

# Collision Avoidance Systems and Collision Warning Systems

## Reducing Surface Mobile Equipment Accidents Through Technology

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MSHA POWERED HAULAGE INITIATIVE

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MSHA Technical Support



# MSHA Powered Haulage Safety Initiative

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## Areas of Focus

- Mobile Equipment at Surface Mines
  - Seat Belts
  - Large Equipment Striking Smaller Equipment
  - Highwalls and Dump Points
- Conveyor Belt Safety

# MSHA Powered Haulage Safety Initiative

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## Mobile Equipment at Surface Mines

- Equipment Collisions with Other Equipment
- Equipment Collisions with Pedestrians

# MSHA Powered Haulage Safety Initiative

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## Mobile Equipment at Surface Mines

- 2017 Accidents
  - Nearly 40 % of Fatalities Involved Mobile Equipment
  - Over 30% of Injuries Involved Mobile Equipment
- Since 2007 - 61 Mining Fatalities Involving Mobile Equipment

# Mobile Equipment at Surface Mines

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## Blind Areas

- Mobile Equipment Size and Shape and the Operator's Cab Location can each Create Unique Blind Areas
- Blind Areas have Contributed to Mobile Equipment Operators Driving over Highwalls or Dump Points, Colliding with Other Equipment, and Striking Miners



