Control Devices Rule

- Effective date: December 4, 2008
- Purpose: to decrease the likelihood of highway work zone fatalities and injuries to **workers and road users**





# Subpart K: Temporary Traffic Control Devices Rule

- Safety in work zone policy
- **Positive protection**
- Exposure control measures
- Other traffic control measures
- Uniformed law enforcement
- **Safe entry/exit for vehicles and equipment**
- Payment of traffic control
- Quality guidelines

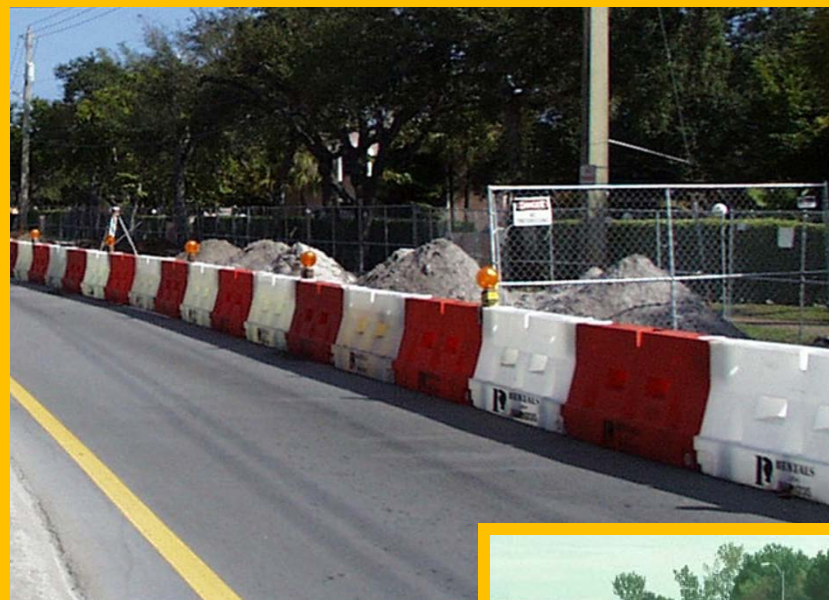




