

NIOSH Reports! Studies on Heavy Equipment Blind Spots and Internal Traffic Control



Presented by

David E. Fosbroke

NIOSH, Division of Safety
Research

2004 Roadway Work Zone Safety & Health Conference

Baltimore, Maryland

November 4, 2004



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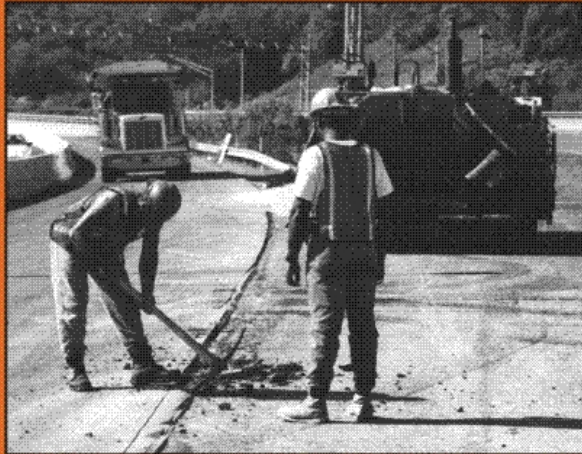
Outline

- **Background**
 - ◆ **NIOSH Research**
 - ◆ **Worker Deaths**
- **Blind Area Diagrams**
- **Internal Traffic Control Plans**



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Building Safer Highway Work Zones:

Measures to Prevent Worker Injuries
from Vehicles and Equipment

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



*Delivering on the Nation's Promise:
Safety and health at work
For all people
Through research and prevention*

To receive other information about occupational safety and health topics, call
1-800-35-NIOSH (1-800-356-4674), or
visit the NIOSH Website at:
www.cdc.gov/niosh

DHHS (NIOSH) PUBLICATION No. 2001-128



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Evaluating Roadway Construction Work Zone Interventions



Doug Ammons, Steve Berardinelli, Jennifer Beaupre, Dave Fosbroke, Chris Griffin, Robert Hammer, Mat Hause, Scott Hendricks, Gary Mowrey, Brad Newbraugh, Kara Perritt, John Powers, Stephanie Pratt, Justin Tolpa, Todd Ruff, Bill Schiffbauer

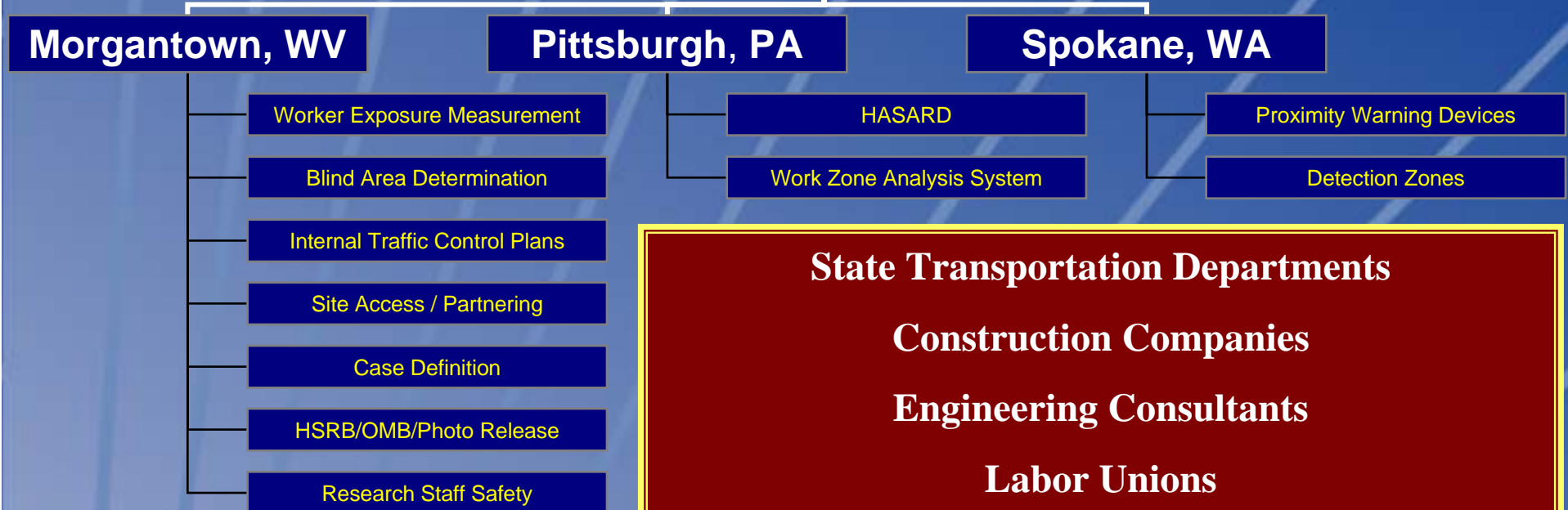


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Project Organization

Roadway Work Zone Intervention Evaluations



State Transportation Departments

Construction Companies

Engineering Consultants

Labor Unions

Construction Trade Associations

Equipment Manufacturers

FHWA, OSHA



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The Problem

- Preventing workers from being run over by construction trucks and equipment.



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The Project Goals

- Limit exposure of workers-on-foot to construction traffic.
- Focus on blind areas around construction vehicles and equipment.
 - ◆ Develop exposure monitoring system(s)
 - ◆ Evaluate injury prevention measures



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The Interventions

- Proximity Warning Systems
- Internal Traffic Control Plans



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Proximity Warning Systems

➤ Evaluate off-the-shelf technology including:

- ★ Radar
- ★ Sonar
- ★ Cameras
- ★ Tag-based systems



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Camera Systems



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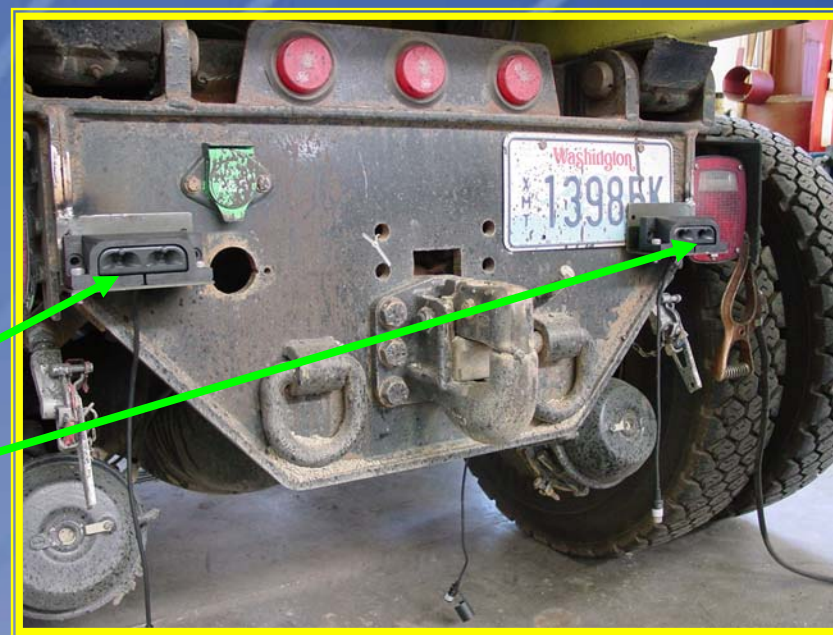
Radar



Sonar



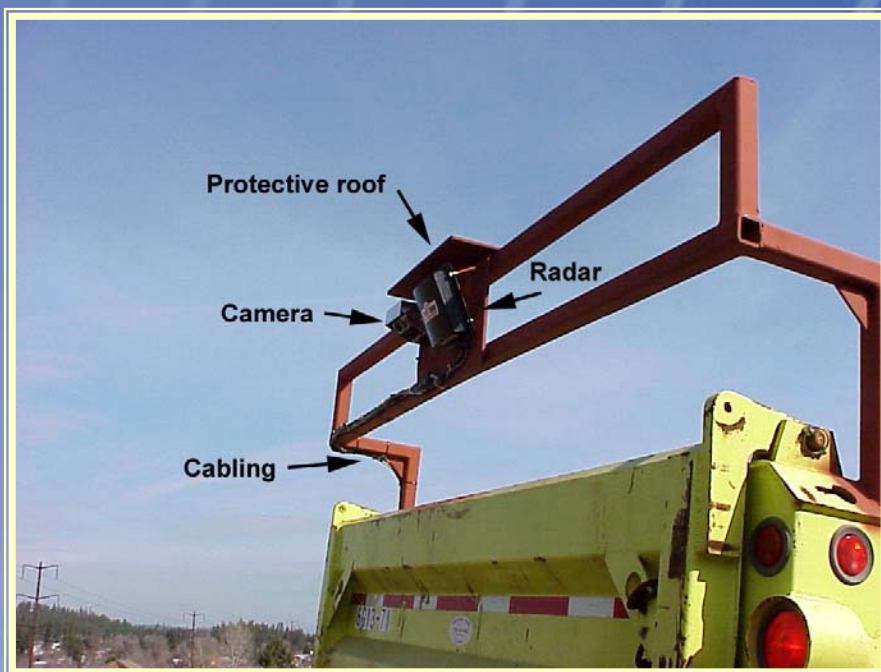
Sensors



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Camera and Radar



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Proximity Warning Systems: Data collection methods

- Video
- Alarm overlay
- Alarm data



Warning system alarms



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HASARD

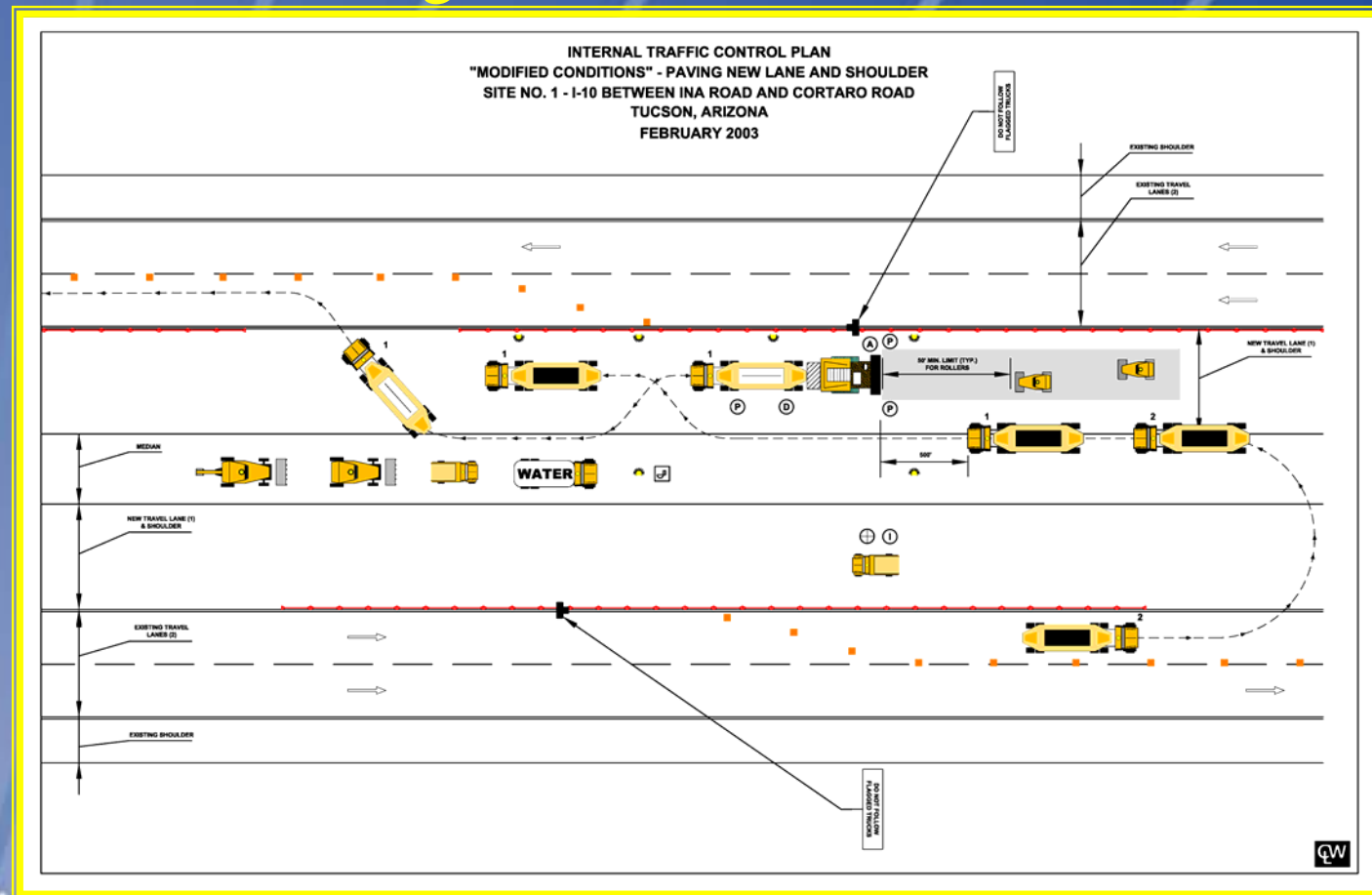


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INTERNAL TRAFFIC CONTROL PLANS

Paving Model Plan – Site #1



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Field Trials

- Direct Observation
- GPS
- Video



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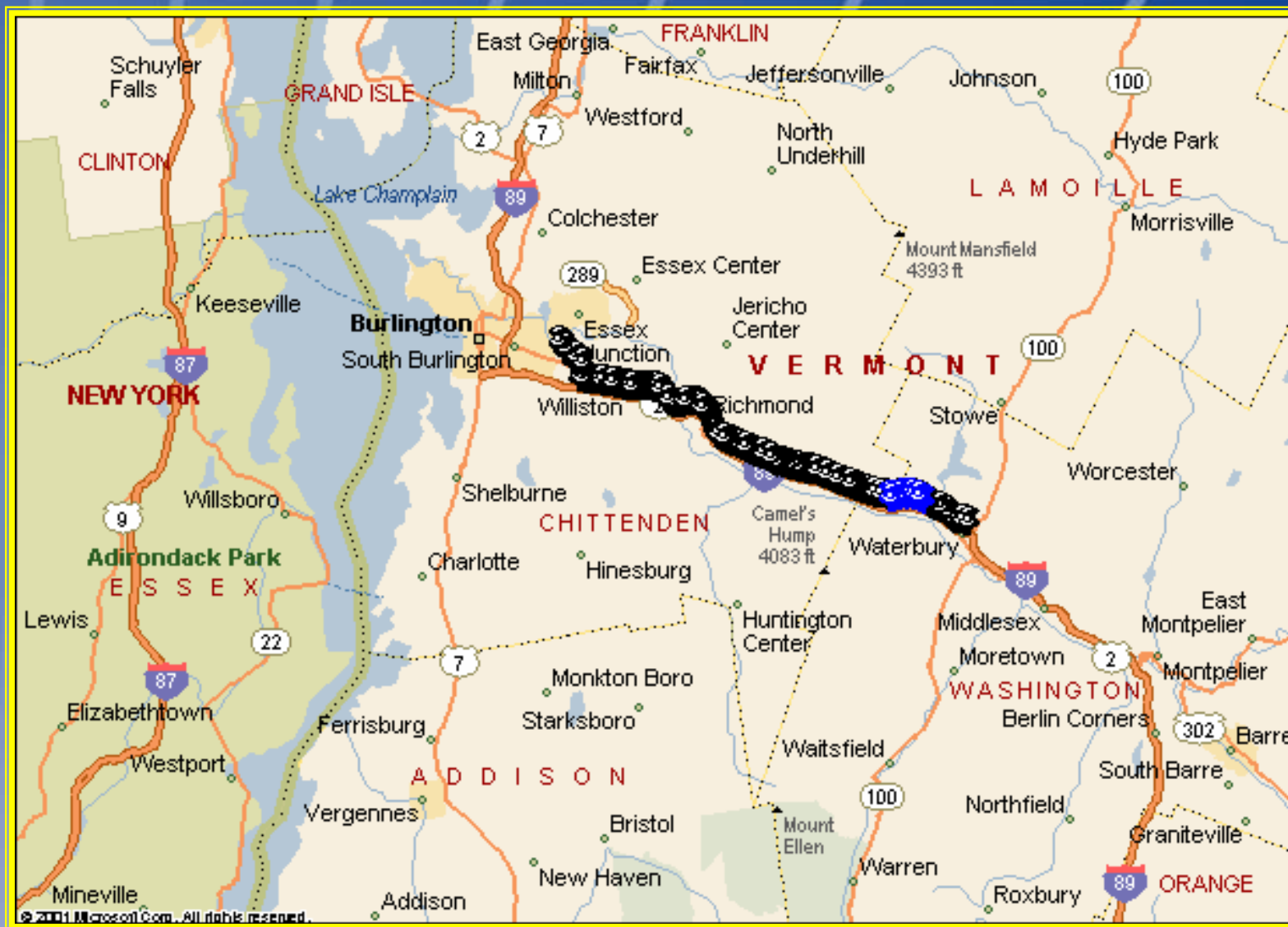


- **GPS Installed on Equipment including:**
 - ◆ **Asphalt Trucks**
 - ◆ **Paver**
 - ◆ **Rollers**
- **GPS receivers worn by workers**