*Driver's Point-of-View*



*Actual Site Activity Outside of Driver's Line of Sight*

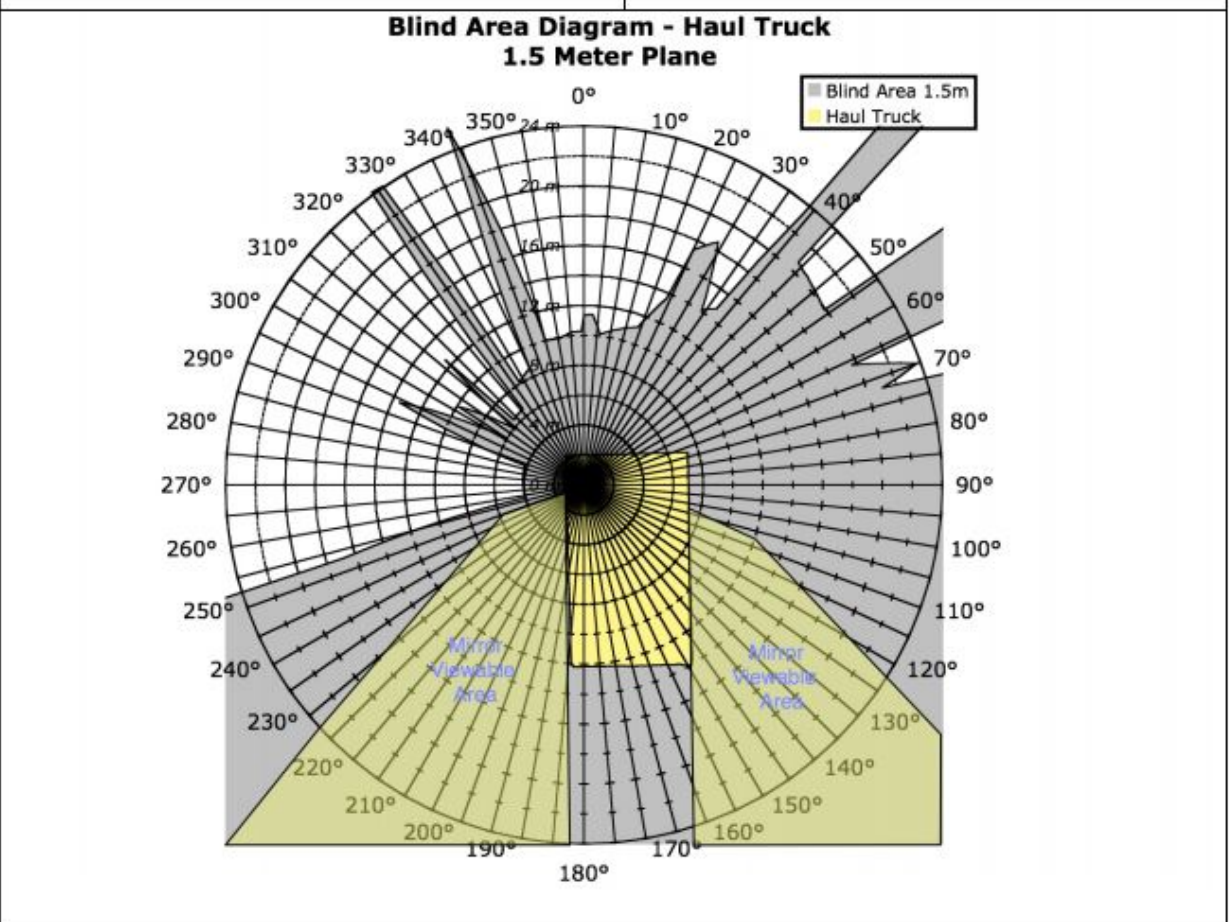
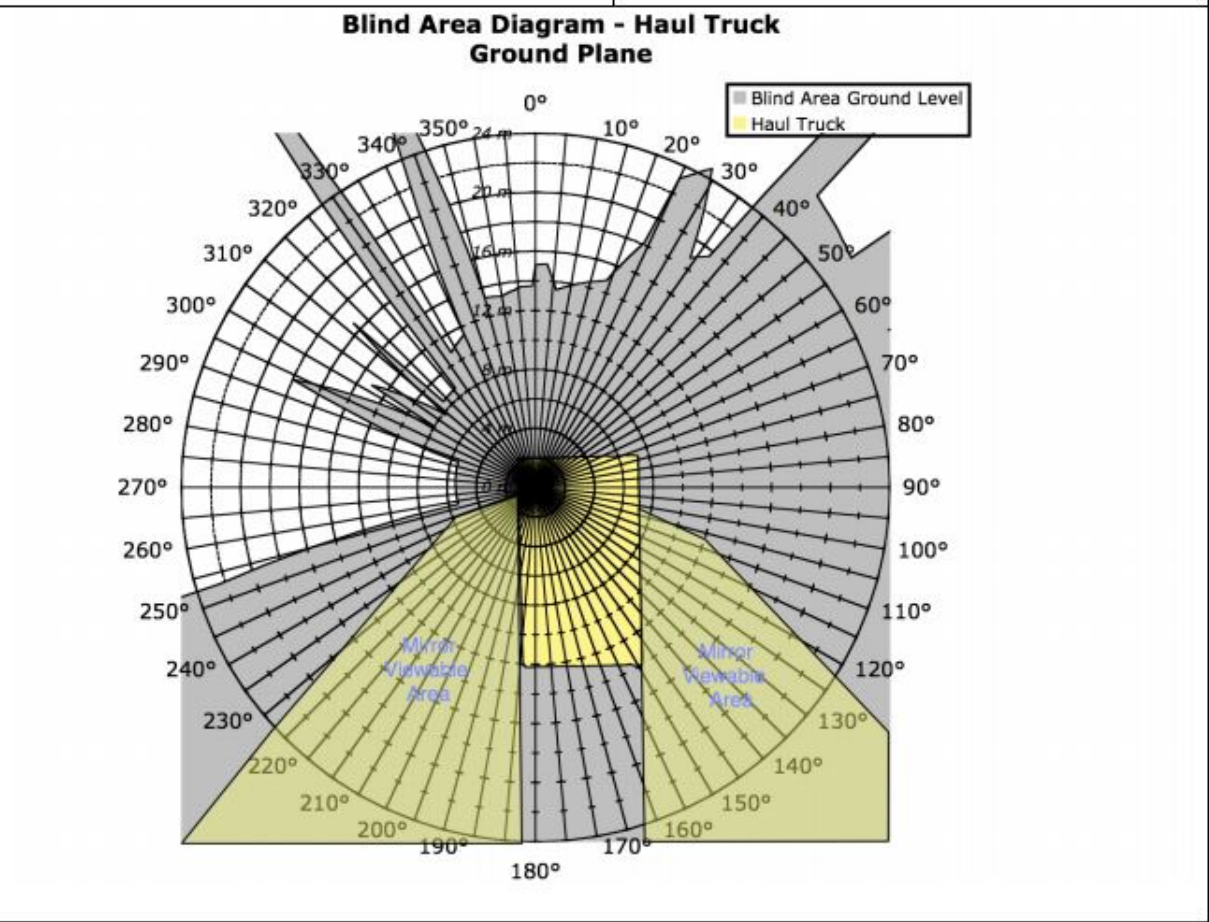
# Blind Areas

