Reducing Surface Mobile Equipment Accidents Through Technology

Preventing Surface Mobile Equipment Collisions

MSHA POWERED HAULAGE SAFETY INITIATIVE

Virginia Transportation Construction Alliance Safety Seminar
December 3-4, 2019
MSHA Powered Haulage Safety Initiative

Request For Information (RFI)

• MSHA published RFI on June 26, 2018
  • RFI title: “Safety Improvement Technologies for Mobile Equipment at Surface Mines, and for Belt Conveyors at Surface and Underground Mines”

• RFI seeks information on technological improvements for powered haulage equipment that may have lifesaving implications for the mining industry

• RFI closed on December 24, 2018

• MSHA is currently reviewing the RFI comments
MSHA Powered Haulage Safety Initiative

Areas of Focus

• Mobile equipment at surface mines
  • Seat belts
  • Large equipment striking smaller equipment
  • Highwalls and dump points

• Belt conveyor safety

Mobile Equipment at Surface Mines

- Mobile equipment collisions with other equipment
- Mobile equipment collisions with pedestrians
Mobile Equipment at Surface Mines

• 2018 accidents – 7 mining fatalities involving mobile equipment

• 2007-2018 - 68 mining fatalities involving mobile equipment
Mobile Equipment at Surface Mines

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

• NIOSH has developed a manual method of evaluating mobile equipment blind areas

• Simplified version of ISO method that OEMs use to enable end users to perform evaluations

  • https://www.cdc.gov/niosh/topics/highwayworkzones/bad/manualmethod.html
Blind Areas

- Haul truck (NIOSH example)

<table>
<thead>
<tr>
<th>Haul Truck (Manuf. &amp; Model)</th>
<th>Euclid EH4500</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVM</td>
<td>435,456 Kg</td>
</tr>
<tr>
<td>Machine Dimensions</td>
<td>14.1 m long 8.15 m wide 7.04 m tall</td>
</tr>
<tr>
<td>Operator Enclosure</td>
<td>Closed ROPS</td>
</tr>
<tr>
<td>Attachments</td>
<td>None</td>
</tr>
<tr>
<td>Other Information</td>
<td>255.5 metric ton (281.6 ton) capacity, 2013 kW (2700 hp)</td>
</tr>
<tr>
<td>Measurement Technique</td>
<td>Physical</td>
</tr>
</tbody>
</table>
Blind Areas

- Haul truck (NIOSH example)
Blind Areas

- Front end loader (NIOSH example)

<table>
<thead>
<tr>
<th>Loader (Manuf. &amp; Model)</th>
<th>Cat 992G Wheeled Loader</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVM</td>
<td>100,227 kg</td>
</tr>
<tr>
<td>Machine Dimensions</td>
<td>16.226 m long 4.84 m wide 5.59 m tall</td>
</tr>
<tr>
<td>Operator Enclosure</td>
<td>Closed ROPS</td>
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<tr>
<td>Attachments</td>
<td>None</td>
</tr>
<tr>
<td>Other Information</td>
<td>11.5 cu. M bucket</td>
</tr>
<tr>
<td>Measurement Technique</td>
<td>Physical</td>
</tr>
</tbody>
</table>
Blind Areas

- Front end loader (NIOSH example)
Blind Areas

• MSHA Technical Support blind area measurement

• 10’ x 10’ grid around Caterpillar 785B haul truck
Blind Areas

• View from operator’s seat in haul truck
Blind Areas

- Haul truck - ground level
Blind Areas

- Haul truck – 6 foot height
Blind Areas

• Haul truck – 12 foot height
Blind Areas

- Haul truck – hybrid map
Low Tech Technology Solutions
EMESRT 9 Levels of Incident Preventative Control

• Level 7 Operator Awareness (Alert)
  • Technologies that provide information to enhance the operator ability to observe and understand potential hazards in the vicinity of the equipment

• Level 8 Advisory Controls (Alert and Advise)
  • Technologies that provide alarms and/or instructions to enhance the operator ability to predict a potential unsafe interaction and the corrective action required

• Level 9 Intervention Controls (Intervene)
  • Technologies that automatically intervene and take some form of equipment control to prevent or mitigate an unsafe interaction
Collision Warning / Collision Avoidance

Collision Warning System (CWS) Levels 7 & 8

• 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) Level 9

• 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

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

- RADAR
- LIDAR
- Ultrasound
- Infrared

- Units installed on mobile equipment to detect other equipment and objects, including pedestrians using time of flight measurements
Collision Warning / Avoidance Technology

Electromagnetic

Radio Frequency Identification (RFID)

• Units installed on mobile equipment to detect sensors mounted on other equipment and objects, including pedestrians
CWS Preventable Fatal Accident Analyses 2003-2018

Using CWS could have prevented 22 accidents that resulted in 24 fatalities
CWS Preventable Fatal Accidents 2003 - 2018

| Pedestrians | 12 |
| Light Vehicle Occupant | 9 |
| Equipment Operator (Machine-Machine Contact) | 3 |

<table>
<thead>
<tr>
<th>Fatal by Equipment Type</th>
<th>COAL</th>
<th>MNM</th>
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</thead>
<tbody>
<tr>
<td>Haul Truck</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Light Vehicle</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other Equipment</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Last Updated: December 10, 2018
CWS Preventable Fatal Accident Analyses

• Victims located in front of haul trucks on 6 of 8 haul truck accidents

• Victims located behind front end loaders in 6 of 8 front end loader accidents

• 14 of 22 surface equipment accidents occurred while equipment was at low speed and initiating a forward or reverse movement
CWS Preventable Fatal Accident Analyses

EXAMPLE #1

• Front end loader backs into pickup truck that had parked behind it
CWS Preventable Fatal Accident Analyses

EXAMPLE #2

• Van pulled up with 9 miners along side haul truck
• 2 miners were killed
CWS Preventable Fatal Accident Analyses

EXAMPLE #3

- Haul truck contacted a pickup truck near dump point

Potential of Save by Available CWS Technologies

<table>
<thead>
<tr>
<th>GNSS</th>
<th>Radar/Lidar</th>
<th>Electromagnetic</th>
<th>RFID</th>
<th>Cameras</th>
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<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
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</table>
Figure 2 - Spatial distribution of CWS preventable surface mining fatalities 2003—2018
Summary

• MSHA Powered Haulage Safety Initiative

• MSHA is currently reviewing the RFI comments

• Improving surface mobile equipment awareness
  • Evaluating equipment blind areas
  • Low tech solutions
  • Technology - Collision Warning Systems / Collision Avoidance Systems
Questions?

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