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

- 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
  - Worker Exposure Measurement
  - Blind Area Determination

- Pittsburgh, PA
  - HASARD
  - Work Zone Analysis System

- Spokane, WA
  - Proximity Warning Devices
  - 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.
The mention of any company name or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

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- 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Local</th>
<th>State/D.C.</th>
<th>Federal</th>
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<td>2003</td>
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<td></td>
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<tr>
<td>2007</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Bridge, Tunnel, and Elevated Highway Construction</th>
<th>Highway and Street Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Protection (50)</td>
<td>Hazard Communication (60)</td>
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<tr>
<td>Cranes (43)</td>
<td>Excavation (60)</td>
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<tr>
<td>General (34)</td>
<td>Respiratory (45)</td>
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<tr>
<td>Lead (26)</td>
<td>Protective Systems (36)</td>
</tr>
<tr>
<td>Working /Over Near Water (23)</td>
<td>Signs and Tags (28)</td>
</tr>
</tbody>
</table>
INJURIES AND ILLNESSES IN ROAD & BRIDGE CONSTRUCTION

CDC

NIOSH
Employment in 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)

- Foundation, structure, and building exterior contractors: 2.4
- Building equipment contractors: 1.6
- Building finishing contractors: 2.0
- Other specialty trade contractors: 1.7

Source: Census of Fatal Occupational Injuries www.bls.gov/iif
Heavy & Civil Engineering Construction
Injuries in 2008

- Total Cases: 40,700
- DAFW: 21,900
- DAFW due to Transportation: 1,230
- Close Calls: ?????
Heavy Civil Engineering Injuries and Illnesses by Subsector in 2008 (n=14,150) (Rate per 100 workers)

- Utility system construction: (1.5)
- Land subdivision: (1.0)
- Highway, street, and bridge construction: (1.8)
- Other heavy and civil engineering construction: (0.6)

Source: Census of Fatal Occupational Injuries  www.bls.gov/iif
Injuries and Illnesses by Occupation in
Highway Street and Bridge Construction (n=5,690)

Transportation and material moving
Production
Installation maintenance and repair
Construction and extractive
Office and administrative support
Service
Professional and related
Management business financial

Injuries and Illnesses in thousand workers

Source: Census of Fatal Occupational Injuries  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
Employment in 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

- Occupational Fatalities: 5,214
- Construction Fatalities: 1,016
- Highway, Street, and Bridge Fatalities: 119
- Worker Struck by Vehicle in Highway, Street, and Bridge: 43
Worker Deaths in Roadway Construction

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
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)

- Struck by Vehicle or Equipment: 37%
- Highway: 23%
- Struck-by Object: 10%
- Non-Highway: 6%
- Caught-in Equipment or Object
- Falls to Lower Level
- Electrical Contact
- Other

Source: Census of Fatal Occupational Injuries  www.bls.gov/iif
Worker Deaths in Highway, Street, and Bridge Construction

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

- Trucks: 58%
- Construction Machinery: 22%
- Automobiles: 13%
- Other: 0%

Source: Census of Fatal Occupational Injuries www.bls.gov/iif
SAFELY WORKING AROUND TRUCKS AND EQUIPMENT
Fatality Assessment and Control Evaluation States Participating in the Program

[Map showing states participating in the program with different colors indicating State FACE, Non-FACE states where investigations have been conducted, In-House FACE, and states where no FACE investigations have been performed.]

** Technical Assistance Visit
Laborer Run Over by Dump Truck at Roadway Resurfacing Operation in Virginia

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

Source: NIOSH FACE-98-19
View from Inside the Cab

Bug Shield

Fan

Air Cleaner and Door Post

Stickers

Mirror

CDC

NIOSH
Blind Area
Dump Truck
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." (Fruit 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 (5'). 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 95th 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.
Efficacy of Site Safety?
Driver Died When Mixer Truck Overturned

Source: Oklahoma Case Report: 00-OK-073
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!!!

<table>
<thead>
<tr>
<th>MPH</th>
<th>Feet in 1.0 Second</th>
<th>Feet in 2.5 Seconds</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>15</td>
<td>37</td>
</tr>
<tr>
<td>20</td>
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<td>30</td>
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<td>70</td>
<td>103</td>
<td>257</td>
</tr>
<tr>
<td>80</td>
<td>118</td>
<td>294</td>
</tr>
</tbody>
</table>

A Dump Truck Backing at 10 MPH Covers 14.7 Feet In 1 Second!!!!!!!!!
Worker Dies After Being Backed Over By a Rear End Dump Truck

Source Minnesota Face Program (MN9207)
Concrete Paving Operation Layout

Turn-around

Truck Line

Paver

CDC

NIOSH
Truck Queue Repositioning

- New Truck
- Last Truck
- Truck Line
- Turn-around

CDC
NIOSH
Proximity Warning Systems

- Preco Preview
Proximity Warning Systems

- Hindsight 20/20

Detection zone for standing and crouching person

CDC

NIOSH
Proximity Warning Systems

- Intec Camera
Detection Zones
# PWS Recommendations

<table>
<thead>
<tr>
<th>Sonar</th>
<th>Radar</th>
<th>Camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Flush mount</td>
<td>• Good range</td>
<td>• View of blind area</td>
</tr>
<tr>
<td>• Short range</td>
<td>• Operates when dirty/wet</td>
<td>• No alarm</td>
</tr>
<tr>
<td>• Nuisance alarms</td>
<td>• Nuisance alarms</td>
<td>• Requires daily maintenance</td>
</tr>
<tr>
<td>• Dirt/water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Efficacy of Channelizing Devices?
Stopping Distance = f(Vehicle Speed, Surface Condition)

Miles/Hour

Feet

Dry Road
Wet Road
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
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
TYPE OF WORK: GRADING, DRAINAGE, PAVING, CULVERTS, STRUCTURES, SIGNING, LONGLIFE 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

Vehicle Detection System activates CMS warning on public roadway. System may be radio control devices operated by the truck drivers.

CONSTRUCTION VEHICLES ONLY

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

- Acceleration Lane
- Haul Road
Signs Activated by Trucks

No Acceleration Lane

Vehicle Detection System activates CMS warning on public roadway. System may be radio control devices operated by the truck drivers.

HAUL ROAD

TRUCKS MERGING 1000 FT BE PREPARED TO STOP

OR Optional Signing

TRUCKS MERGING TRAFFIC WHEN FLASHING

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

Wireless sensor location along haul road
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
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
4 New Topics

• Temporary Traffic Control
• Expanded Night Work Module
• Expanded Runovers and Backovers Module
• Disaster Response
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.
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
Thank you!

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