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- NIOSH has Developed a Manual Method of Evaluating Mobile Equipment Blind Areas
- Simplified Version of ISO Method Used by OEMs to Enable End Users to Perform Evaluations
  - <https://www.cdc.gov/niosh/topics/highwayworkzones/bad/manualmethod.html>

# Blind Areas

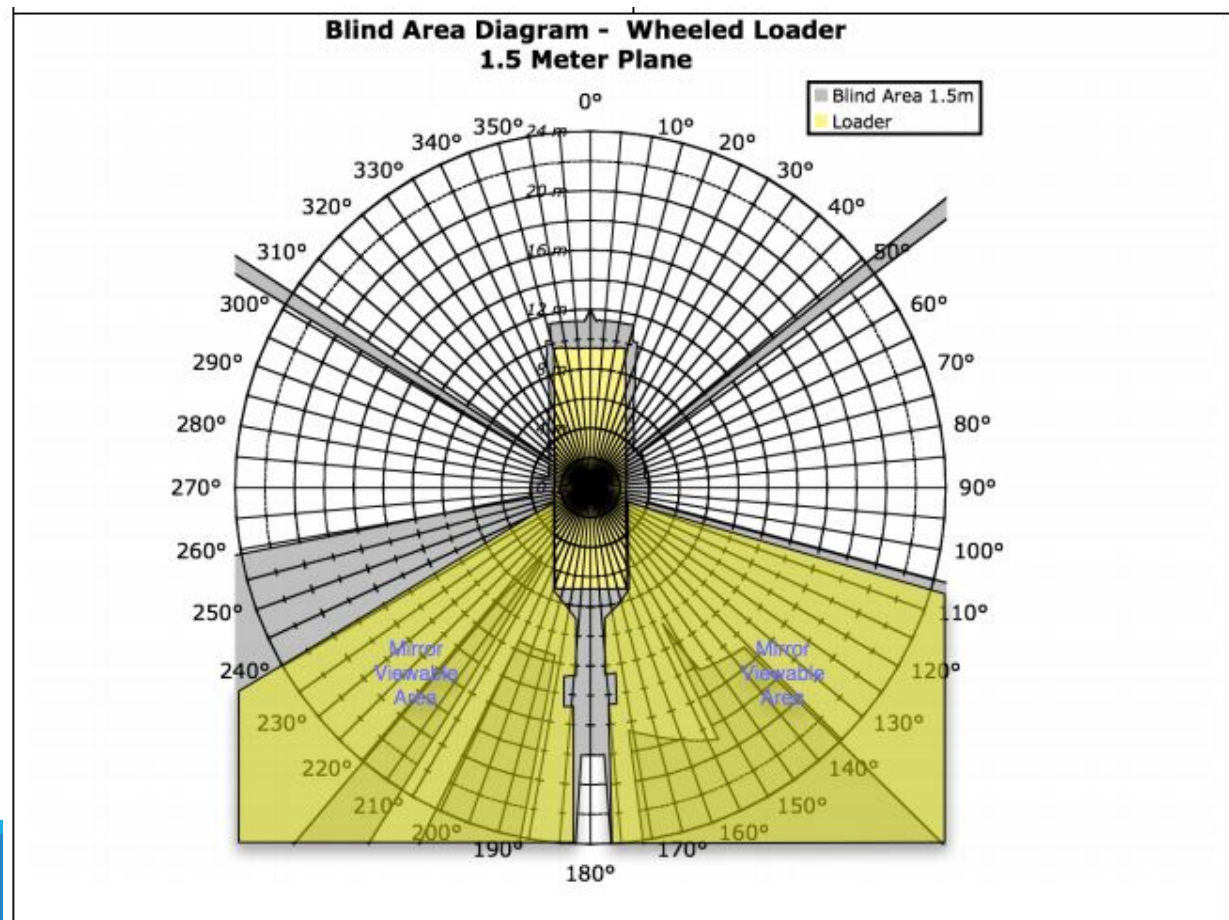
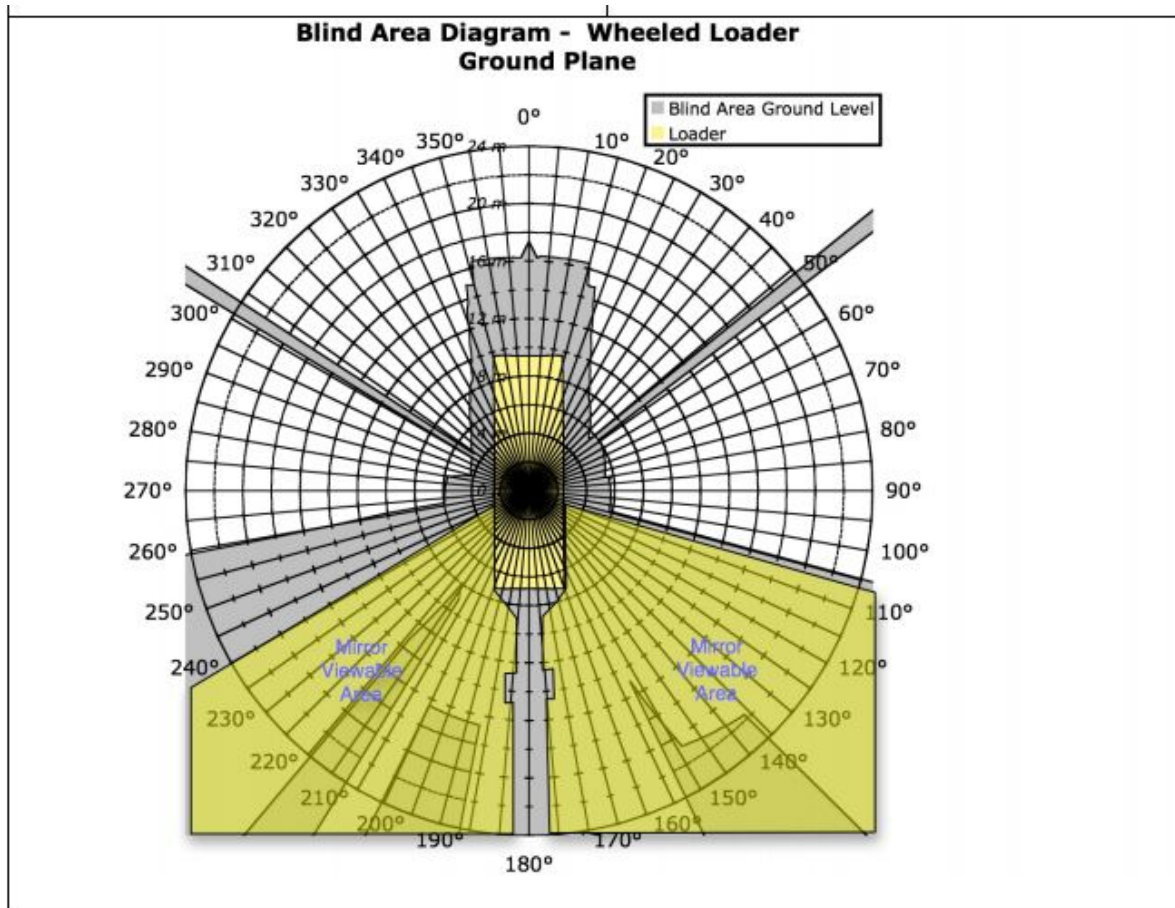
- Haul Truck (NIOSH Example)