# Traffic Control Devices: Good Positive Guidance for the Motorist















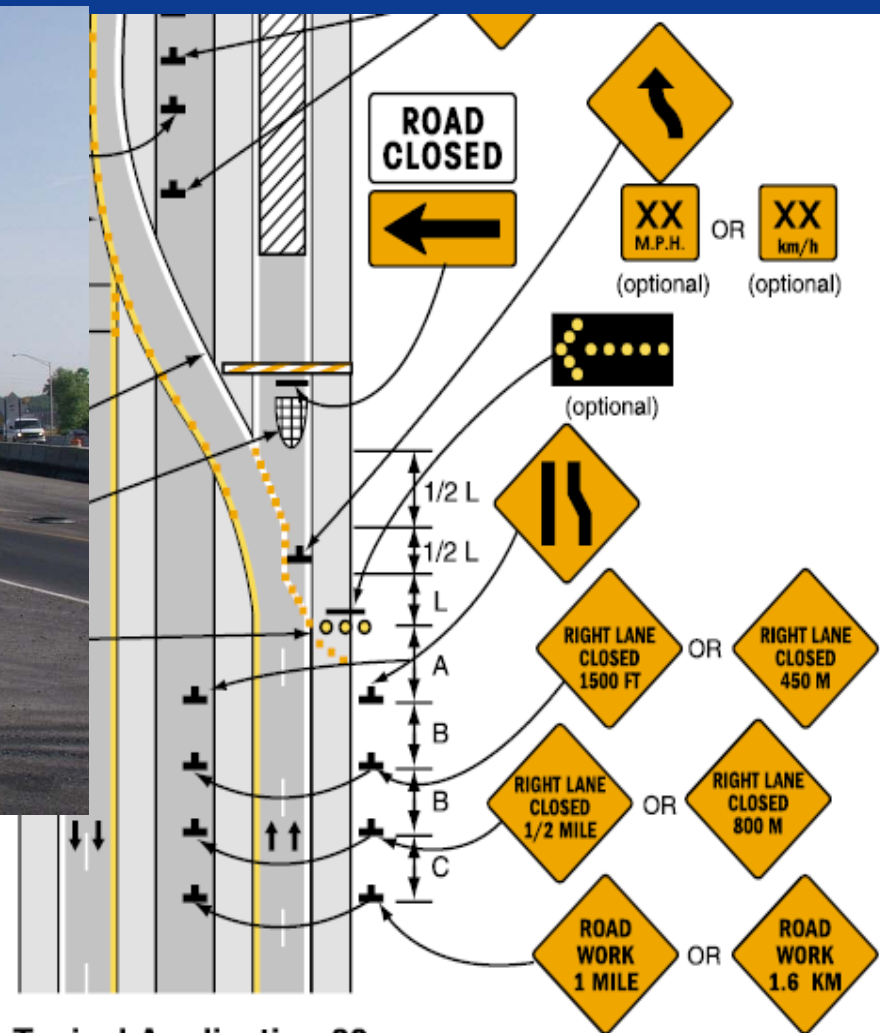












Typical Application 39



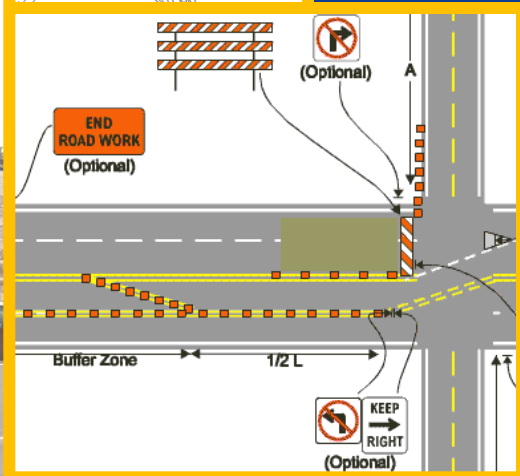
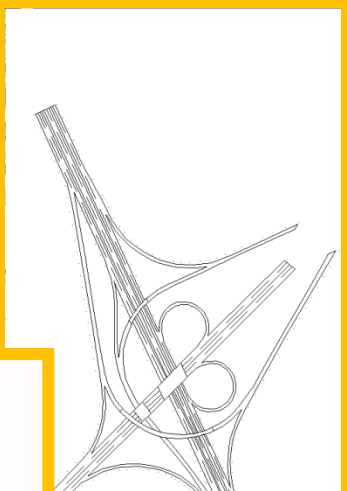




# SAFE ENTRY & EXIT









Agencies should also address **safe means for work vehicles and equipment to enter and exit traffic lanes and for delivery of construction materials to the work space** based on individual project characteristics and factors