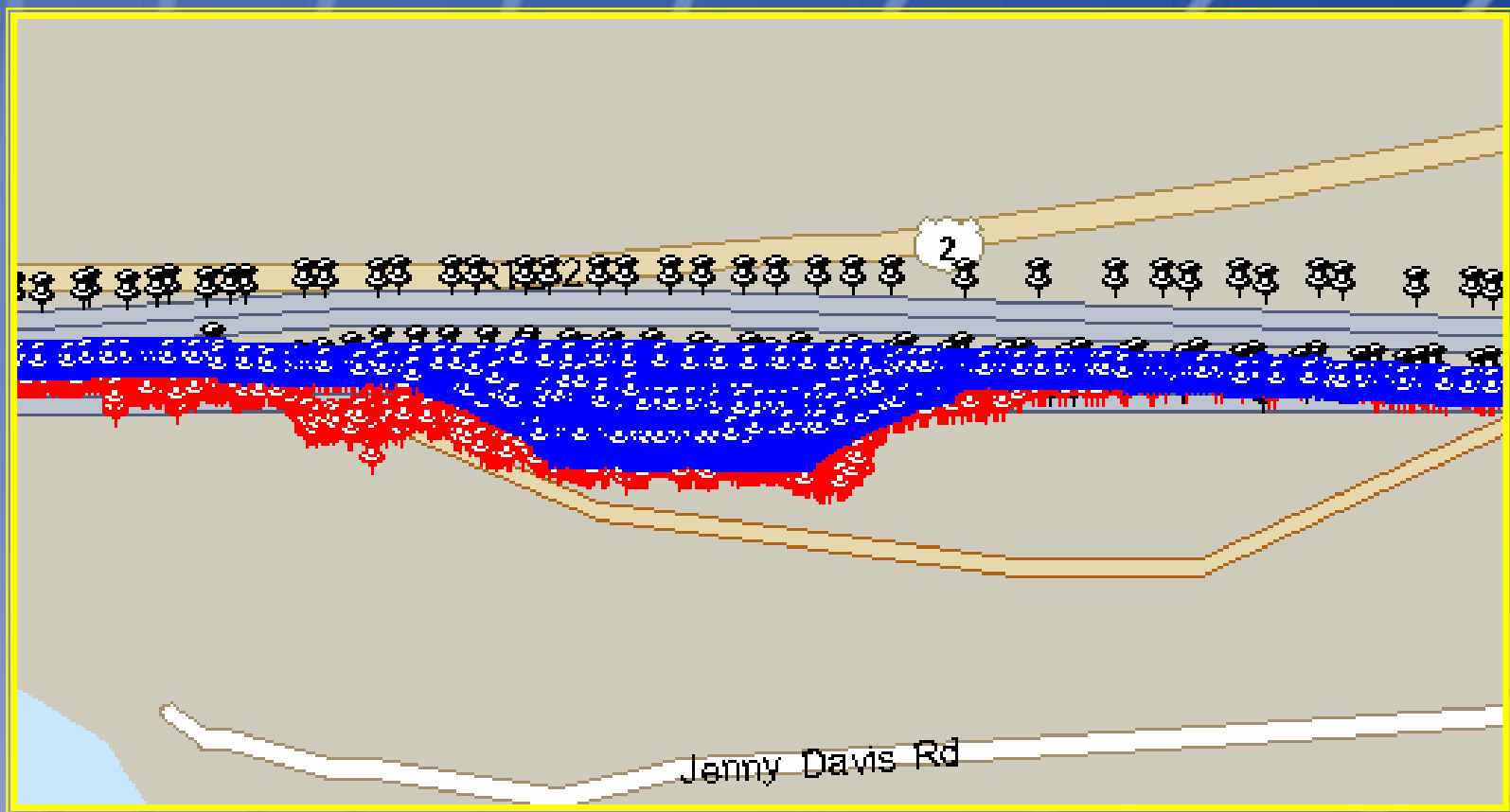
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Vermont GPS Data Overlaid in Map Point





Vermont GPS Data Paving Around a Rest Area



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Background: *Worker Deaths in Work Zones*



- 910 worker deaths in work zones from 1992-2000
- 826 (91%) were vehicle or equipment-related (traffic vehicle, construction vehicle, or both)



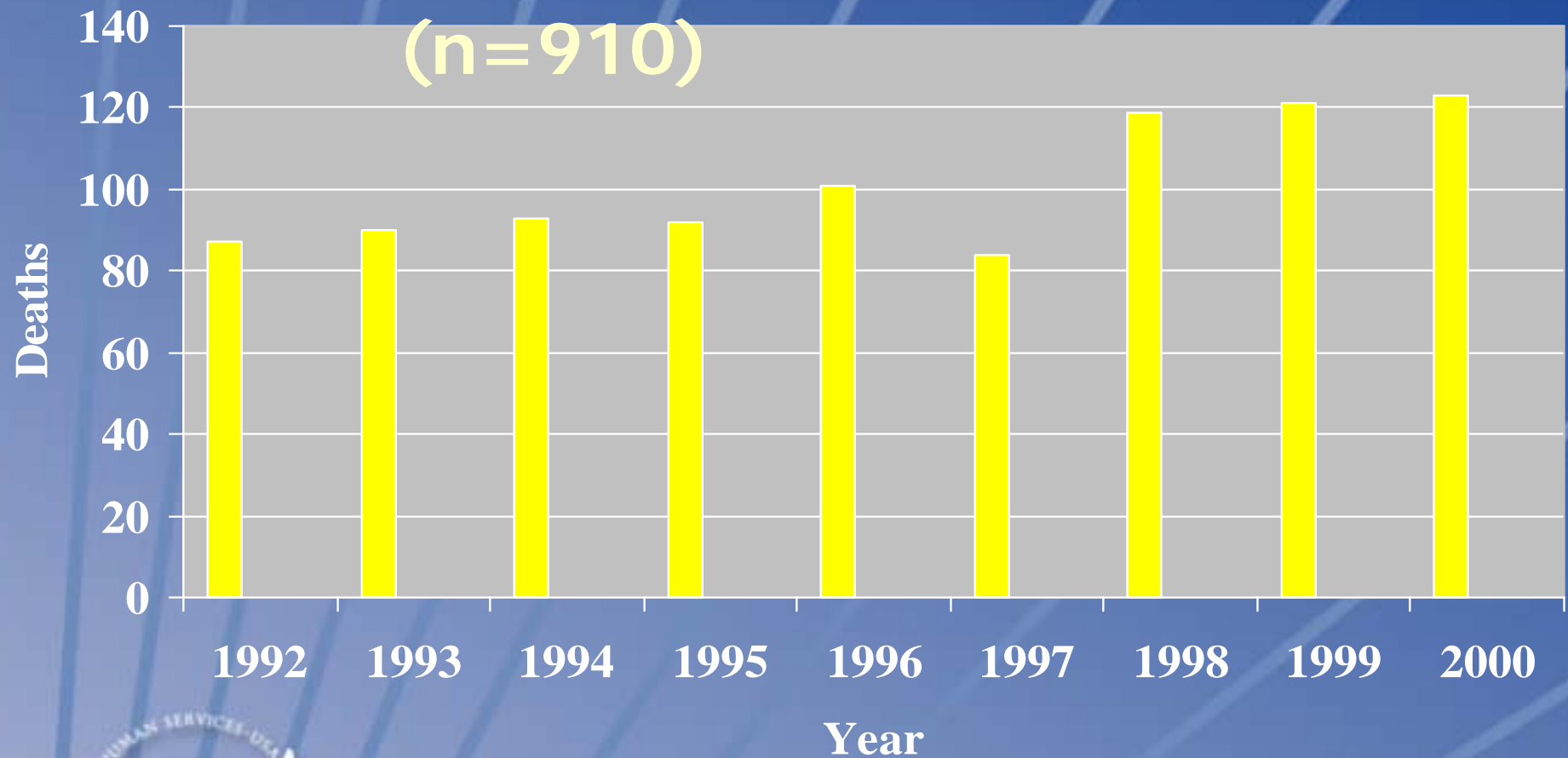
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Worker Fatalities in Roadway Construction

Trend from 1992-2000

(n=910)



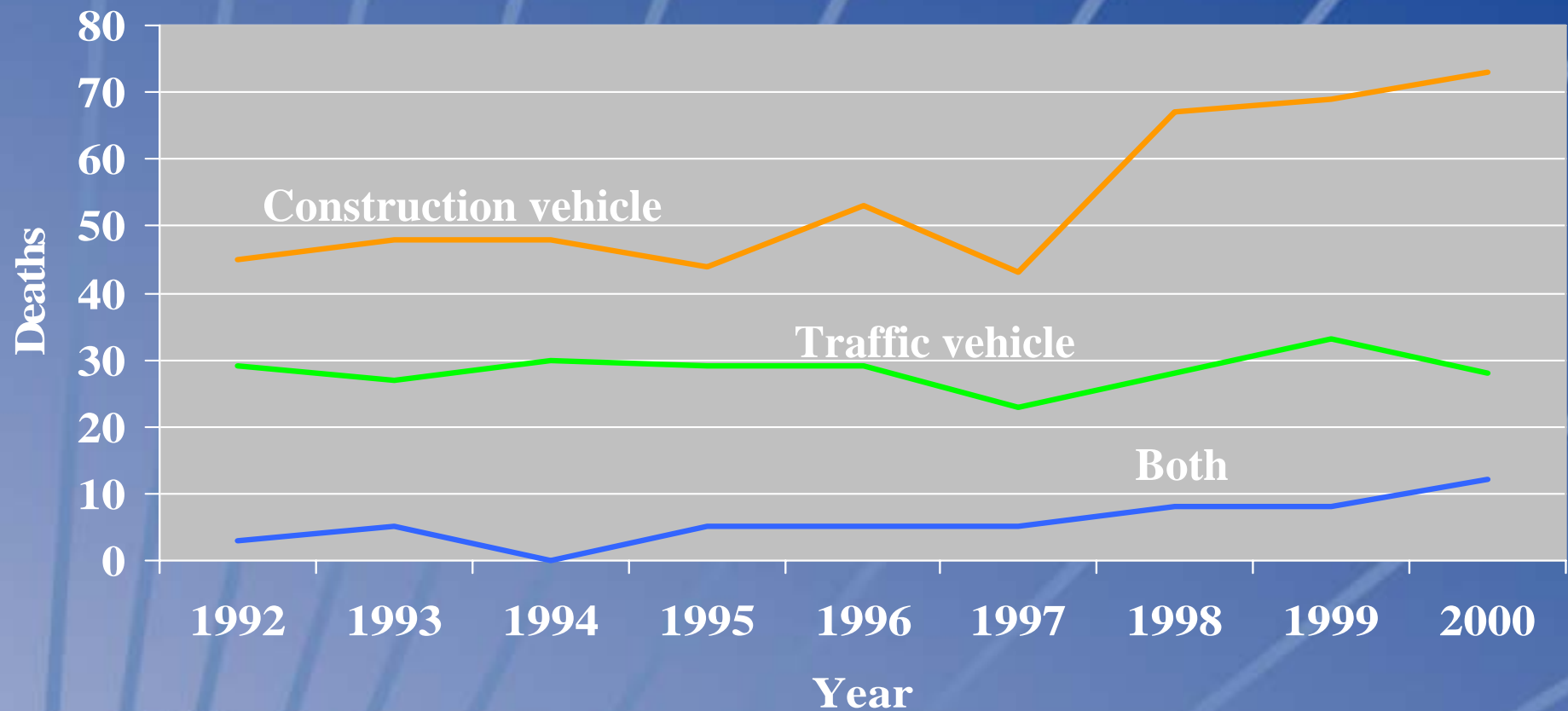
Source: Census of Fatal Occupational Injuries,
special research file (excludes NYC)



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Worker Fatalities in Roadway Work Zones, by Vehicle Type and Year, 1992-2000 (n=797)



Source: Census of Fatal Occupational Injuries,
special research file (excludes NYC)

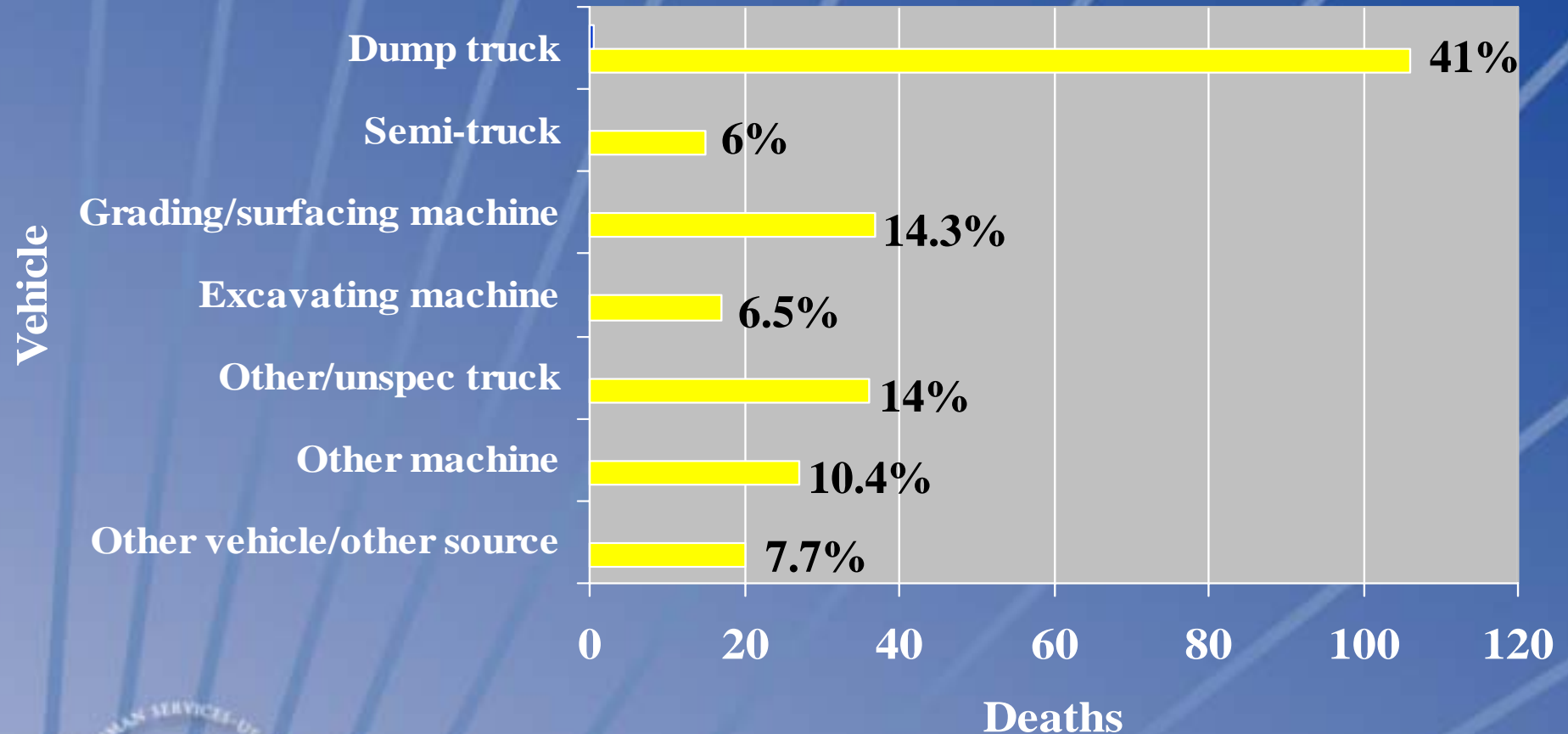


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Workers on Foot – Construction Vehicle Only

Deaths by Construction Vehicle Type, 1992-2000 (n=258)



Source: Census of Fatal Occupational Injuries, special research file (excludes NYC)



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City Worker Killed When Struck by a Dump Truck in Washington State

FATALITY INVESTIGATION REPORT



Investigation: # 00WA041
SHARP Report: # 52-11-2004

Release Date: August 5, 2004



WA FACE Program/SHARP
PO Box 44330
Olympia, WA 98504-4330
(888) 667-4277
<http://www.lni.wa.gov/Safety/Research/FACE>



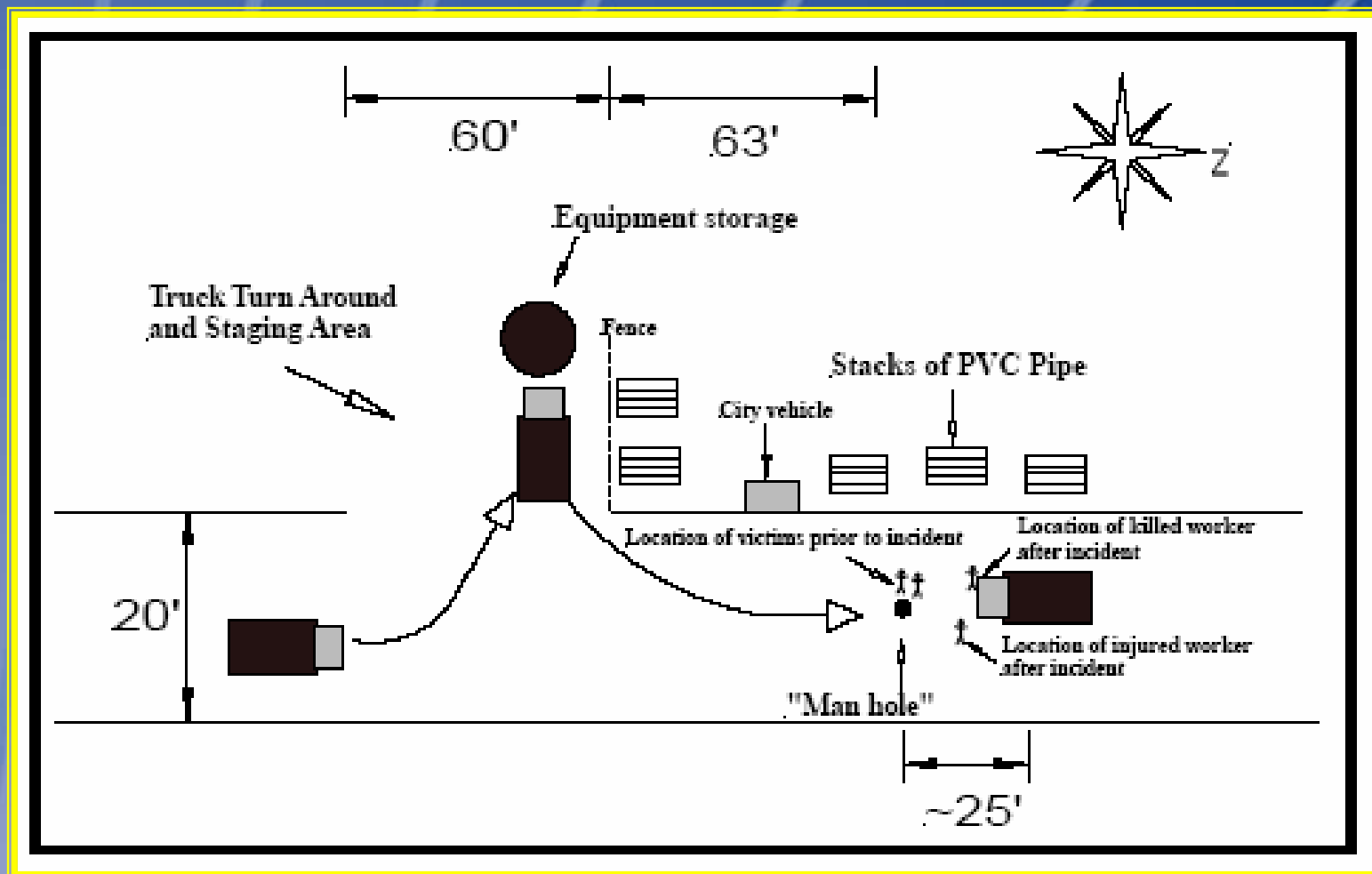
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Blind Areas



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Definition of Blind Area

- A **blind area** is the area around a vehicle or piece of construction equipment that is not visible to the operators, either by direct line-of-sight or indirectly by use of internal and external mirrors.