# Blind Areas

- Front End Loader (NIOSH Example)



# Low Tech Technology Solutions



# Collision Warning / Collision Avoidance

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## Collision Warning System (CWS)

- Provide Equipment Operators with an Awareness of the Location of Nearby Personnel, Light Vehicles, Stationary Structures, and Other Pieces of Equipment through Display Screen in the Operator's Compartment and through Audible and Visible Alarms

## Collision Avoidance System (CAS)

- Operates the Same as CWS Except that CAS can take Control of the Mobile Equipment to Slow Down or Stop it Before an Accident can Occur

# Collision Warning / Avoidance Technology

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## Global Navigational Satellite System (GNSS)

- GPS in United States
- Systems Track Equipment in Relation to One Another
- Ability to “Geo-Fence” Areas to Restrict Equipment to Set Boundaries

# Collision Warning / Avoidance Technology

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RADAR

LIDAR

Ultrasound

- Units Installed on Mobile Equipment to Detect Other Equipment and Objects, including Pedestrians Using Time of Flight Measurements

# Collision Warning / Avoidance Technology

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Electromagnetic

Radio Frequency Identification (RFID)

- Units Installed on Mobile Equipment to Detect Sensors Mounted on Other Equipment and Objects, Including Pedestrians

# Collision Warning / Avoidance Technology

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## Cameras

- Video Screens Display Camera Feeds from Blind Spots Around the Equipment

# CWS Preventable Fatal Accident Analyses

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## United States Surface Mining Operations Since 2003