# The Typical Interstate Project







Source: Steve Hubbard



# What is the most common method of entering and exiting work zones in the United States?

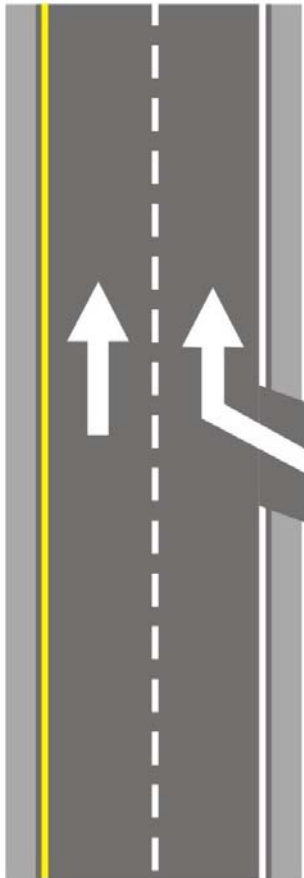








# Trucks Entering Traffic



Haul Road

No Acceleration Lane





# Past Deployments

- Trucks Entering / Exiting
- Slow Speed Advisory















CONSTRUCTION VEHICLE  
DO NOT FOLLOW















Source: Steve Hubbard

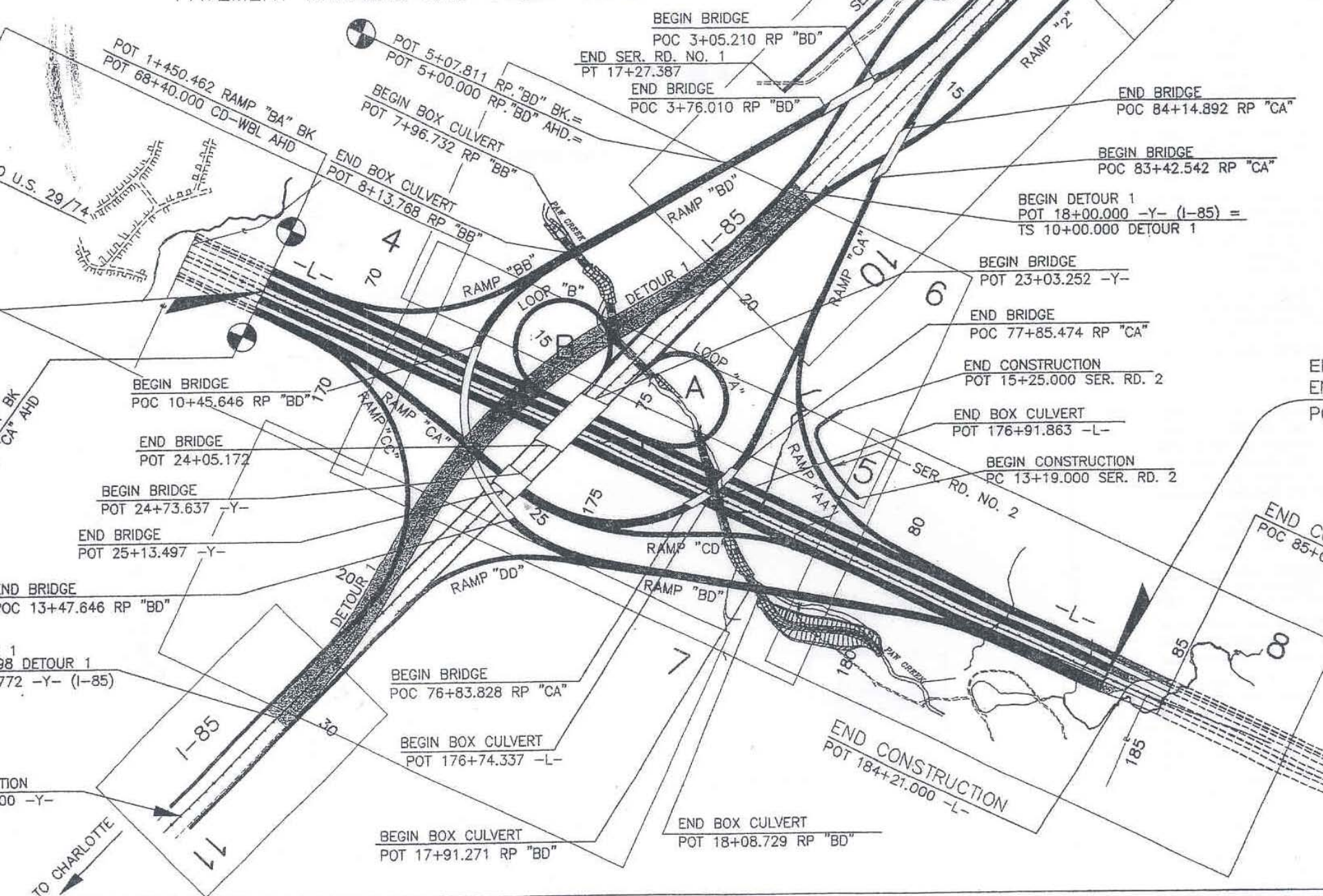




Source: Steve Hubbard



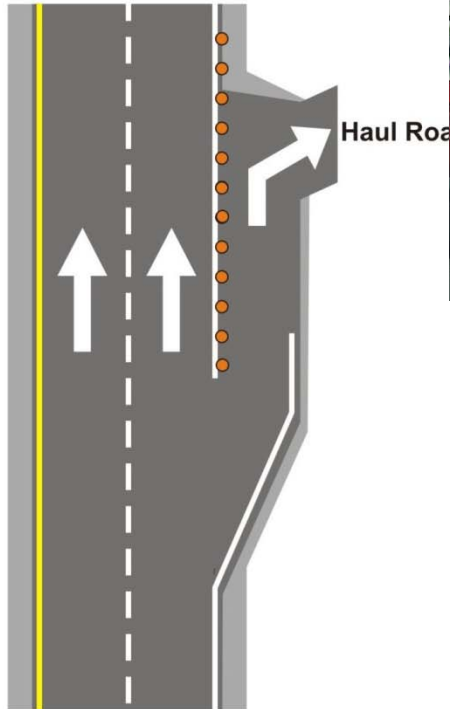
TYPE OF WORK: GRADING, DRAINAGE, PAVING, CULVERTS, STRUCTURES,  
SIGNING, LONGIFE PAVEMENT MARKING, SNOWPLOWABLE  
PAVEMENT MARKERS AND UTILITY CONSTRUCTION