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Vehicle Blind Spots

- Running over people
- Running over materials
- Striking other equipment and vehicles
- Rollovers
- Contact with utilities



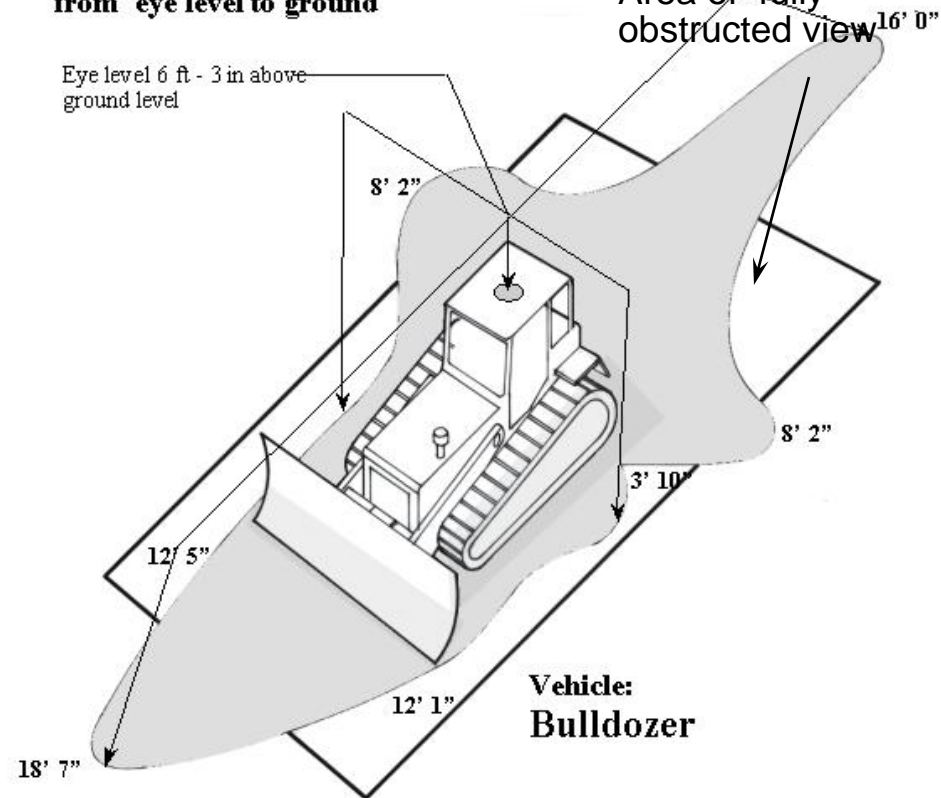
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**Operator sight distances
from eye level to ground**

Eye level 6 ft - 3 in above
ground level

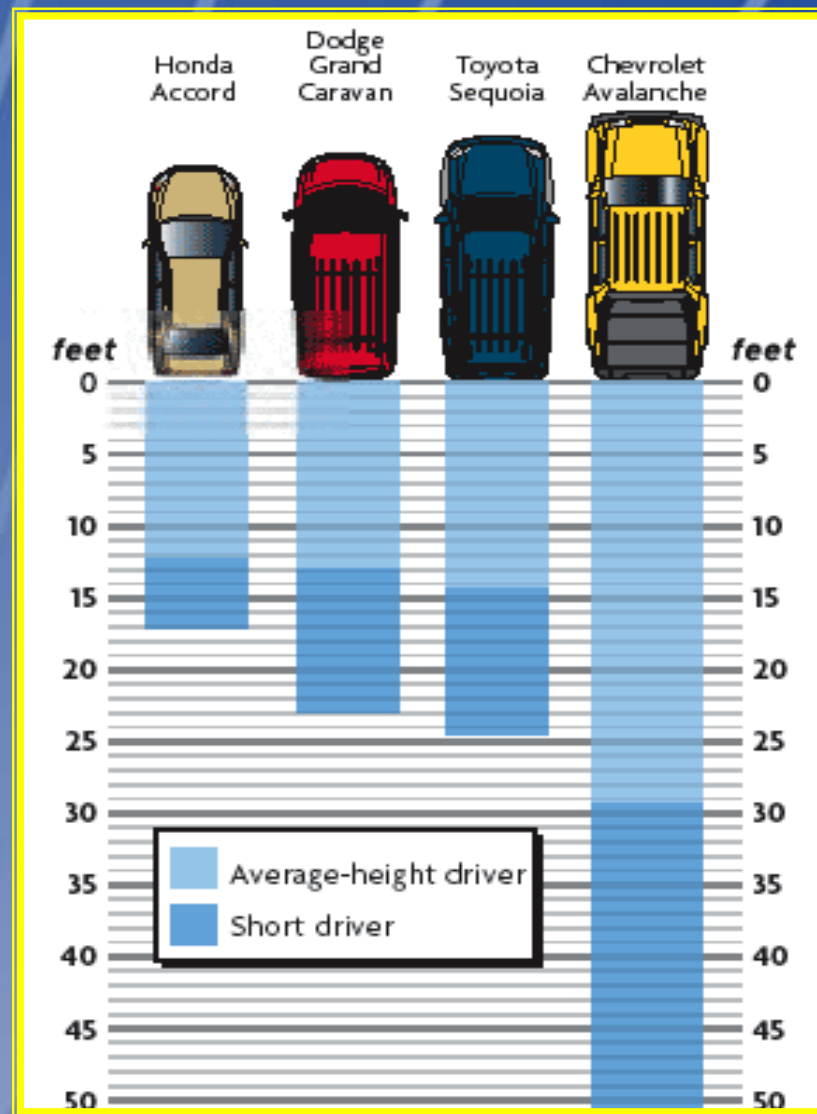
Area of fully
obstructed view



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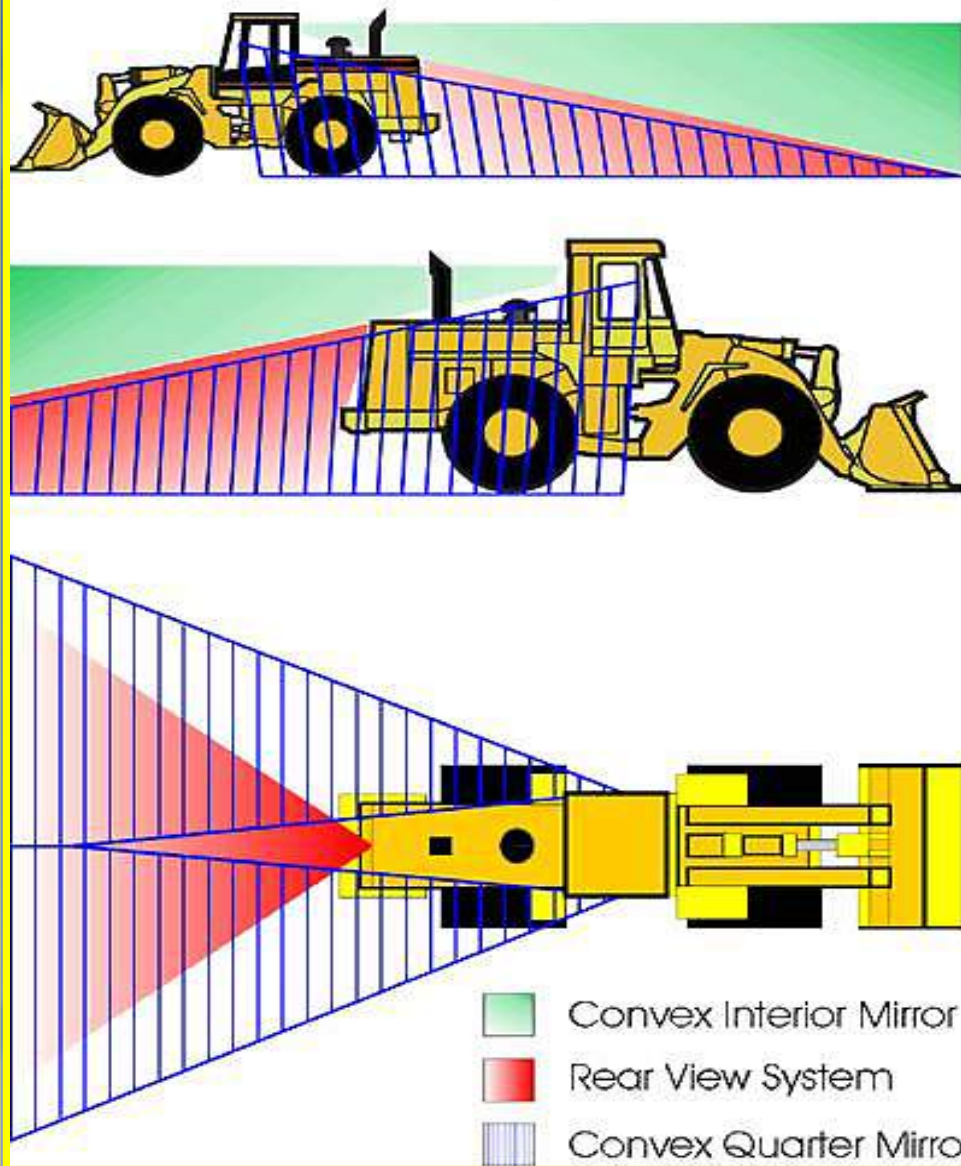
Non-Construction Vehicle Blind Spot Measurements



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Visibility Diagram



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Methods

- **International Organization for Standardization (ISO) 5006**
- **Manual methods**
 - ◆ Light Bar
 - ◆ Operator
- **Computer methods**
 - ◆ Design Drawings
 - ◆ Laser Scans
 - ◆ Photographs



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Manual Light Bar Method



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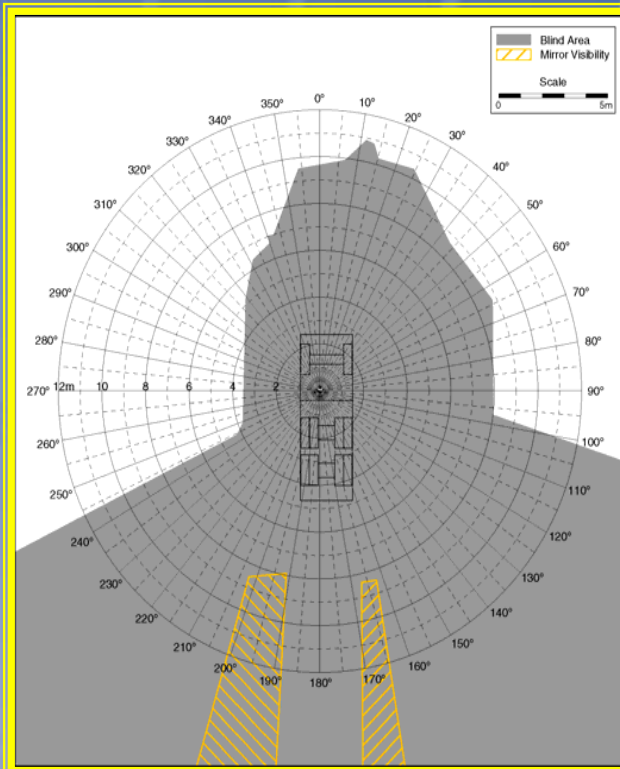
| | |
|--|-------------------------|
| Dump Truck (Manufacturer and Model) | Ford 880 |
| GVW | 54,000 lb |
| Serial # | V00131 |
| Machine Dimensions | 7' 10" wide 23' 2" long |
| Operator Enclosure | Closed ROPS |
| Attachments | None |
| Other Information | None |
| Measurement Technique | Physical |



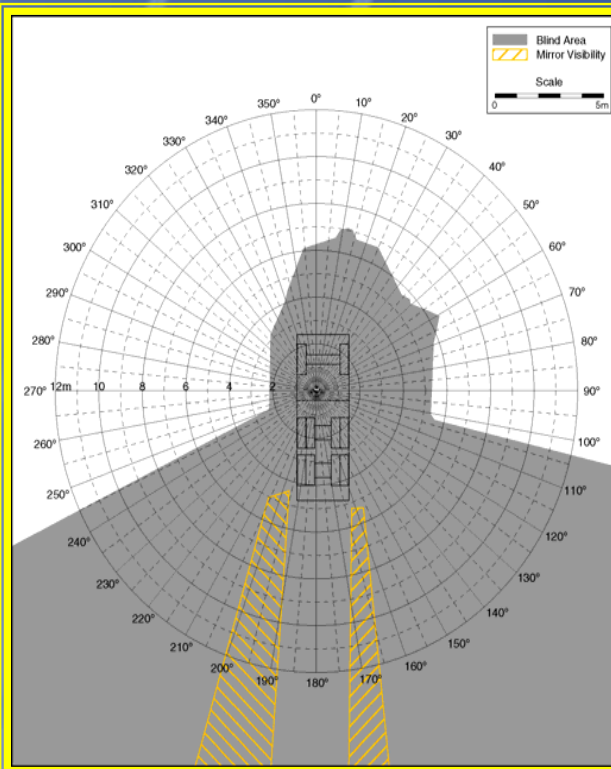
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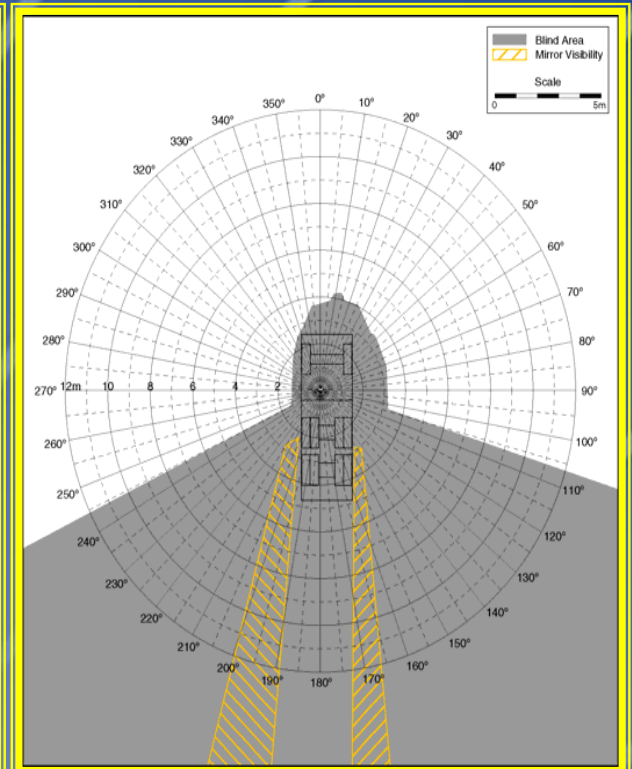
Blind Area Diagrams - Ford 880



Ground



Construction Barrel
~3ft



Worker
partially bent over
~5ft



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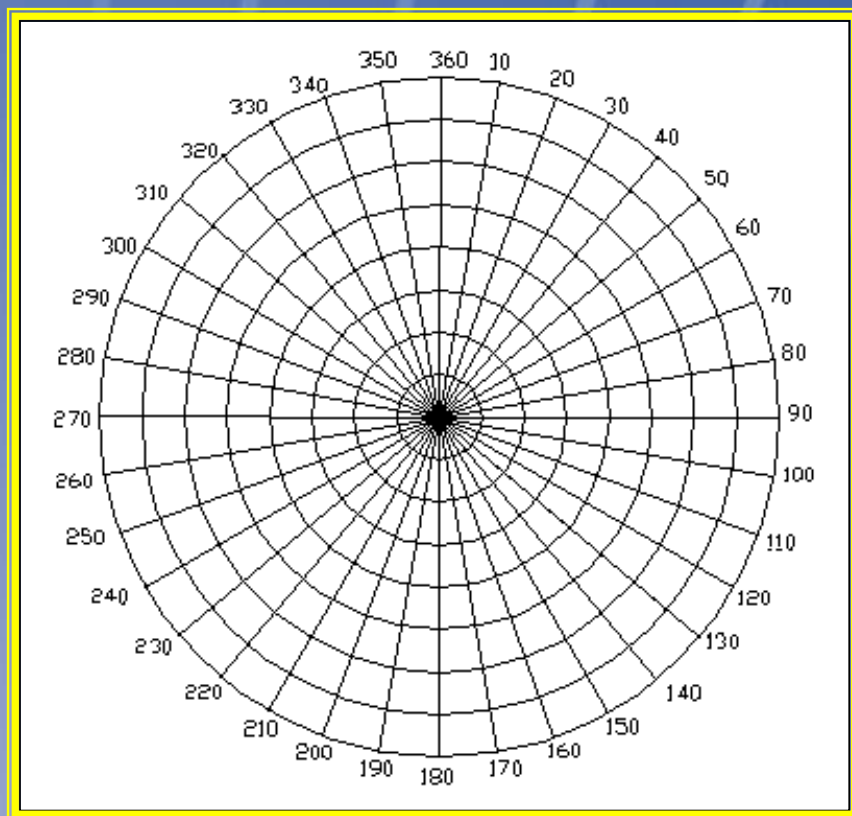
Manual Operator Method



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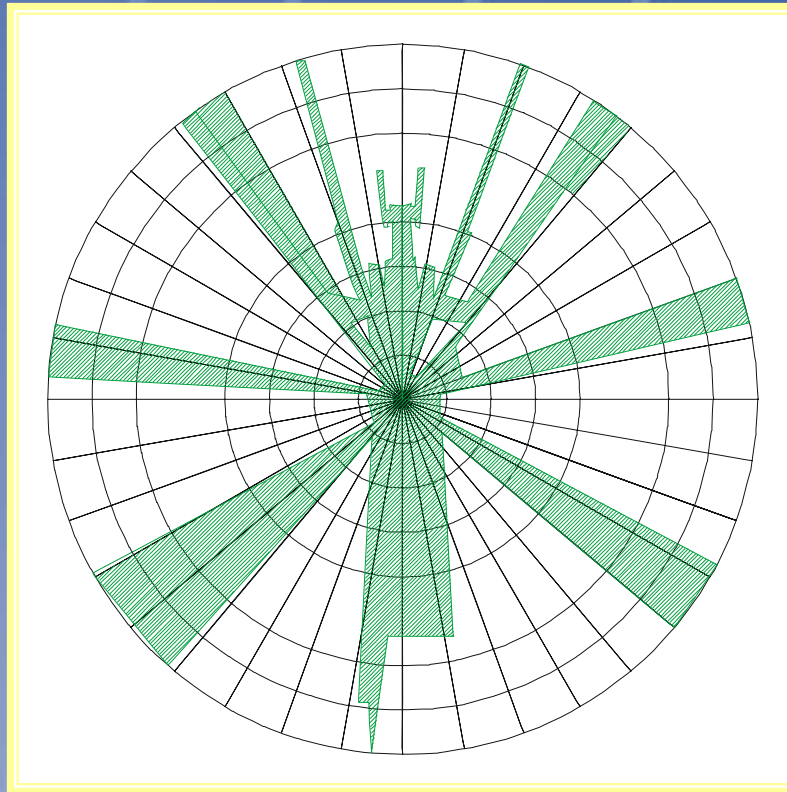
Marking Blind Areas Within a Polar Grid