- Using CWS could have Prevented 21 Accidents that Resulted in 23 Fatalities



# CWS Preventable Fatal Accident Analyses

## EXAMPLE #1

- Front End Loader Backs into Pickup Truck that had Parked Behind it



### Potential of Save by Available CWS Technologies

GNSS	Radar/Lidar	Electromagnetic	RFID	Cameras
Yes	Yes	Yes	Yes	Possibly

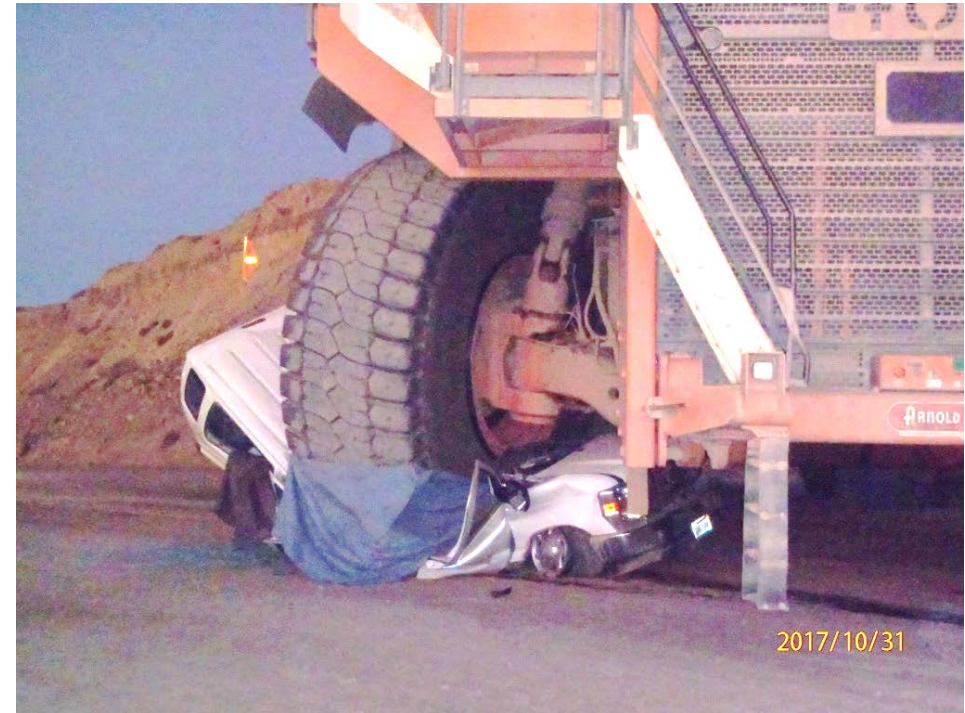
# CWS Preventable Fatal Accident Analyses