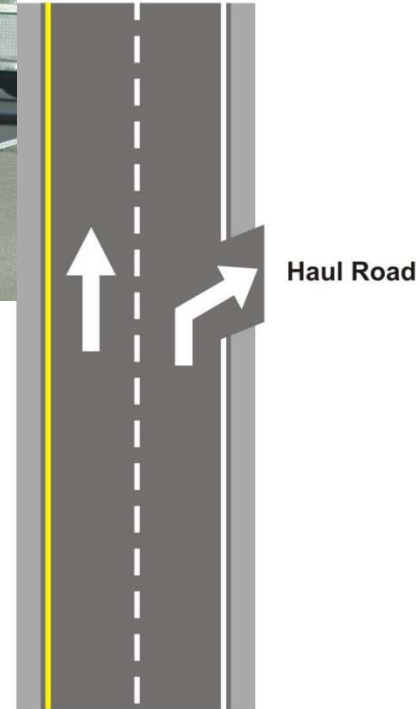


# Trucks Exiting Traffic

CONSTRUCTION VEHICLE  
DO NOT FOLLOW



De-acceleration Lane



No De-acceleration Lane



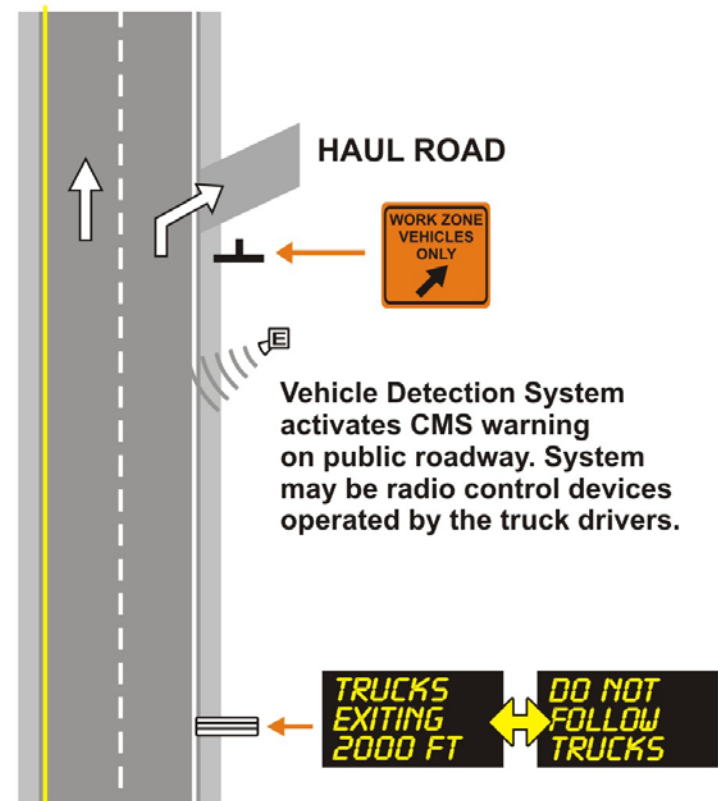




# Truck Activated Caution Message



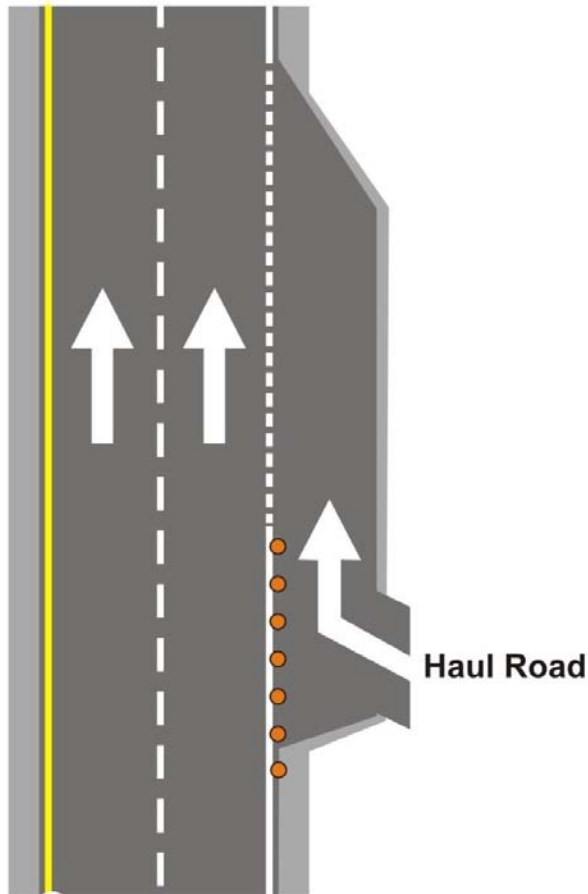
## No De-acceleration Lane



NOTE: Some temporary traffic control devices may have been omitted from this diagram for clarity purposes.