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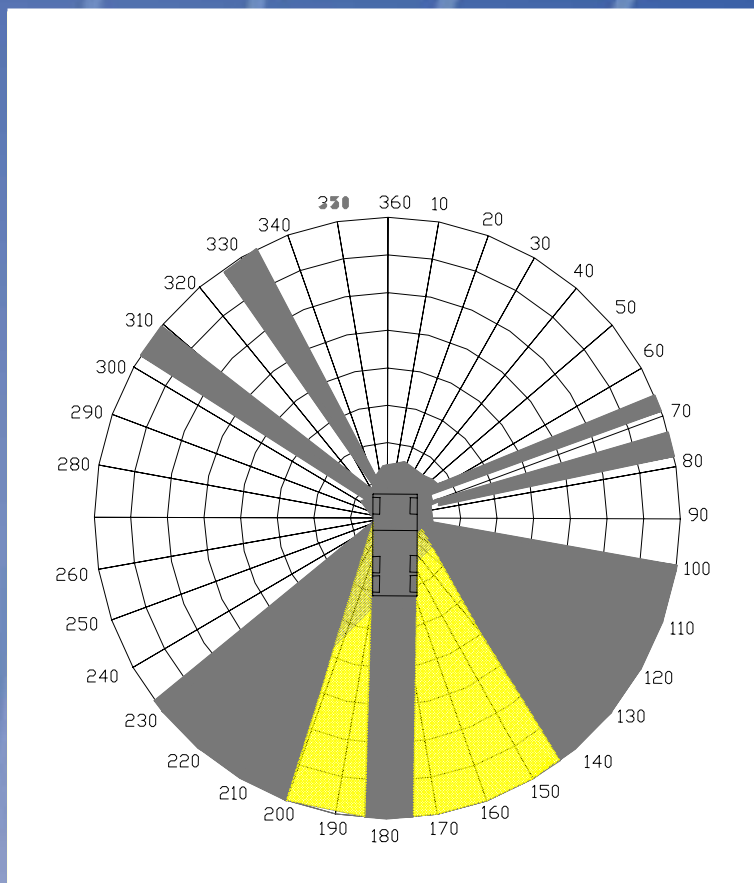
Caterpillar 672CH Blind Area at 900mm above Ground Plane



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Blind Area Diagram Ford 880 Dump Truck



**Not Visible to
Operator**



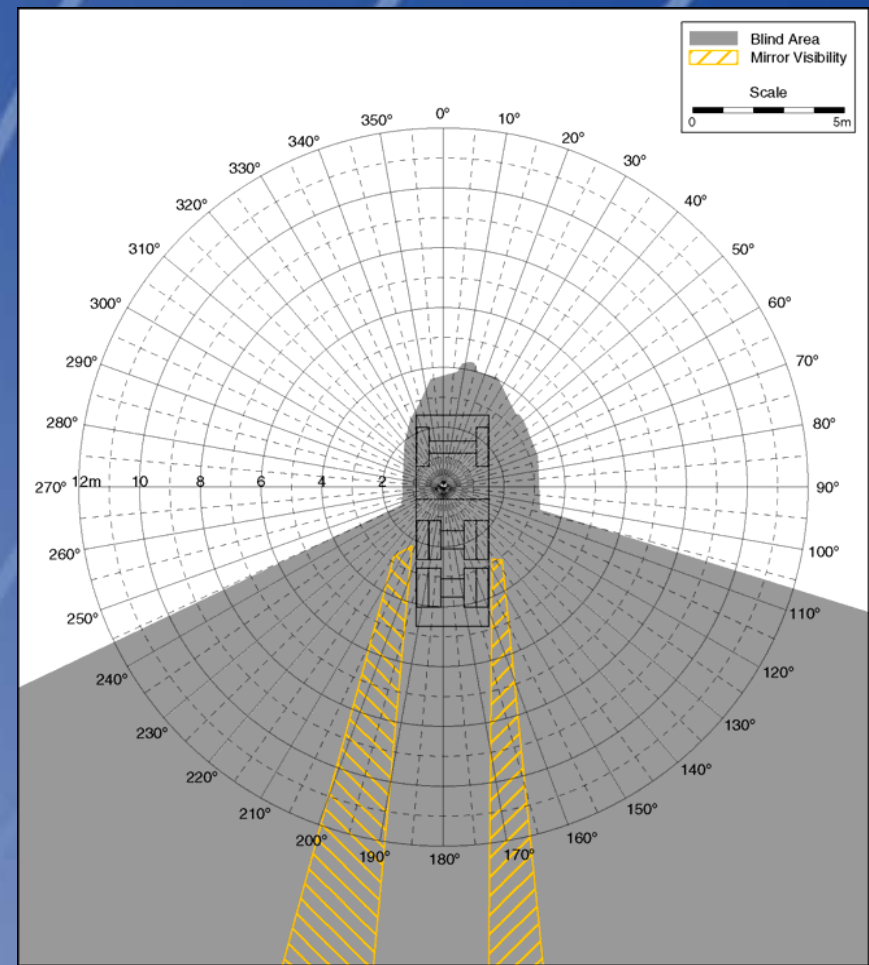
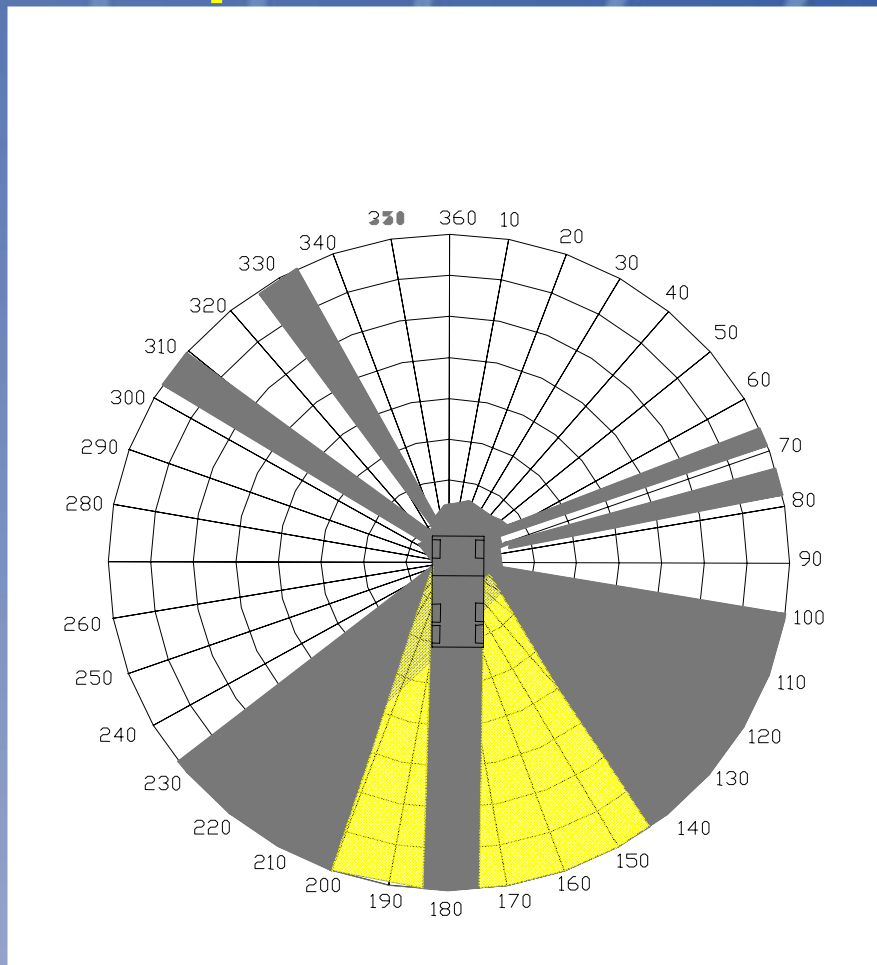
**Visible in mirrors
only**



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Comparison of Manual Methods



Field Crew

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Light Bar



Virtual Reality Method



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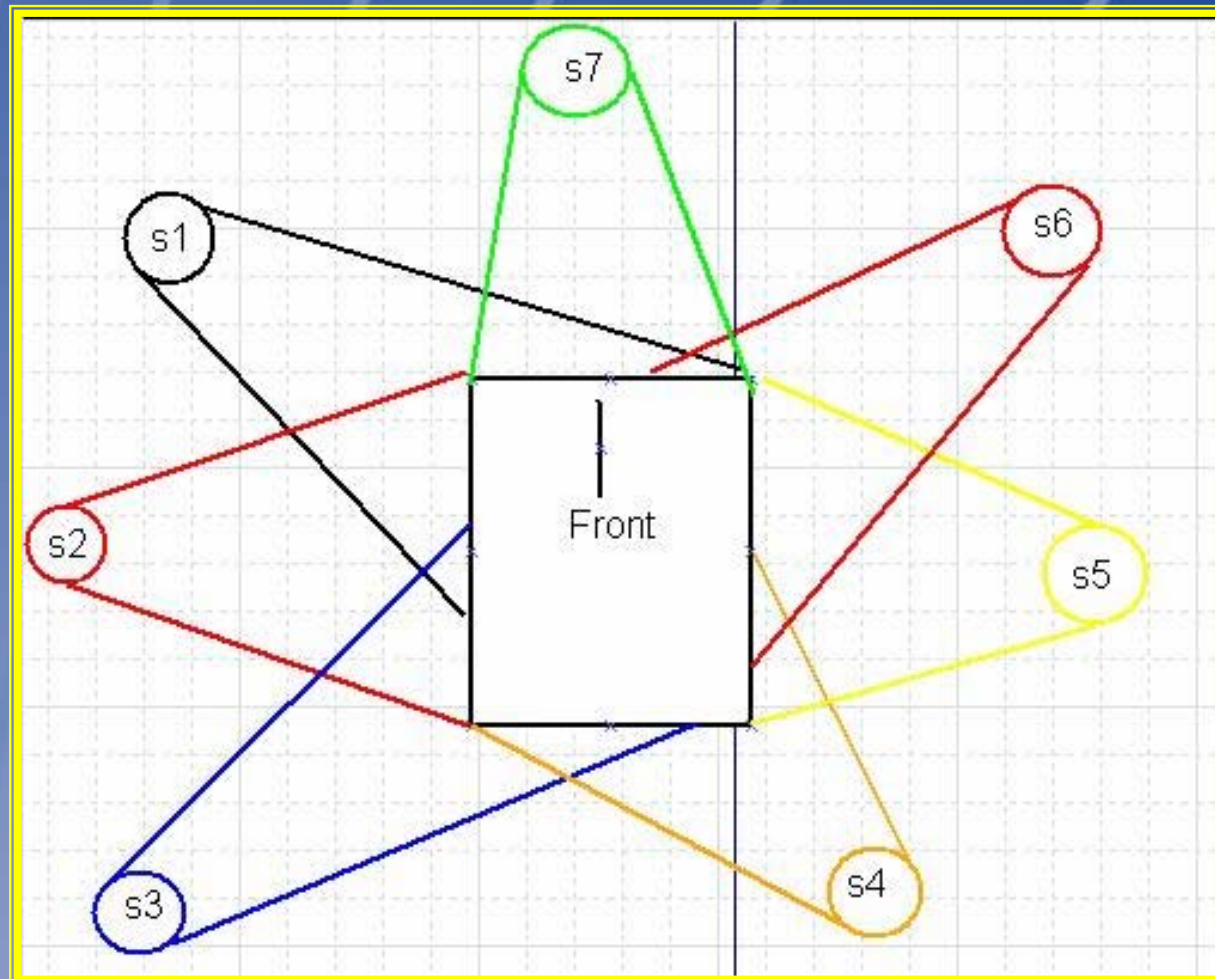
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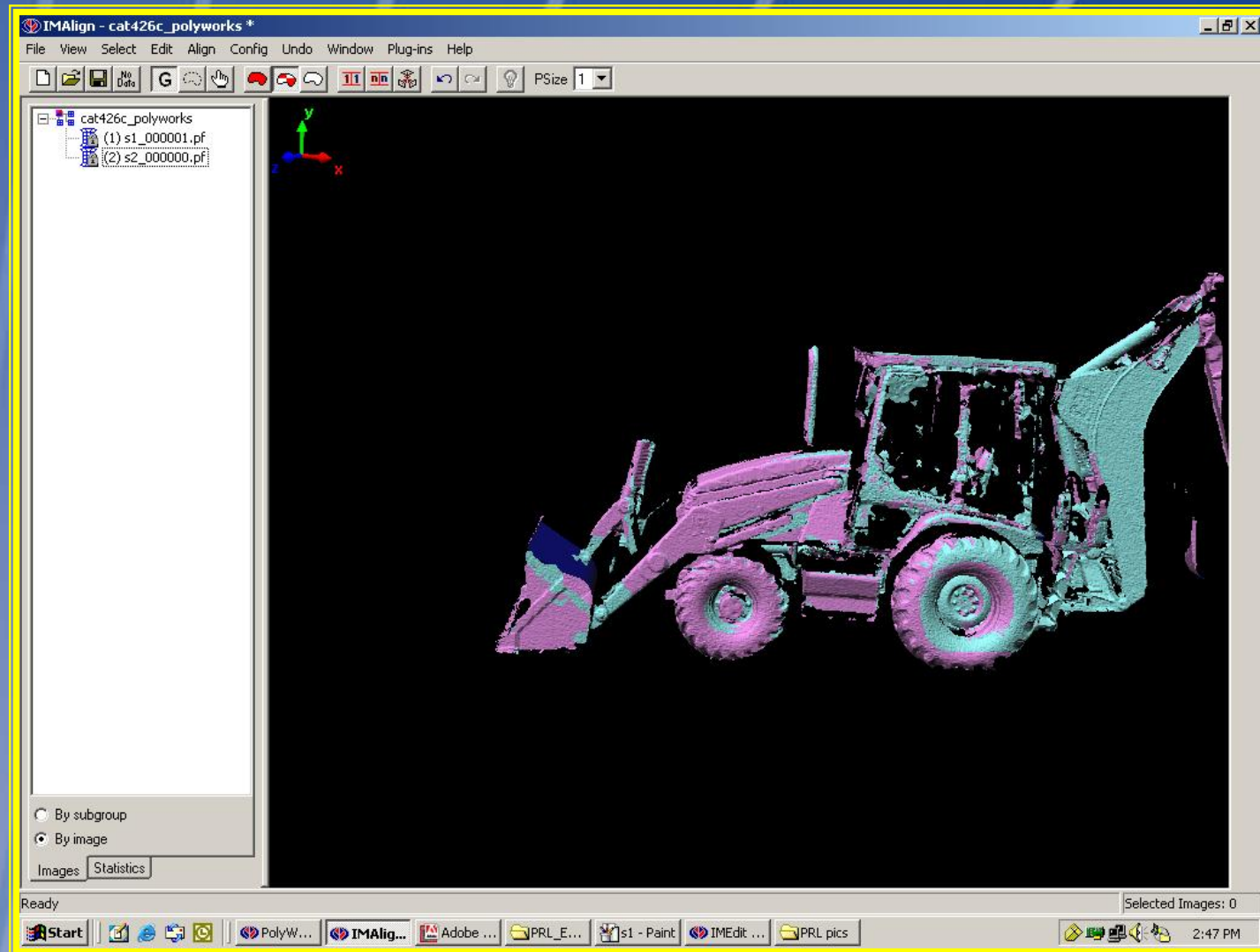
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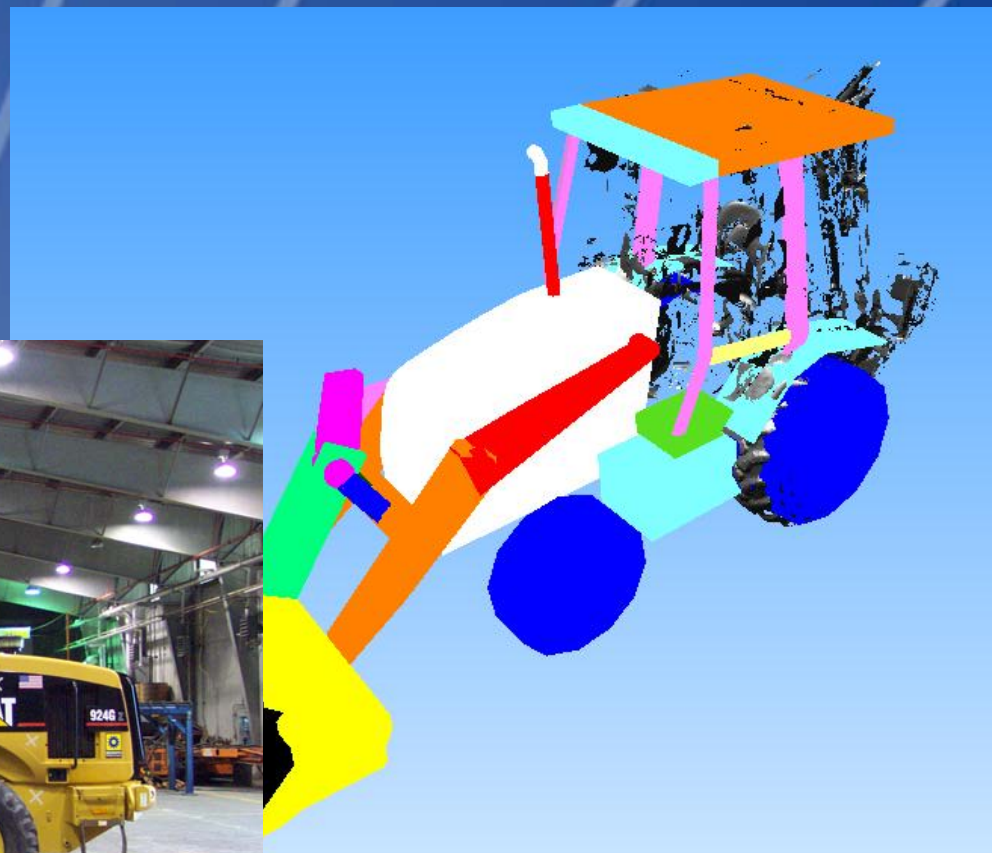
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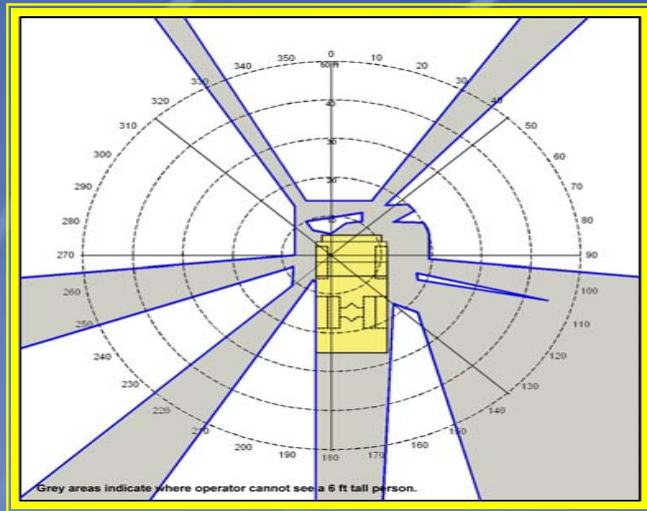
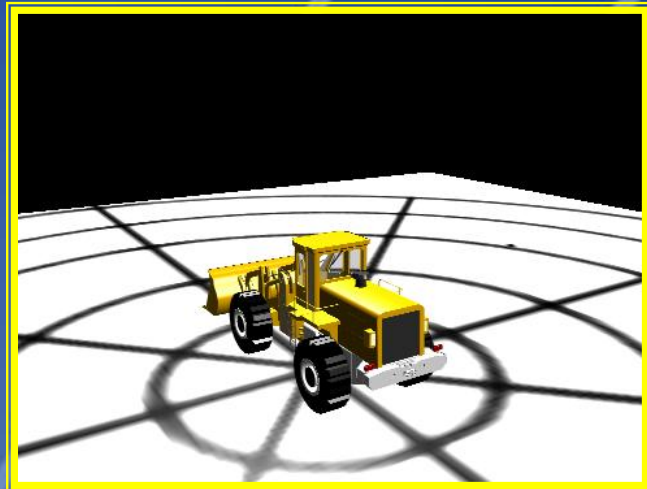
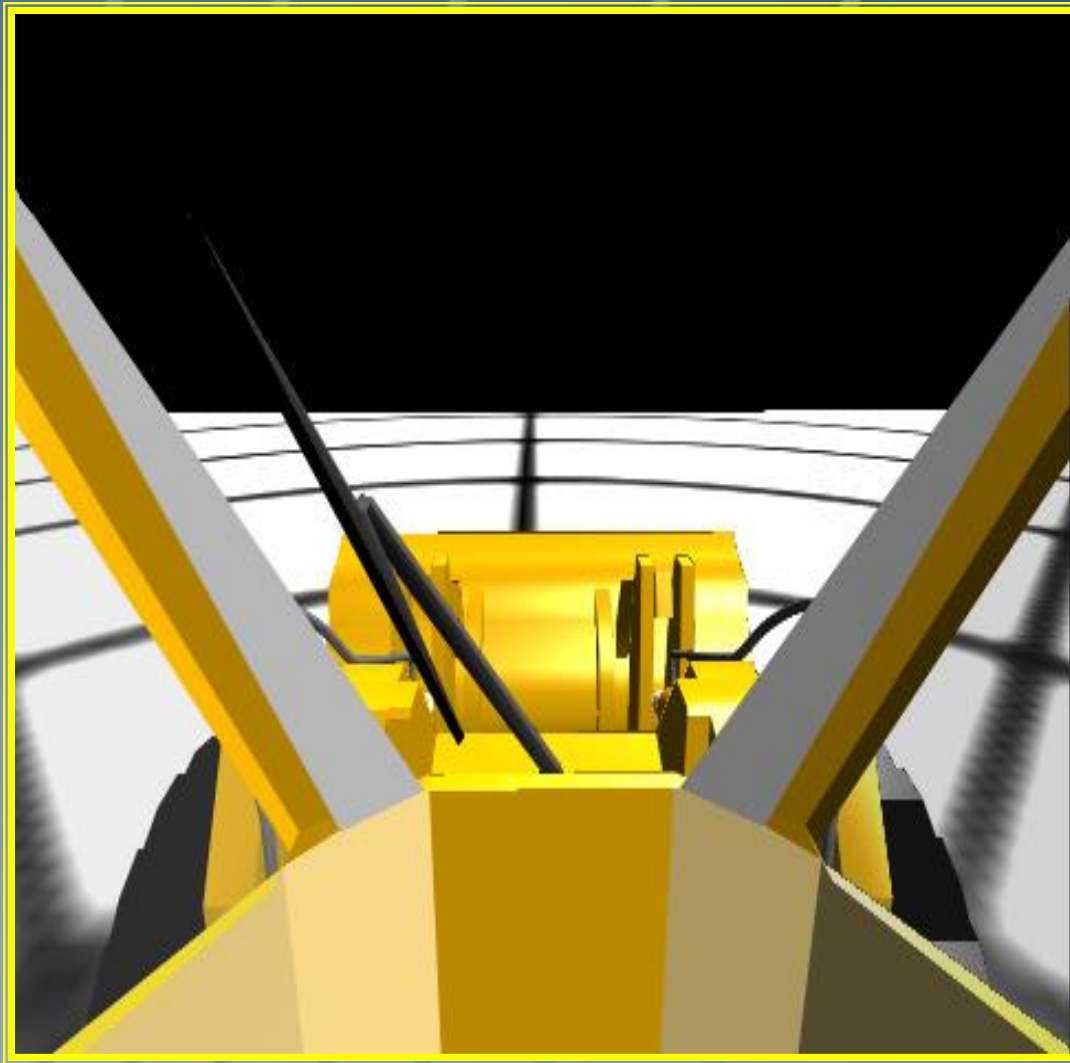
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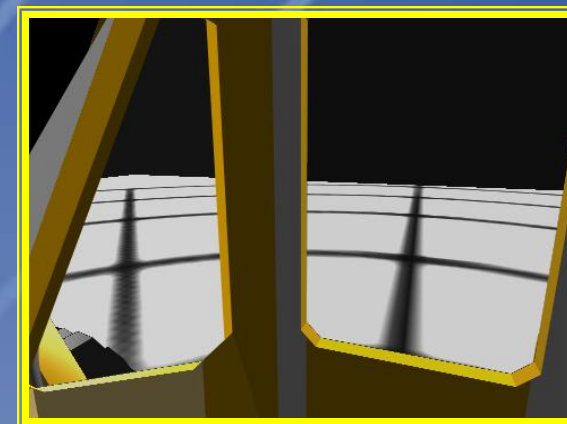
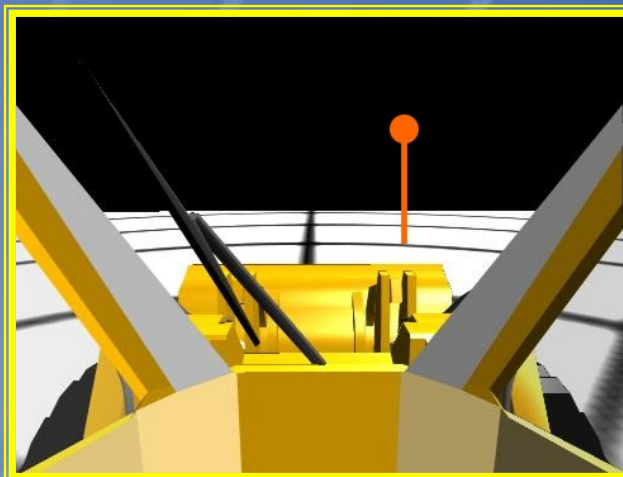
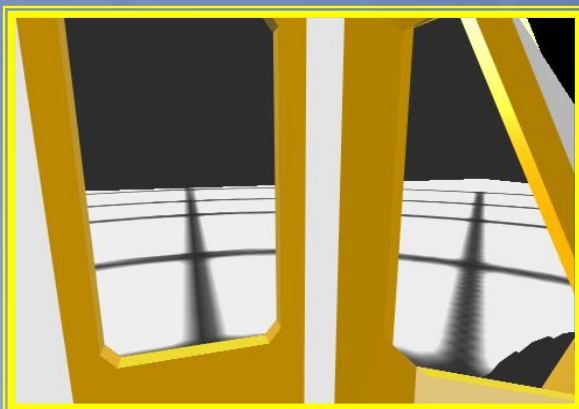
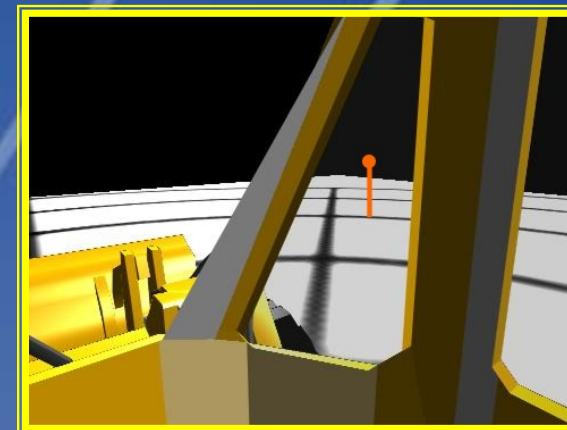
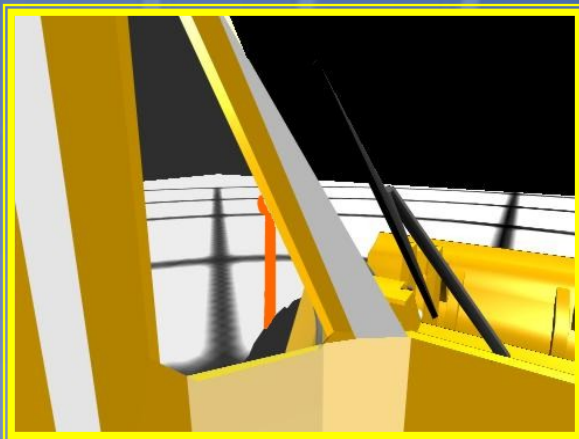
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Blind Area Diagrams