## EXAMPLE #2

- Van Pulled Up with 9 Miners along side Haul Truck
- 2 miners were killed

### Potential of Save by Available CWS Technologies

GNSS	Radar/Lidar	Electromagnetic	RFID	Cameras
Yes	Yes	Yes	Yes	Possibly



# CWS Preventable Fatal Accident Analyses

## EXAMPLE #3

- Pickup Truck Parked in the Haul Truck Traffic Path



### Potential of Save by Available CWS Technologies

GNSS	Radar/Lidar	Electromagnetic	RFID	Cameras
Yes	Yes	Yes	Yes	Possibly

# CWS Preventable Fatal Accident Analyses

## EXAMPLE #4

- Truck Driver Ran over Portable Toilet



### Potential of Save by Available CWS Technologies

GNSS	Radar/Lidar	Electromagnetic	RFID	Cameras
Possibly	Yes	Yes	Yes	Possibly

# CWS Preventable Fatal Accident Analyses

## EXAMPLE #5

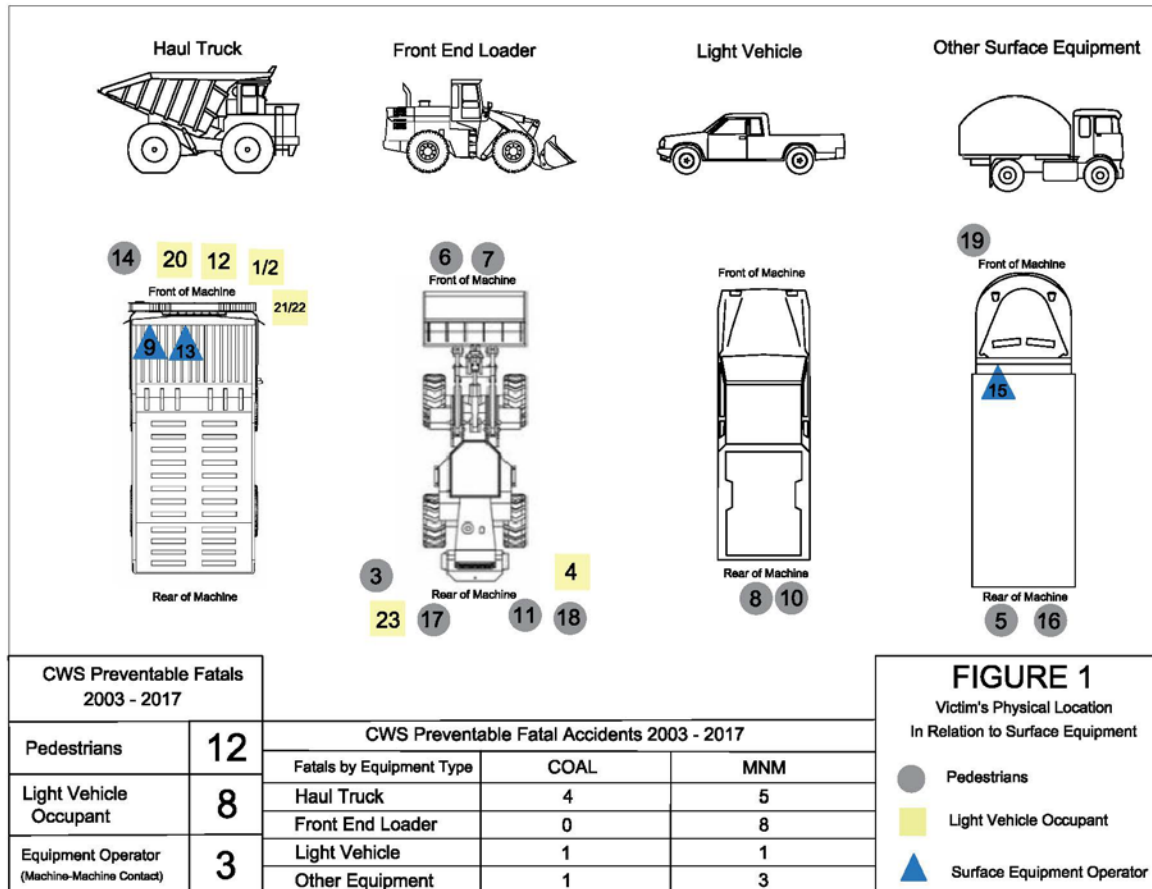
- Scrapper and Fuel/Grease Truck Collided on Haul Road

### Potential of Save by Available CWS Technologies

GNSS	Radar/Lidar	Electromagnetic	RFID	Cameras
Yes	Yes	Yes	Yes	Possibly



# CWS Preventable Fatal Accident Analyses



# CWS Preventable Fatal Accident Analyses

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- Victims Located in Front of Haul Trucks on 5 of 7 Haul Truck Accidents
- Victims Located Behind Front End Loaders in 6 of 8 Front End Loader Accidents
- 14 of 21 Surface Equipment Accidents Occurred while Equipment was at Low Speed and Initiating a Forward or Reverse Movement

# CWS Preventable Fatal Accident Analyses

## CWS Preventable Fatal By Mine Size (2003-Present)

Mine Size	Fatals
<20	4
20-200	11
>200	8

## CWS Preventable Fatal by Mine Type (2003-Present)

Mine Type	Fatals
Coal	6
Gold	4
Cement	3
Stone	3
Sand & Gravel	2
Copper	2
Limestone	2
Phosphate	1



# CWS Preventable Fatal Accident Analyses

SPATIAL DISTRIBUTION OF CWS PREVENTABLE SURFACE  
MINING ACCIDENTS 2003— Present



# Summary

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- MSHA Powered Haulage Safety Initiative
- RFI Open thru December 24, 2018
- Improving Surface Mobile Equipment Awareness
  - Evaluating Equipment Blind Areas
  - Low Tech Solutions
  - Collision Warning Systems / Collision Avoidance Systems

# Questions?

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