Improving Ingress/Egress Systems on Mobile Equipment

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What is an Ingress/Egress System?

- Ingress – getting on

  Ground → Cab of the equipment

- Egress – getting off

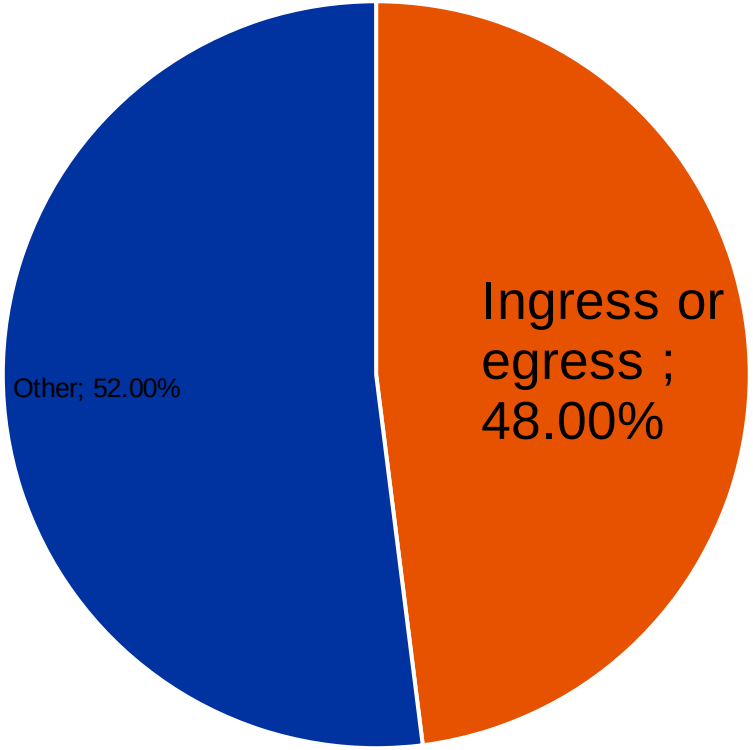
  Cab of the equipment → Ground

Background: Injuries on Ingress/Egress Systems

Based on MSHA injury data from 1996-2015

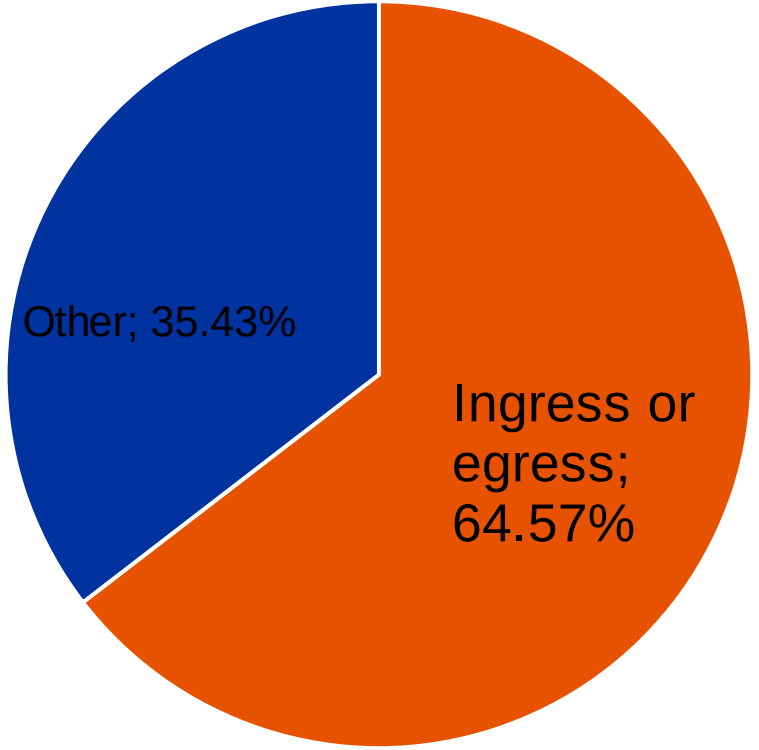
Background: Results from other studies

Falls from all equipment between 2006-2007



Fall from equipment injuries in U.S. mining: Identification of specific research areas for future investigation. (2009) Moore, S. M., Porter, W. L., & Dempsey, P. G. *Journal of Safety Research, 40*(6), 455-460.

Slips and falls from haul trucks between 2004-2008



An Analysis of Injuries to Haul Truck Operators in the U.S. Mining Industry. (2010) Santos, B. R., Porter, W. L., & Mayton, A. G. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 54*(21), 1870-1874.

Background: Mining Equipment Ingress/Egress Systems

The equipment is large

Ladder, stair, or a combination of both are needed to get to the cab

The ground conditions are harsh

Bottom rungs with flexible rails or retractable ladders or stairs are needed to prevent damage

Objective: Questions

- What factors contribute to ingress and egress injuries on front end-loaders?