- Photo Generated Blind Areas



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Contract Deliverable

Center for Disease Control and Prevention

Contract 200-2002-00563

***“Construction Vehicle and Equipment
Blind Area Diagrams”***

Final Report

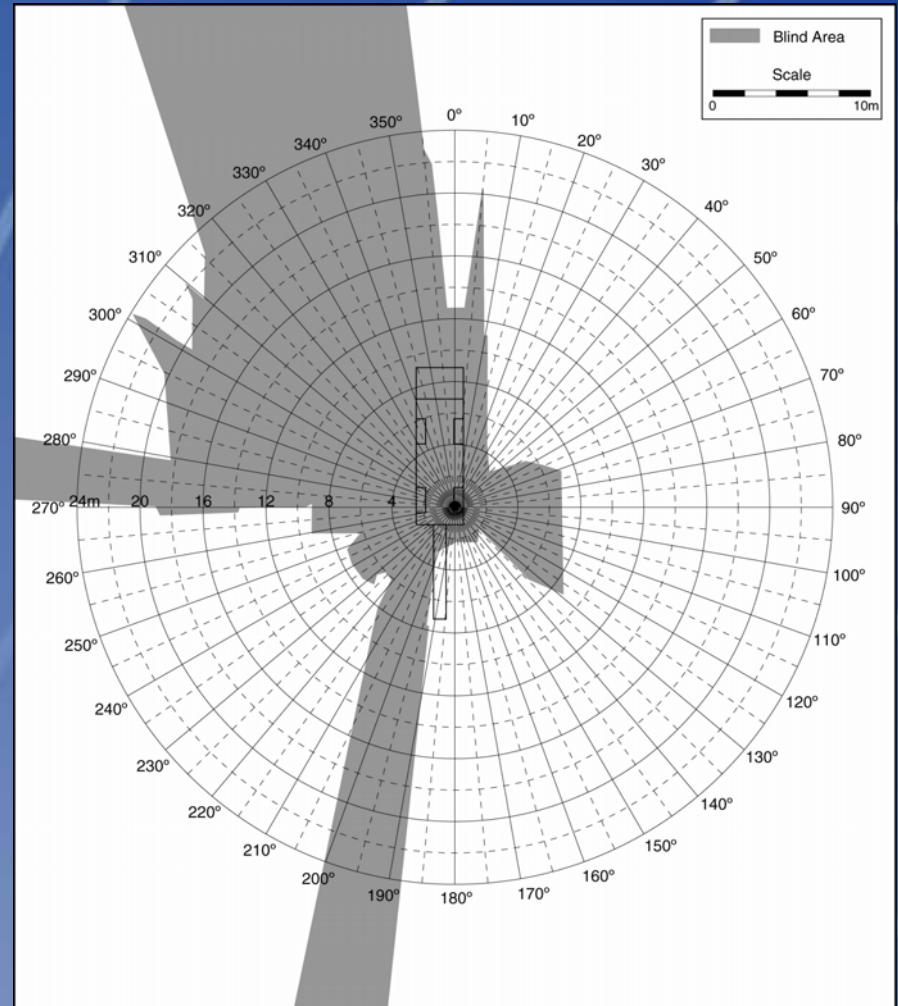
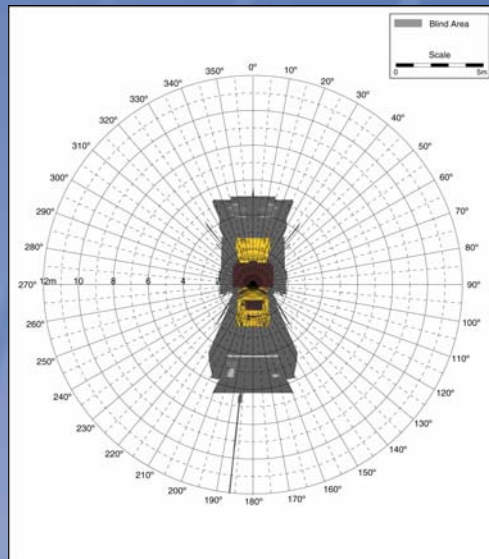


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Blind Area Diagrams

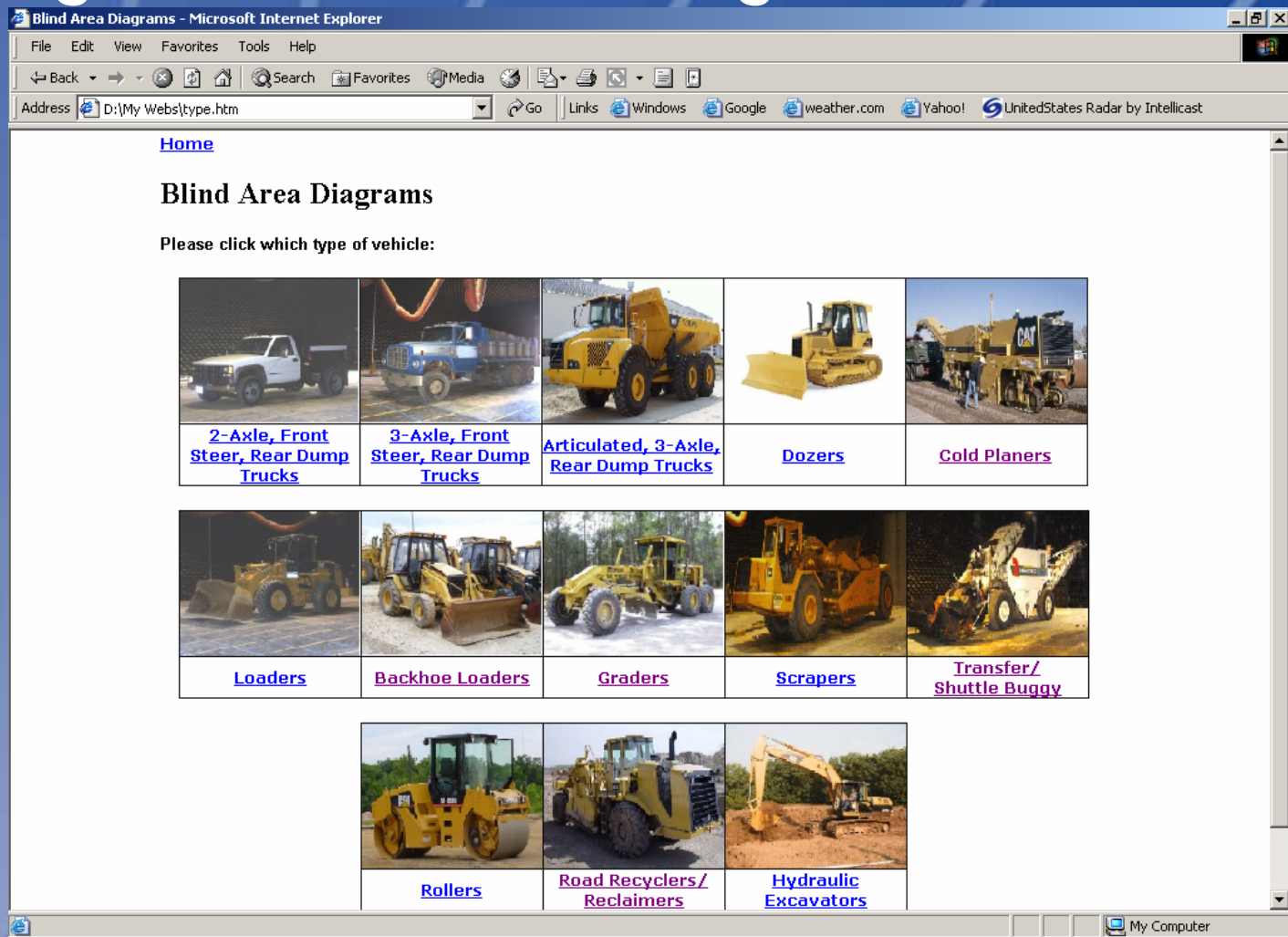
- Caterpillar Contract
 - ◆ Shadow Method and Computer Generated Blind Areas



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Web Page of Blind Area Diagrams



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Graders / Scrapers - Microsoft Internet Explorer

File Edit View Favorites Tools Help


Back Forward Stop Reload Home Search Favorites Media Print Copy Paste

Address D:\My Webs\gradermain.htm Go Links Windows Google weather.com Yahoo! UnitedStates Radar by Intellicast


[Back to Type of Vehicle](#)

Blind Area Diagrams


Graders



[Cat 12G](#)




[Volvo G726](#)

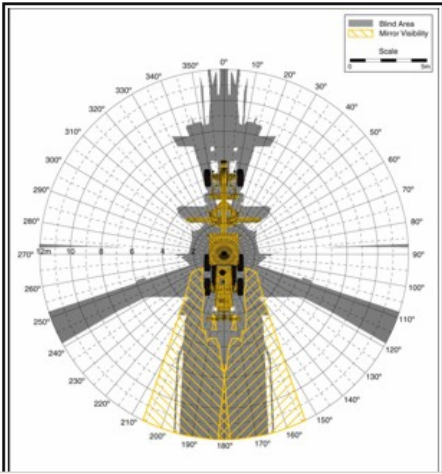
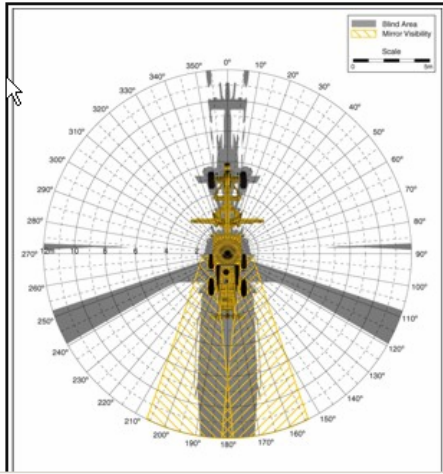


[John Deere 772CH](#)

| | |
|--|---------------------|
| Grader (Manufacturer and Model) | Cat 12G |
| GVW | 31,410 lb |
| Serial # | 61Mxxxxxx |
| Machine Dimensions | 8' 2" wide 28' long |
| Operator Enclosure | Closed ROPS |
| Attachments | None |
| Other Information | None |
| Measurement Technique | Computer |



Click on an image below to enlarge.

