Collision Avoidance Systems and Collision Warning Systems

Reducing Surface Mobile Equipment Accidents Through Technology

MSHA POWERED HAULAGE INITIATIVE

Matt Wharry
MSHA Technical Support
MSHA Powered Haulage Safety Initiative

Request For Information (RFI)

• MSHA Published RFI on June 26, 2018

• RFI Seeks Information on Technological Improvements for Powered Haulage Equipment that may have Lifesaving Implications for the Mining Industry

• RFI Closes on December 24, 2018
MSHA Powered Haulage Safety Initiative

7 Stakeholder Meetings Held During August and September

- Birmingham, AL
- Dallas, TX
- Reno, NV
- Beckley, WV
- Albany, NY
- Arlington, VA
- Webinar
MSHA Powered Haulage Safety Initiative

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

Mobile Equipment at Surface Mines

• Equipment Collisions with Other Equipment

• Equipment Collisions with Pedestrians
MSHA Powered Haulage Safety Initiative

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

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
Blind Areas

• 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

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

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

- 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
Collision Warning / Avoidance Technology

Cameras

- Video Screens Display Camera Feeds from Blind Spots Around the Equipment
CWS Preventable Fatal Accident Analyses

United States Surface Mining Operations Since 2003

- Using CWS could have Prevented 21 Accidents that Resulted in 23 Fatalities
EXAMPLE #1

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

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>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>GNSS</th>
<th>Radar/Lidar</th>
<th>Electromagnetic</th>
<th>RFID</th>
<th>Cameras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
</tbody>
</table>

2017/10/31
CWS Preventable Fatal Accident Analyses

EXAMPLE #3

- Pickup Truck Parked in the Haul Truck Traffic Path

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>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
</tbody>
</table>
EXAMPLE #4

• Truck Driver Ran over Portable Toilet

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>
</tr>
</thead>
<tbody>
<tr>
<td>Possibly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
</tbody>
</table>
CWS Preventable Fatal Accident Analyses

EXAMPLE #5

- Scraper and Fuel/Grease Truck Collided on Haul Road

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>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
</tbody>
</table>
CWS Preventable Fatal Accident Analyses

FIGURE 1
Victim’s Physical Location
In Relation to Surface Equipment

<table>
<thead>
<tr>
<th>CWS Preventable Fatal Accidents 2003 - 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal by Equipment Type</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Haul Truck</td>
</tr>
<tr>
<td>Front End Loader</td>
</tr>
<tr>
<td>Light Vehicle</td>
</tr>
<tr>
<td>Other Equipment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CWS Preventable Fatalities 2003 - 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrians</td>
</tr>
<tr>
<td>Light Vehicle Occupant</td>
</tr>
<tr>
<td>Equipment Operator (Machine-Machine Contact)</td>
</tr>
</tbody>
</table>
CWS Preventable Fatal Accident Analyses

• 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

<table>
<thead>
<tr>
<th>Mine Size</th>
<th>Fatals</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>4</td>
</tr>
<tr>
<td>20-200</td>
<td>11</td>
</tr>
<tr>
<td>&gt;200</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mine Type</th>
<th>Fatals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>6</td>
</tr>
<tr>
<td>Gold</td>
<td>4</td>
</tr>
<tr>
<td>Cement</td>
<td>3</td>
</tr>
<tr>
<td>Stone</td>
<td>3</td>
</tr>
<tr>
<td>Sand &amp; Gravel</td>
<td>2</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td>Limestone</td>
<td>2</td>
</tr>
<tr>
<td>Phosphate</td>
<td>1</td>
</tr>
</tbody>
</table>
CWS Preventable Fatal Accident Analyses

SPATIAL DISTRIBUTION OF CWS PREVENTABLE SURFACE MINING ACCIDENTS 2003 — Present
Summary

• 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?

Matt Wharry
MSHA Technical Support
wharry.matthew@dol.gov
304-547-2323