# Trucks Entering Traffic



Acceleration Lane



**OSHA**

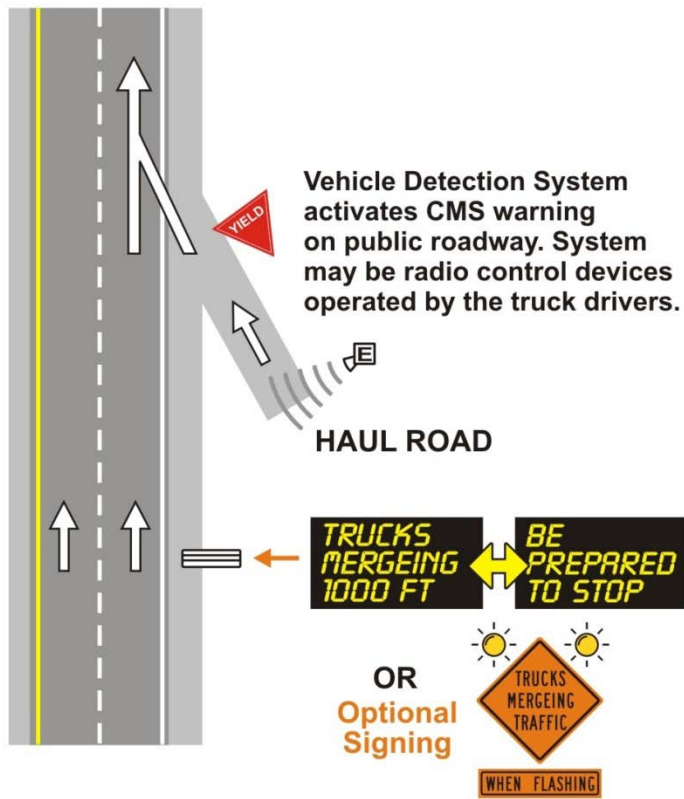






# Signs Activated by Trucks

## No Acceleration Lane



NOTE: Some temporary traffic control devices may have been omitted from this diagram for clarity purposes.