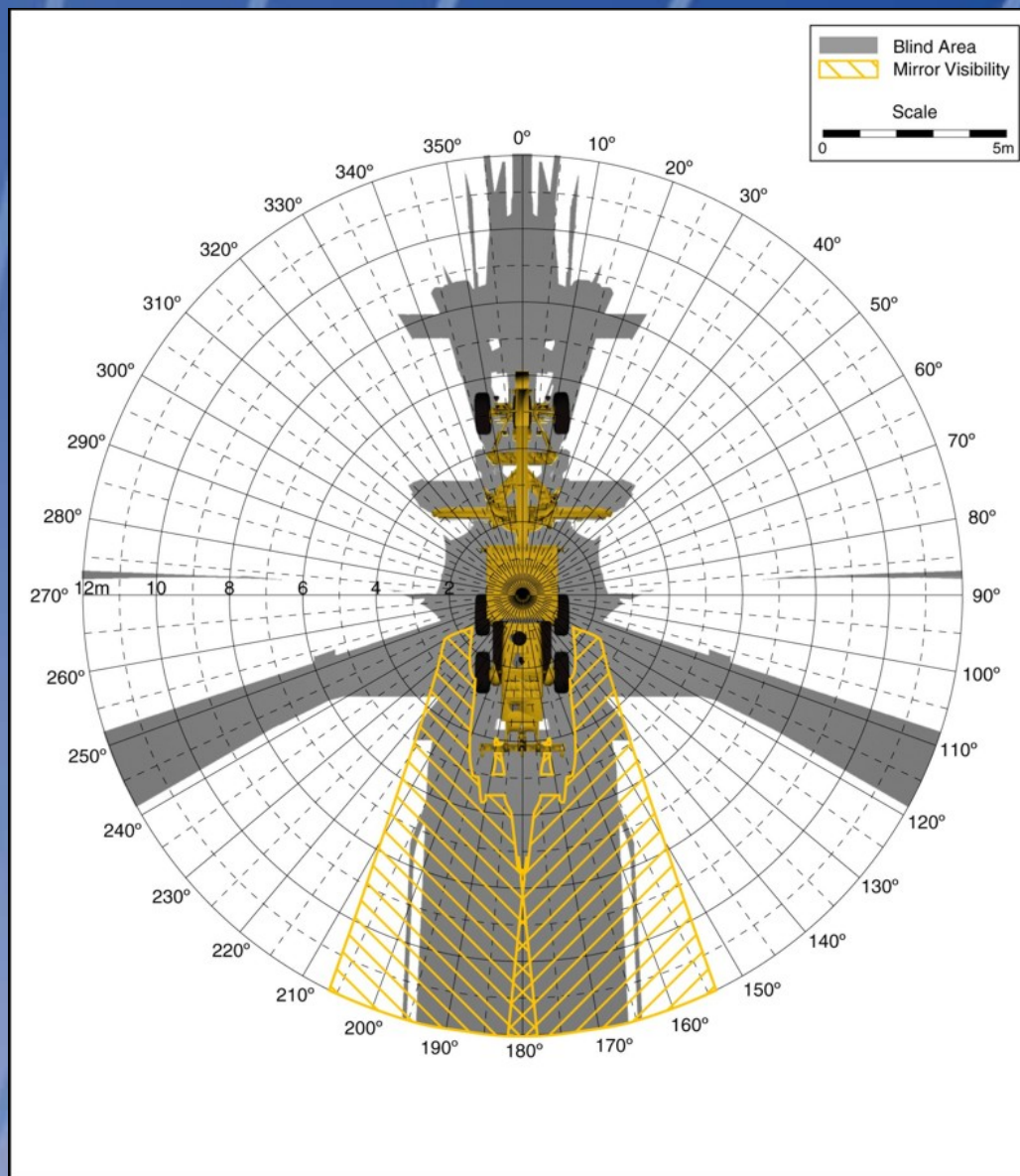



My Computer



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Internal Traffic Control Plans



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Why Develop an Internal Traffic Control Plan?



- **Coordinate vehicle/equipment movement inside the work zone**
- **Limit exposure of workers on foot to construction traffic**
- **Reduce hazards for equipment operators**



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Definition of Internal Traffic Control Plans (ITCP)



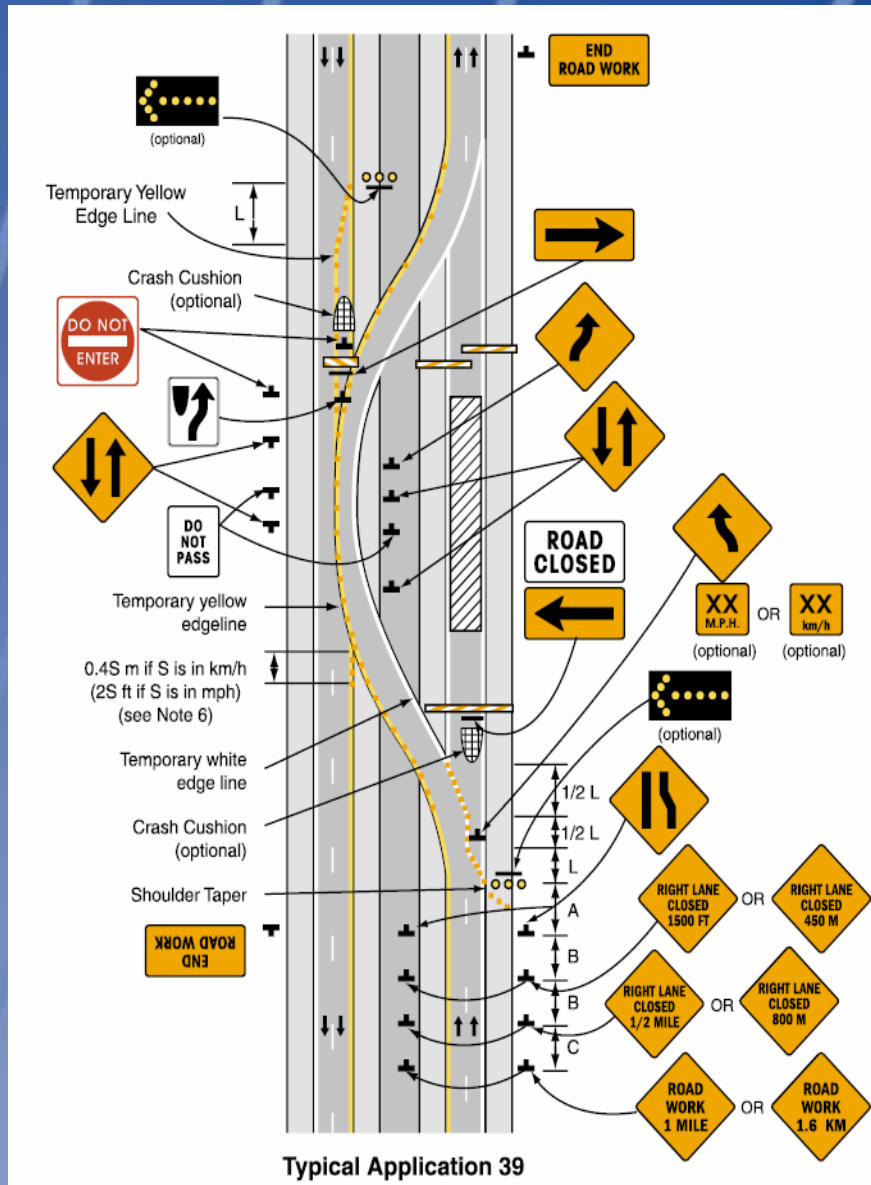
“STRATEGIES TO CONTROL THE FLOW OF CONSTRUCTION WORKERS, VEHICLES AND EQUIPMENT **INSIDE** THE WORKZONE”



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Traffic Control Plans



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TCP – ITCP PARALLELS

TCP

TYPICAL



ITCP

MODEL

RESPONSIBLE
PERSON



COMPETENT
PERSON

REQUIRED BY
MUTCD



CONCEPT



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PRINCIPLES OF SAFE CONSTRUCTION TRAFFIC CONTROL

- Reducing the need to back up equipment
- Limiting access points to work zones
- Establishing pedestrian-free areas where possible
- Establishing work zone layouts commensurate with type of equipment



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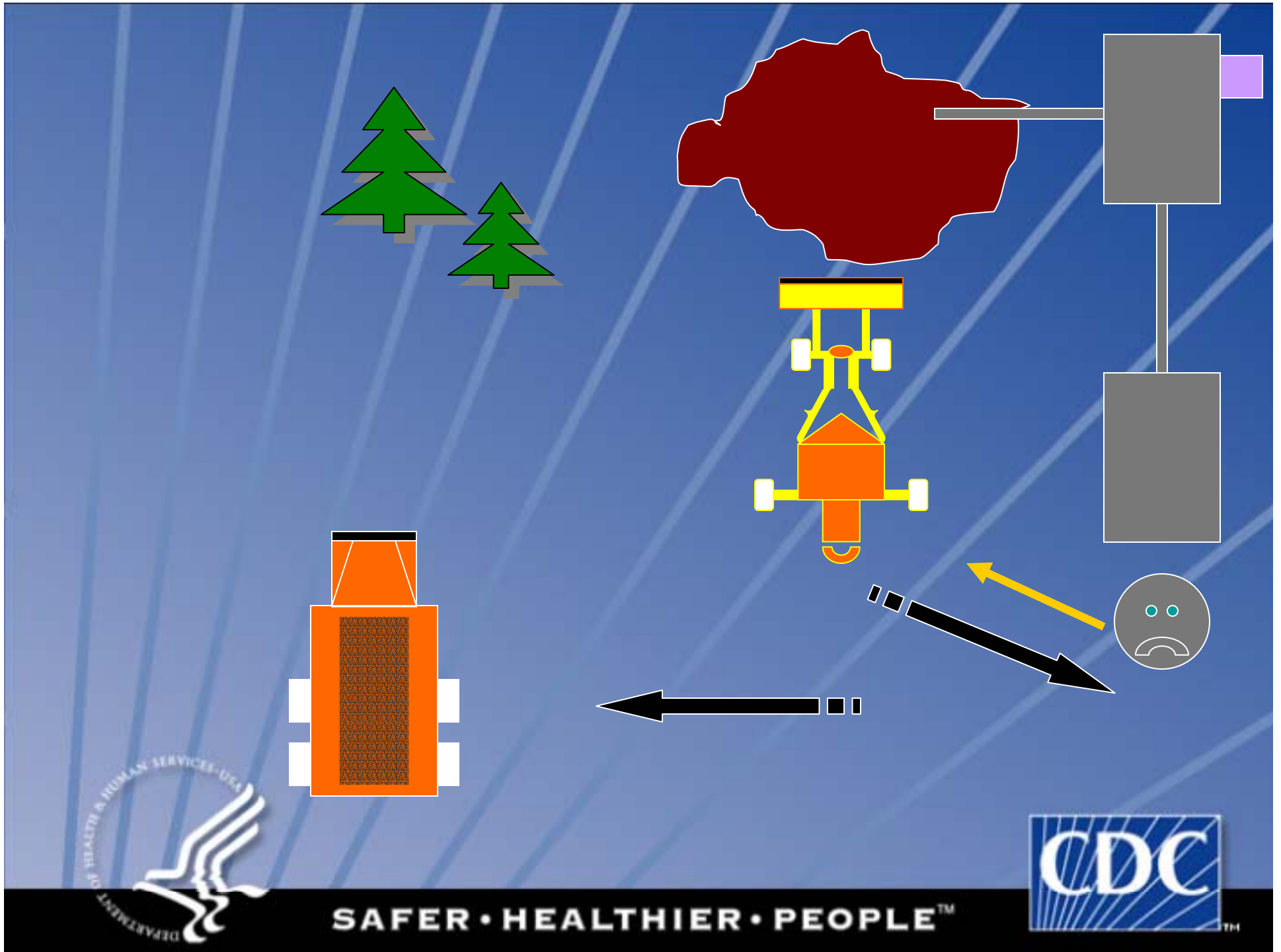
PRINCIPLES OF SAFE CONSTRUCTION TRAFFIC CONTROL

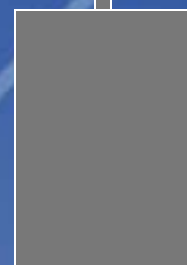
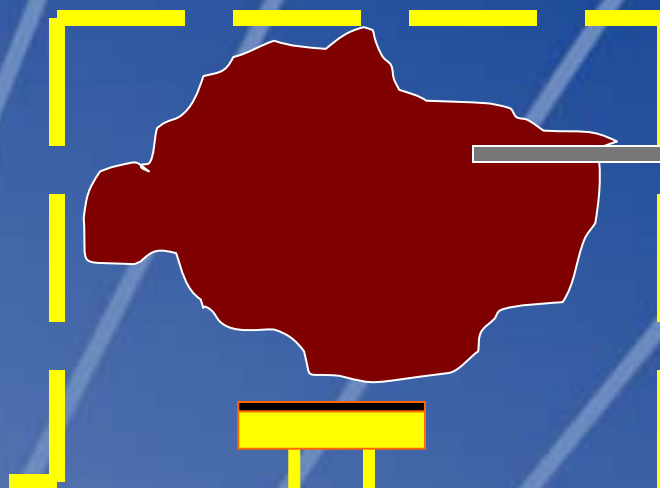
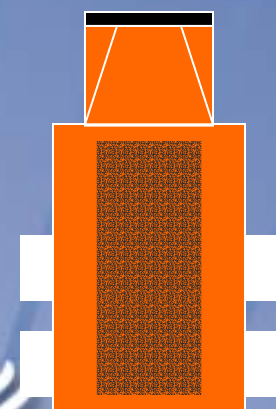
- Providing signs within the work zone to give guidance to pedestrians, equipment and trucks
- Designing buffer spaces to protect pedestrians from errant vehicles or work zone equipment



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ITCP COMPONENTS

- **NOTES PAGE**
- **LEGEND**
- **WORK AREA
DIAGRAMS**



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SAFETY POINTS

1. Truck spotter stays at paver
2. Stage trucks to minimize backing
3. No walking behind backing trucks, in front of paving machine, across hot mat, or over trailer tongue.

PERSONNEL

Truck Drivers

Truck Spotter

Paver Operator

Roller Operators

Inspector

Superintendent

Test Personnel

EQUIPMENT

Oiler Trucks

Dump Trucks

Pavers

Rollers

NOTES PAGE

SAFETY POINTS

PERSONNEL

EQUIPMENT



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INTERNAL TRAFFIC CONTROL PLAN NOTES

Site #2 – Interstate 10 – Interchange with Jimmie Kerr Boulevard
Casa Grande, Arizona

GENERAL CONDITIONS

Safety Points

1. Pedestrian Worker Movement Patterns.
 - a. In no case shall a Pedestrian Worker move outside the designated task corridor without approval of the designated Competent Person.
 - b. Inspectors shall coordinate sampling frequency and location with the designated Competent Person. Sampling shall only occur when vehicle traffic has stopped or does not occur within 100 feet of said inspector.
 - c. "Rakers" shall maintain a location immediately between the rear of the paving machine and no more than 50 feet behind the paving machine.
2. Pedestrian Worker Identification.
 - a. Pedestrian Workers shall use distinctive color clothing and headgear for designated personnel as approved by the Safety Officer. The designated competent person shall also wear a distinctive armband or hardhat. The purpose of different colored hard hats and or retro-reflective clothing is to distinguish ground personnel on the jobsite. It is important on paving/construction projects for the safety officer, competent person, and supervisor be able to recognize laborers, operators, truck drivers, inspectors or other ground personnel.
3. Truck Spotter.
 - a. Spotter shall maintain a location between truck traffic and the paving machine thereby allowing complete view and control of truck movement and staging.
 - b. Communications should be maintained between the spotter and truck operators via hands-free radios or an approved equal. If such an equivalent method of communications is necessary, said method shall be submitted to the designated Competent Person for approval 48 hours prior to its use.
 - c. A pedestrian worker may be employed if data obtainment (e.g., retrieval of tare tickets...etc.) from truck operators cannot be adequately completed by the spotter. Said pedestrian worker shall maintain a location outside and near the truck depositing material.