Wireless sensor location along haul road

**MOSH**

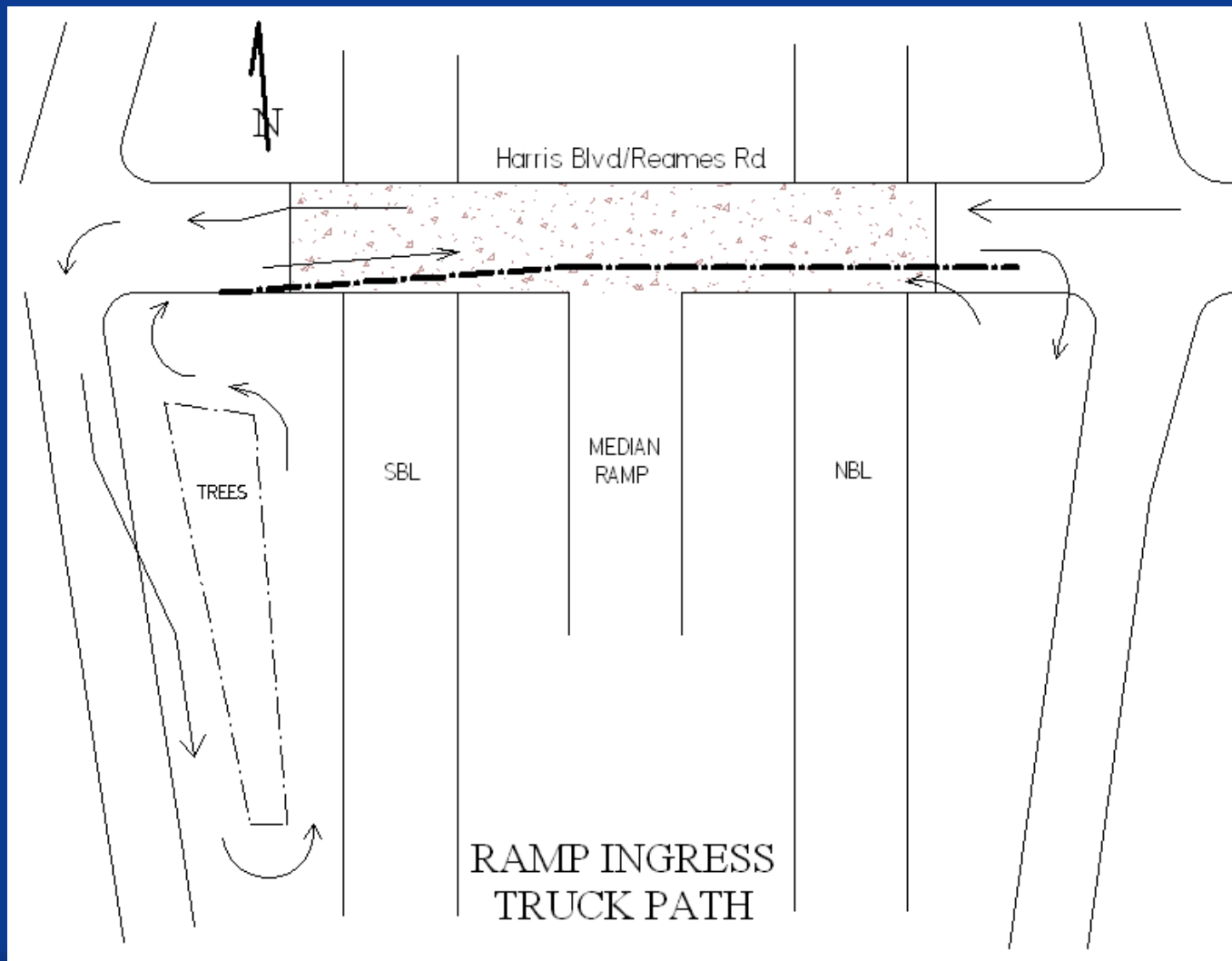


# Safe entry and exit from the work space

- **Innovation - Design/Build Ramp**
  - ◆ Limit entry into high-speed traffic stream
  - ◆ Utilize overpass and local street traffic control signals















Source: Steve Hubbard

























Source: Steve Hubbard





Source: Steve Hubbard







# Safe entry and exit from the work space



- Controlled access points
- Entering and exiting vehicles same direction as traffic
- Signage – Truck, VMS, Static
- Work scheduling



# Roadway

# Safety+ It's Here Now!

v9.0

DTFH61-06-G-00007

## 4 New Topics

- Temporary Traffic Control
- Expanded Night Work Module
- Expanded Runovers and Backovers Module
- Disaster Response







## The National Work Zone Safety Information Clearinghouse

THE WORLD'S LARGEST INTERNET RESOURCE

[Crash Data](#)[Expert  
Contacts](#)[Laws &  
Regulations](#)[News &  
Events](#)[Public  
Awareness](#)[Research](#)[Safety  
Products](#)[Standards &  
Practices](#)[Training](#)[Links](#)

### RUNOVER AND BACKOVER

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- › [Vendors](#)
- › [Internal Traffic  
Control Plans](#)
- › [Blind Spot Alley](#)
- › [Research](#)
- › [Links](#)

### SEARCH IN THIS SECTION

## Preventing Backovers

Did you know that the leading cause of fatalities for workers in work zones is being run over or backed over by vehicles? While we often worry about construction workers being killed by motorists, road workers working behind the barriers in the work zone are at equal risk of being killed by construction vehicles due to their large "blind spots." Each month, at least one worker is killed by being backed over by a construction vehicle, often a dump truck. These deaths are completely preventable. This section is designed to help you prevent more workers from being killed on the job. Let's stop back over deaths now!

To view the contents of this section, use the links on the left column.







FHWA Roadway Work Zone  
Training Consortium

# ANSI Standards Development

- ANSI A10 Standard for Roadway Construction
- Topics Include:
  - ◆ Traffic Control
  - ◆ Flagger Safety
  - ◆ Runover/Backover Prevention
  - ◆ Equipment Operator Safety
  - ◆ Health Hazards
  - ◆ Night Work
  - ◆ Personal Protective Equipment



A photograph of two individuals, likely researchers or field workers, standing in front of industrial machinery. They are wearing high-visibility yellow-green safety suits with orange reflective stripes and hard hats. The person on the left is holding a small object, possibly a sample or tool. The background shows complex industrial equipment, including a yellow tank with the 'Igloo' brand name visible. The scene is dimly lit, suggesting an indoor or nighttime industrial setting.

# Thank you!

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