Page 1

Detailed Notes



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Safety Points

- No workers in traffic zone
- Spotter uses hands free radio to talk to trucks
- No workers on foot between a backing truck and the paver
- Truck spotter remains at paver until truck stops
- Inspectors remain away from paving train and notify spotter before obtaining samples



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INTERNAL TRAFFIC CONTROL PLANS

| | | | |
|--|--|--|---------------------------|
| | LIGHT(S) | | TRUCK MOVEMENT |
| | CHANNELING DEVICE(S) | | SIGN (SHOWN FACING RIGHT) |
| | BARRIER | | PORTABLE LAVATORY |
| | DIRECTION OF TEMPORARY TRAFFIC OR DETOUR | | EXISTING PAVEMENT |
| | DIRECTION OF TRAFFIC | | NEW PAVEMENT |

- On foot personnel classes -

| | | | |
|--|----------------------|--|-------------|
| | PEDESTRIAN WORKER | | FOREMAN |
| | SPOTTER | | FLAGGER |
| | INSPECTOR | | SURVEYOR |
| | PEDESTRIAN-FREE ZONE | | OTHER CLASS |

- Vehicle Types -







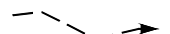


| | | | | | |
|--|-----------|--|---------------------------------|--|---------------------|
| | ROLLER | | PAVING MACHINE w/ELEVATOR/BUGGY | | FORKLIFT |
| | GRADER | | PAVING MACHINE | | SWEEPER |
| | BACKHOE | | FRONT LOADER | | PICKUP TRUCK |
| | DOZER | | DUMP TRUCK (EMPTY) | | BOTTOM DUMP (EMPTY) |
| | OIL TRUCK | | DUMP TRUCK (FULL) | | BOTTOM DUMP (FULL) |
| | CRANE | | WATER TRUCK | | MILLING MACHINE |
| 3 2 1 NUMBER OF STAGED VEHICLE(S) | | | | | |

Legend-Symbols used in Model Plans











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| | | |
|---|---|---|
|  |  | LIGHT(S) |
|  | | CHANNELING DEVICE(S) |
|  | | BARRIER |
|  | | DIRECTION OF TEMPORARY TRAFFIC OR DETOUR |
|  | | DIRECTION OF TRAFFIC |
|  | | TRUCK MOVEMENT |
|  | | SIGN (SHOWN FACING RIGHT) |
|  | | PORTABLE LAVATORY |

- On foot personnel classes -

| | | | |
|---|-----------------------------|---|--------------------|
|  | PEDESTRIAN WORKER |  | FOREMAN |
|  | SPOTTER |  | FLAGGER |
|  | INSPECTOR |  | SURVEYOR |
|  | PEDESTRIAN-FREE ZONE |  | OTHER CLASS |



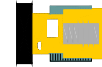
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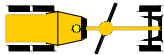
- Vehicle Types -



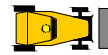
ROLLER



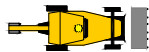
PAVING MACHINE



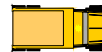
GRADER



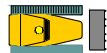
FRONT LOADER



BACKHOE



DUMP TRUCK (EMPTY)



DOZER



DUMP TRUCK (FULL)



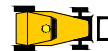
OIL TRUCK



WATER TRUCK



CRANE



FORKLIFT



SWEEPER



BOTTOM DUMP



PICKUP TRUCK



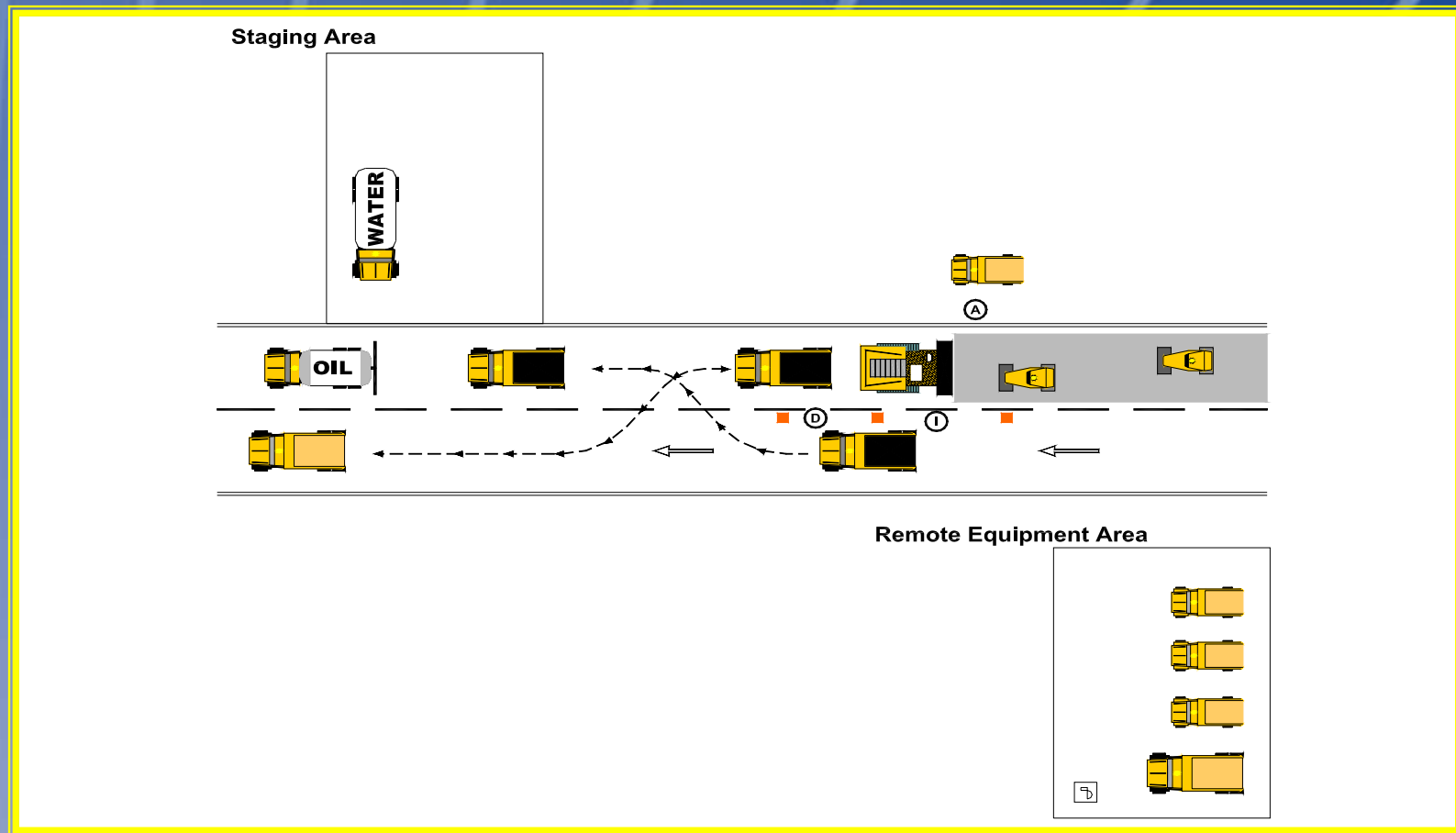
MILLING MACHINE



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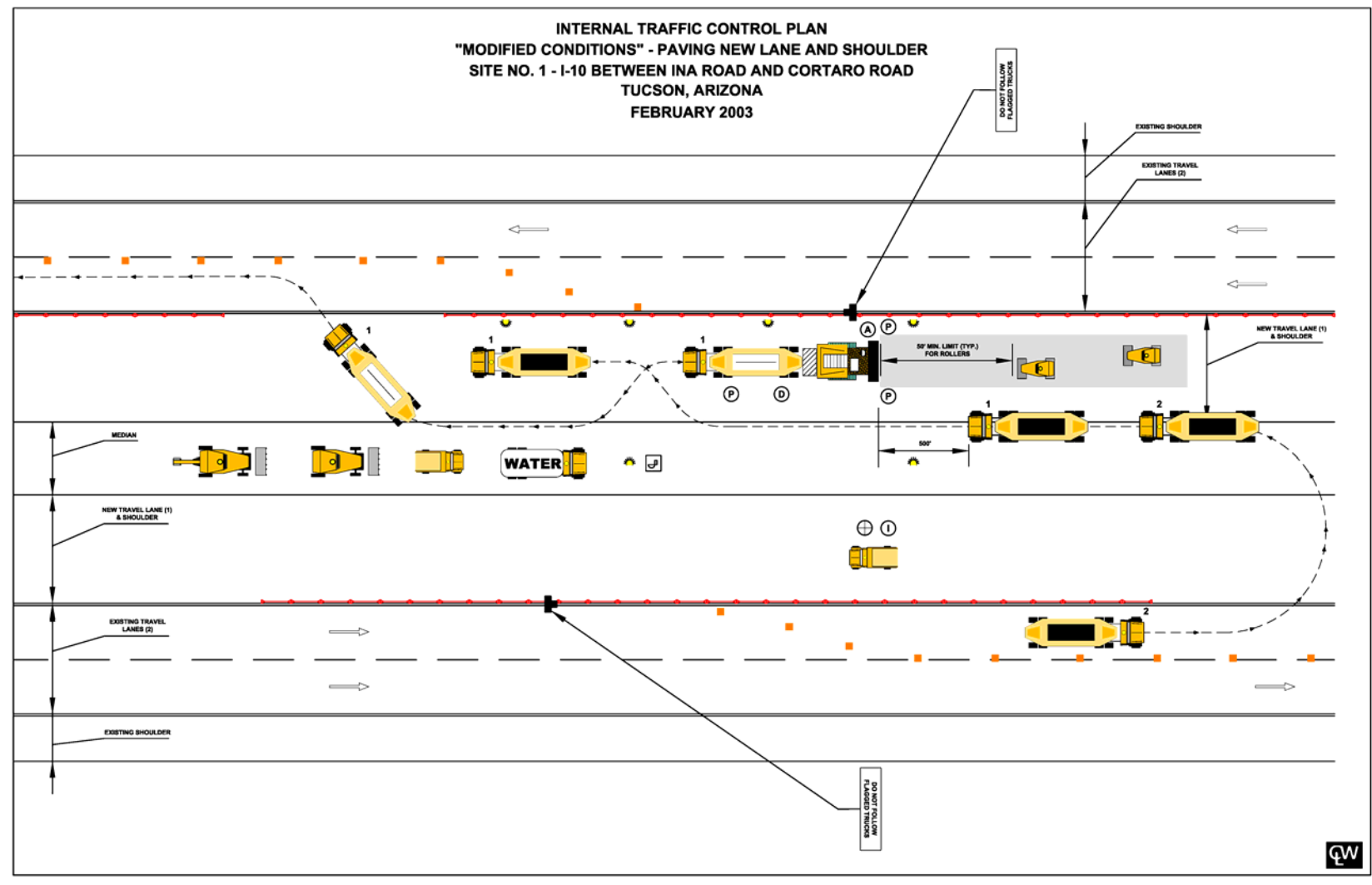
Paving Model Plan – Traffic Adjacent



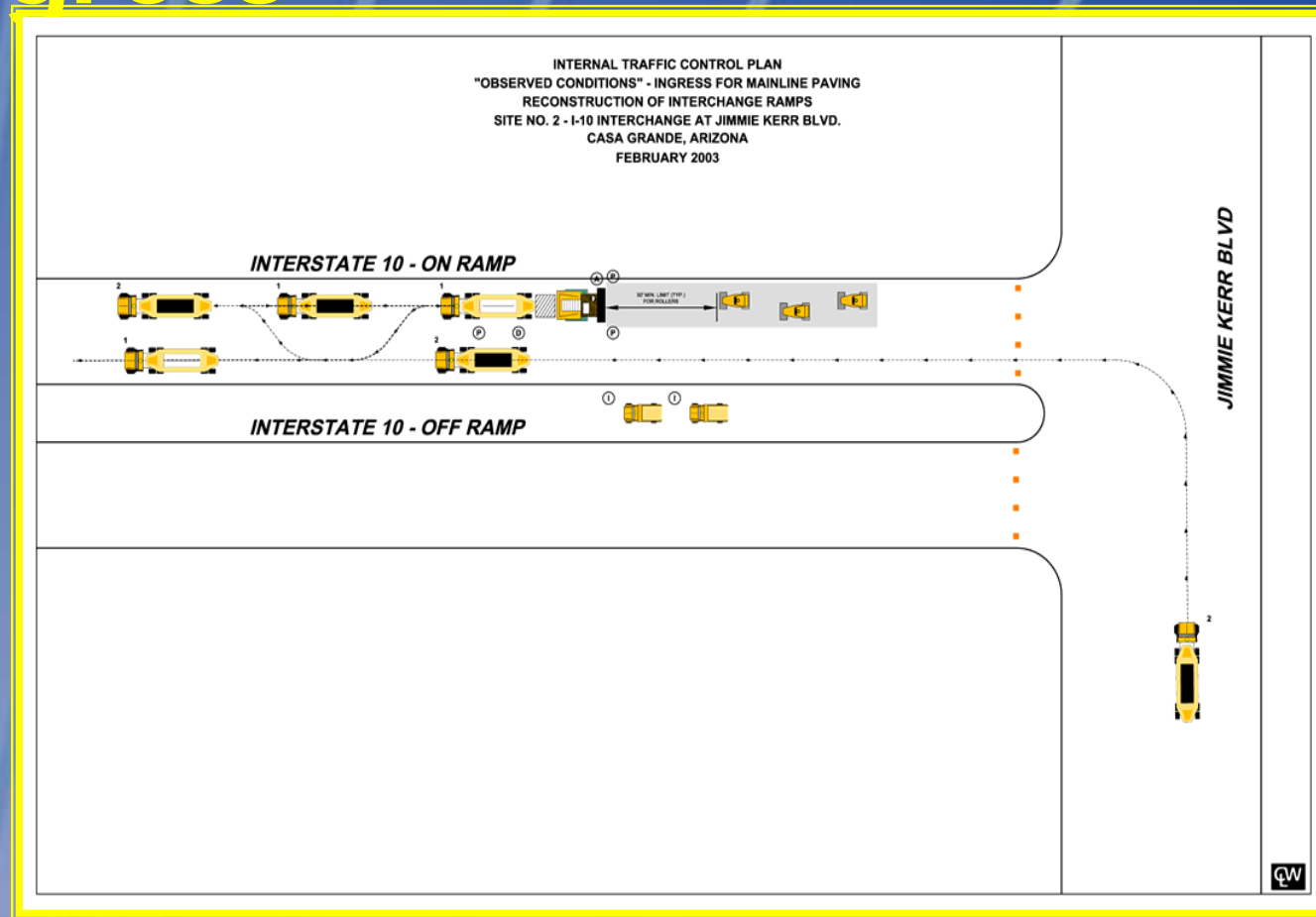
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Paving Model Plan – Site #1



Paving Model Plan – Site #2 Ingress

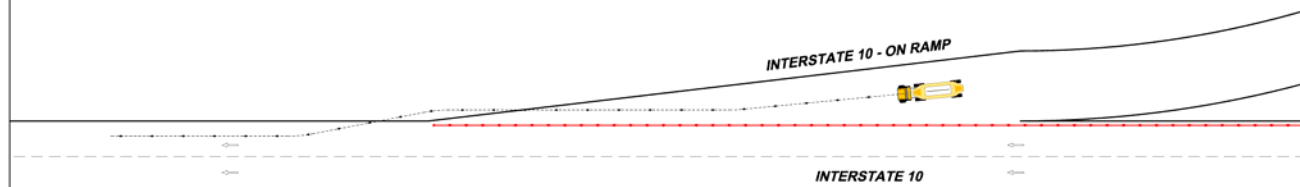


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Paving Model Plan – Site #2 Egress

INTERNAL TRAFFIC CONTROL PLAN
"OBSERVED CONDITIONS" - ALL OPERATIONS - EGRESS
RECONSTRUCTION OF INTERCHANGE RAMP
SITE NO. 2 - I-10 INTERCHANGE AT JIMMIE KERR BLVD.
CASA GRANDE, ARIZONA
FEBRUARY 2003



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STEPS IN PREPARATION OF ITCPS

- Review TCP and other contract documents
- Determine site-specific ITCP needs
- Draw work space
- Add pedestrian and equipment paths
- Locate staging areas
- Prepare notes and plan



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Internal Traffic Control Plans – Questions

- Can the need for backing be reduced or eliminated?
- Can the number of vehicle access points into the work space be reduced?
- Can pedestrian-free zones be established?
- Can the work space accommodate the equipment being used?
- Do any physical features of the site place operators at risk?



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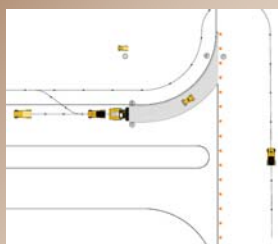


Internal Traffic Control Plan: How-To Guide

Revised Internal Traffic Control Plan Site 2

Internal Traffic Control Plans for Asphalt Paving Operations On Freeway Segments Task 7.1

Contract No. 200-2002-00596



INTERNAL TRAFFIC CONTROL PLAN NOTES

- Interstate 10 - Interchange with Jimmie Kerr Boulevard
Casa Grande, Arizona

- Spotter stays at paver.
Spotter should maintain a location between truck traffic and the paver thereby allowing complete view and control of truck movement and staging.
- Communications should be maintained between the spotter and truck operators.
 - A pedestrian worker may be employed if data obtained from truck operators cannot be adequately completed by the spotter. Said pedestrian worker should maintain a location outside and near the truck depositing material.
2. Truck Spotter stages trucks to minimize truck backing.
- The spotter should organize truck arrival times so that downtime and bottlenecks can be avoided.
 - Incoming and outgoing truck traffic should be the same.
 - If incoming truck traffic requires too many vehicles in the primary staging area, then a secondary staging location should be used.

Submitted to the



CENTERS FOR DISEASE CONTROL
and PREVENTION
CONTRACTS MANAGEMENT BRANCH

Submitted by

C.L. Williams Consulting, Inc.
4720 W. Maverick Lane, Suite #103
Lakeside, Arizona 85929



May 16, 2003

Internal Traffic Control Plan Draft Development Guide

Internal Traffic Control Plans for Asphalt Paving Operations On Freeway Segments Task 8.1

Contract No. 200-2002-00596

Submitted to the



CENTERS FOR DISEASE CONTROL
and PREVENTION
CONTRACTS MANAGEMENT BRANCH

Submitted by

C.L. Williams Consulting, Inc.
4720 W. Maverick Lane, Suite #103
Lakeside, Arizona 85929



June 19, 2003



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ITCP Concrete Plans

**Internal Traffic Control Plan
Site 1
Internal Traffic Control Plans for Portland
Cement Concrete Paving Operation
Task 7.1**

Contract No. 200-2002-00596
Modification No. 00001

INTERNAL TRAFFIC CONTROL

- LIGHT(S)
- CHANNELIZING DEVICE(S)
- BARRIER
- DIRECTION OF TEMPORARY TRAFFIC OR DETOUR
- DIRECTION OF TRAFFIC

- On foot personnel -

| | |
|------------------------|---------------|
| ① PEDESTRIAN WORKER | ② FOREMAN |
| ③ SPOTTER | ④ FLAGGER |
| ⑤ INSPECTOR | ⑥ SURVEYOR |
| ⑦ PEDESTRIAN-FREE ZONE | ⑧ OTHER CLASS |

- Vehicle Types -

- FINISHER/FINISHING
- WATER TRUCK
- PAVING MACHINE
- DUMP TRUCK (EMPTY)

Submitted to the

CENTERS FOR DISEASE CONTROL
and PREVENTION
CONTRACTS MANAGEMENT BRANCH

Submitted by
 C.L. Williams Consulting, Inc.
4720 W. Maverick Lane #103
Lakeside, Arizona 85929

May 13, 2004

**Summary Field Report
Site 1
Internal Traffic Control Plans for Portland
Cement Concrete Paving Operation
Task 7.1**

Contract No. 200-2002-00596
Modification No. 00001

Submitted to the

CENTERS FOR DISEASE CONTROL
and PREVENTION
CONTRACTS MANAGEMENT BRANCH

Submitted by
 C.L. Williams Consulting, Inc.
4720 W. Maverick Lane #103
Lakeside, Arizona 85929

May 13, 2004



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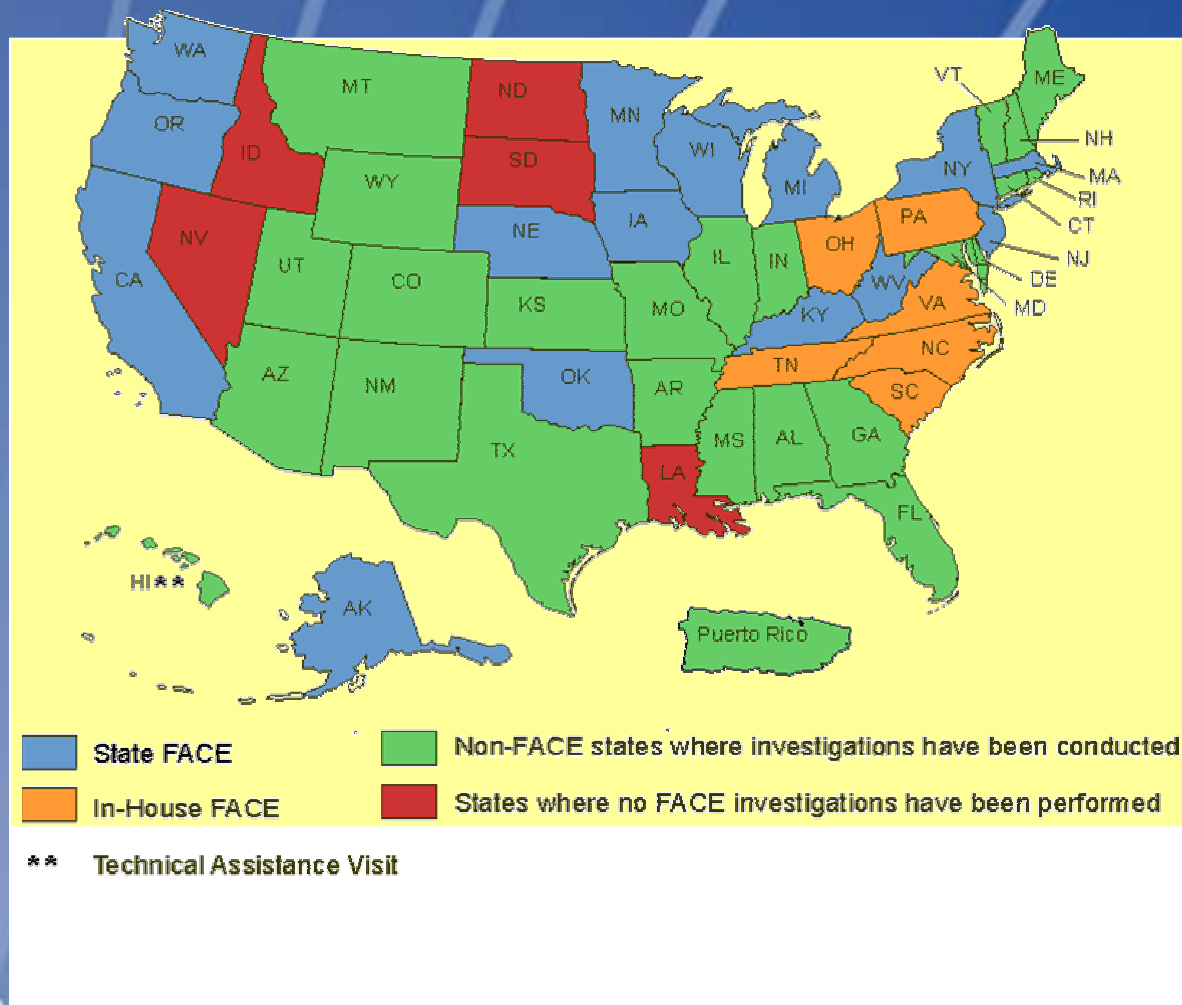
Fatality Investigations



<http://www.cdc.gov/niosh/fac/facweb.html>



Participating FACE States



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Example Fatality Cases

Case 1: 45-year-old boom truck driver run over by dump truck that was backing during a repositioning maneuver.

Case 2: 31-year-old worker run over by front-end loader at the site of a crushing machine.

Case 3: 35-year-old laborer run over by dump truck at roadway resurfacing operation.



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Case 1



Minnesota Face Program
(MN9207)

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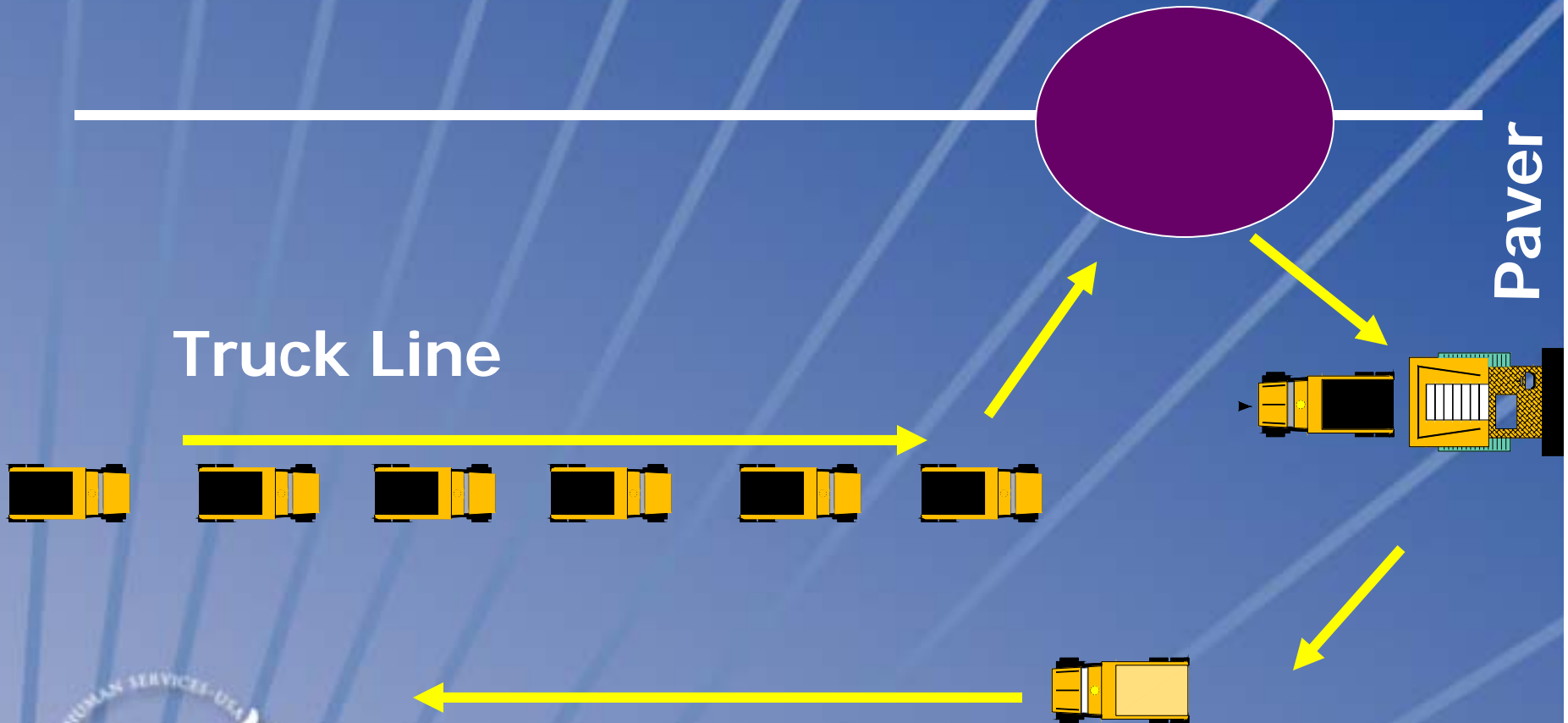


Concrete Paving Operation Layout

Turn-around

Paver

Truck Line



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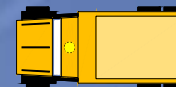
Truck Queue Repositioning

Turn-around

New
Truck

Last
Truck

Truck Line



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Case 2



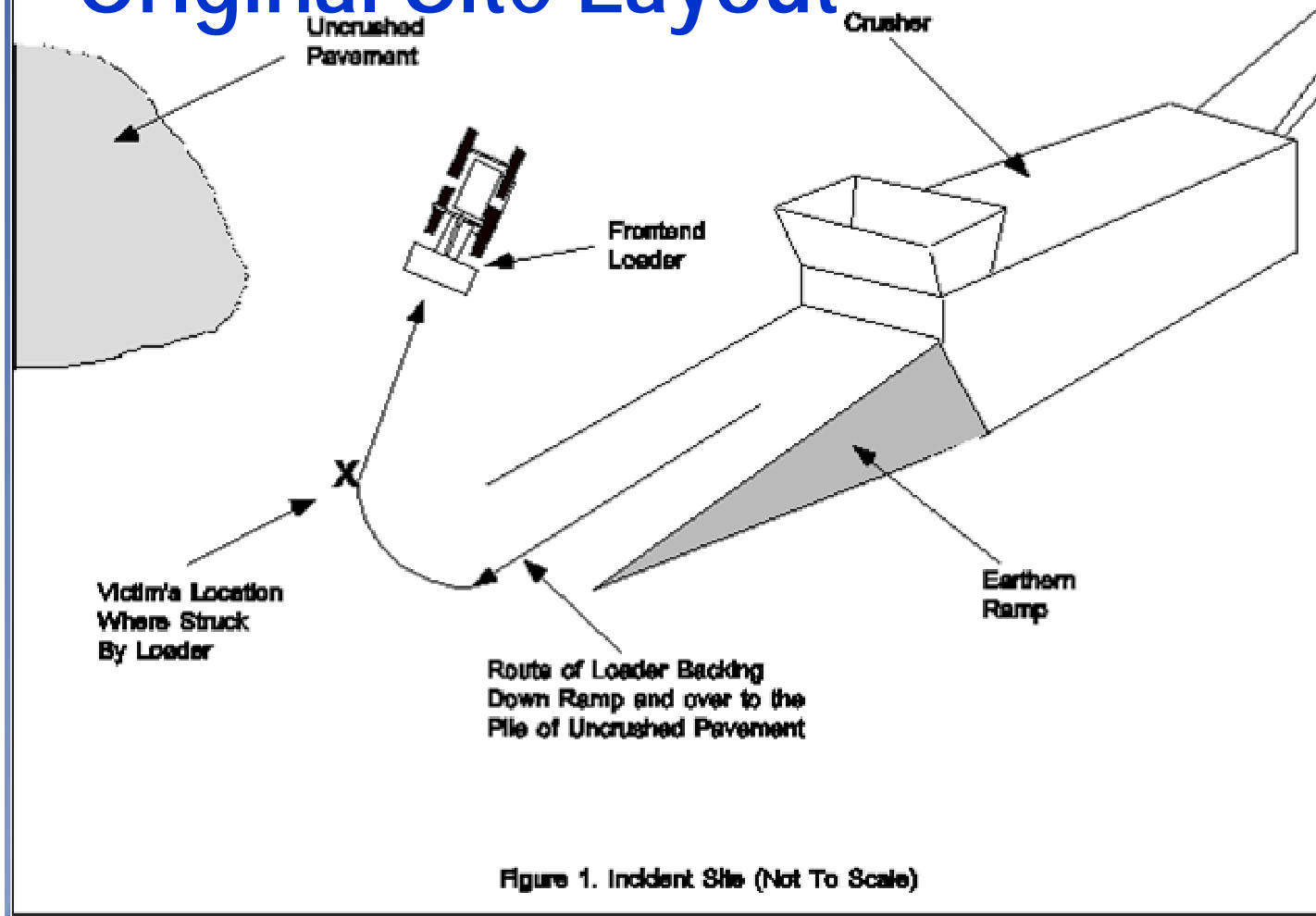
Minnesota FACE Program (98MN030)



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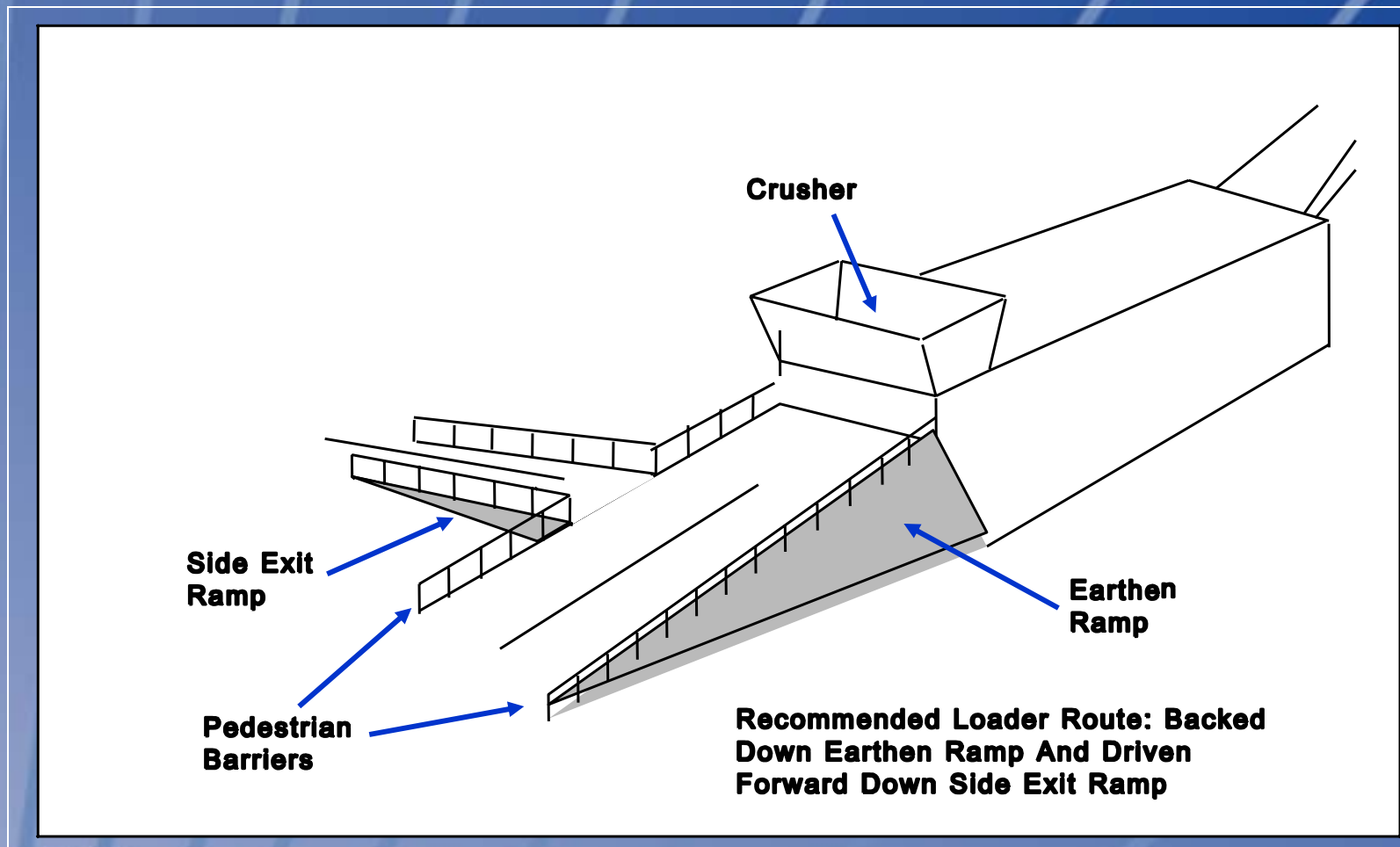
Original Site Layout



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Redesigned Site Layout



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Case 3

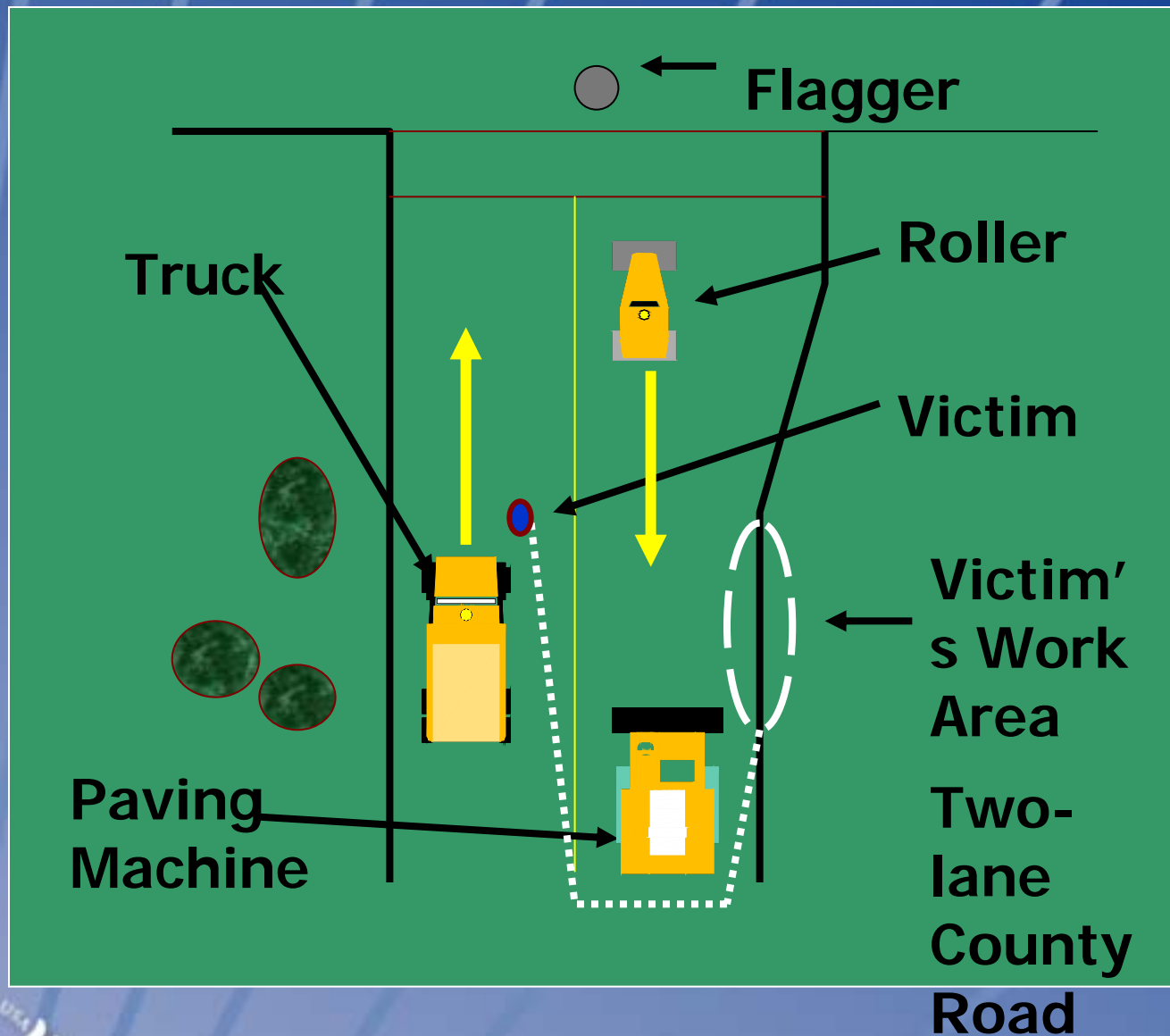


Two-lane County Road -- Four-lane State Highway



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View from the Street



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View from Inside the Cab



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Evaluating Roadway Construction Work Zone Interventions

- Highway paving operations (probably major recon or new const)
- Separated from traffic by more than cones and barrels
- Asphalt paving



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- **Daytime operation**
- **Control and treatment sites being paved by different crews**
- **Room for research trailer**
- **Three weeks of paving at site**
- **Contractor and DOT cooperation**



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David E. Fosbroke
NIOSH
Division of Safety
Research Morgantown,
WV

(304) 285-6010

dFosbroke@cdc.gov



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