- What equipment characteristics may lead to injury?

Methods: Two Approaches

Analysis of MSHA non-fatal injury data

For wheel front-end loaders

Interviews with equipment operators

Any mobile equipment operator

MSHA Data

We looked at 20 years of data (1996-2015) and read approximately 1,300 narratives

- Identify factors that led to non-fatal injury
- Identify the location of the operators at the time of incident
- Record characteristics of ingress and egress systems

MSHA Data: What factors led to the injuries?

Analysis of the ***narrative description of the event*** reported in the MSHA 7000-1 form

Event that led to the incident

- Foot slip
- Hand slip
- Trip
- Missed step
- Lost balance
- Step on
- Generic fall
- Other

Contributing factors

- Contaminant on equipment
- Ground conditions
- Equipment failure
- Unexpected movement
- Other

Contributing factor details

- Water
- Ice/snow
- Mud
- Grease/oil
- Rock
- Uneven surface
- Hose/pipe
- Weather

MSHA Data: Where did the incident happen?

Analysis of the ***narrative description of the event*** reported in the MSHA 7000-1 form

Platform / cab

Tire / fender

Ladder

Top step

2nd step from top or bottom

Bottom step

Ground

MSHA Data: How do you get on or off that equipment?

1. Look for images of equipment on Google® or manufacturers' and dealers' websites
2. Systematically code equipment characteristics

Type of system

- Vertical ladder
- Inclined ladder
- Stairs
- Combination

Type of rail on bottom rung

- Cable sided
- Rubber sided
- Chain sided
- Other

Number of rungs / stairs

- Flexible
- Rigid
- Stairs

Methods: Second Approach

Analysis of MSHA non-fatal injury data

For wheel front-end loaders

Interviews with equipment operators

Any mobile equipment operator

Operator Interviews

- At what point do slips or falls occur when getting on or off the equipment?
- What makes getting on and off equipment difficult or may increase the risk of slipping or falling?
- What are some good (and bad) practices while getting on and off equipment?
- What could be done to improve the ingress/egress system?

Recall Our Initial Questions

- What factors contribute to ingress and egress injuries on front end-loaders?

- What equipment characteristics may lead to injury?

Results

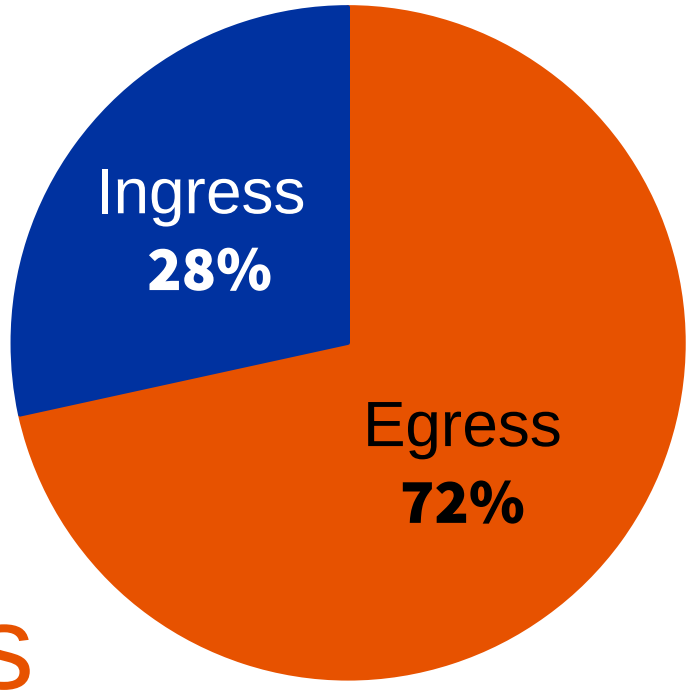
Goal:
Help to improve the ingress/egress system and make getting on and off the equipment safer

Egress is more dangerous than ingress because of increased forces due to gravity

Ingress

vs

Egress



Based on activity at time of incident from MSHA non-fatal data analysis

A similar trend was identified in the interviews by

Poor ground conditions: Step on or step in

Look out for…

Rocks

Hoses/pipes and other materials

Uneven surface, ruts and holes

Contaminants
Slips: Most commonly led to injuries

These contaminants were mentioned in the interviews as well

Recommendations: Ground Conditions and Contaminants

- Provide a well-maintained, designated parking area that is free of rocks, ruts, and debris
- Increase lighting on and around the ingress/egress system **(recommended by operators)**
- Provide deeper ladder rungs with a non-slip coating **(recommended by operators)**
- Provide shoe cleaning station on the equipment and on the ground
- Build a boarding platform with stairs that allow operators to access the cab of the equipment directly

Unexpected Movement & Equipment Failure

Unexpected movement
associated with blowing wind

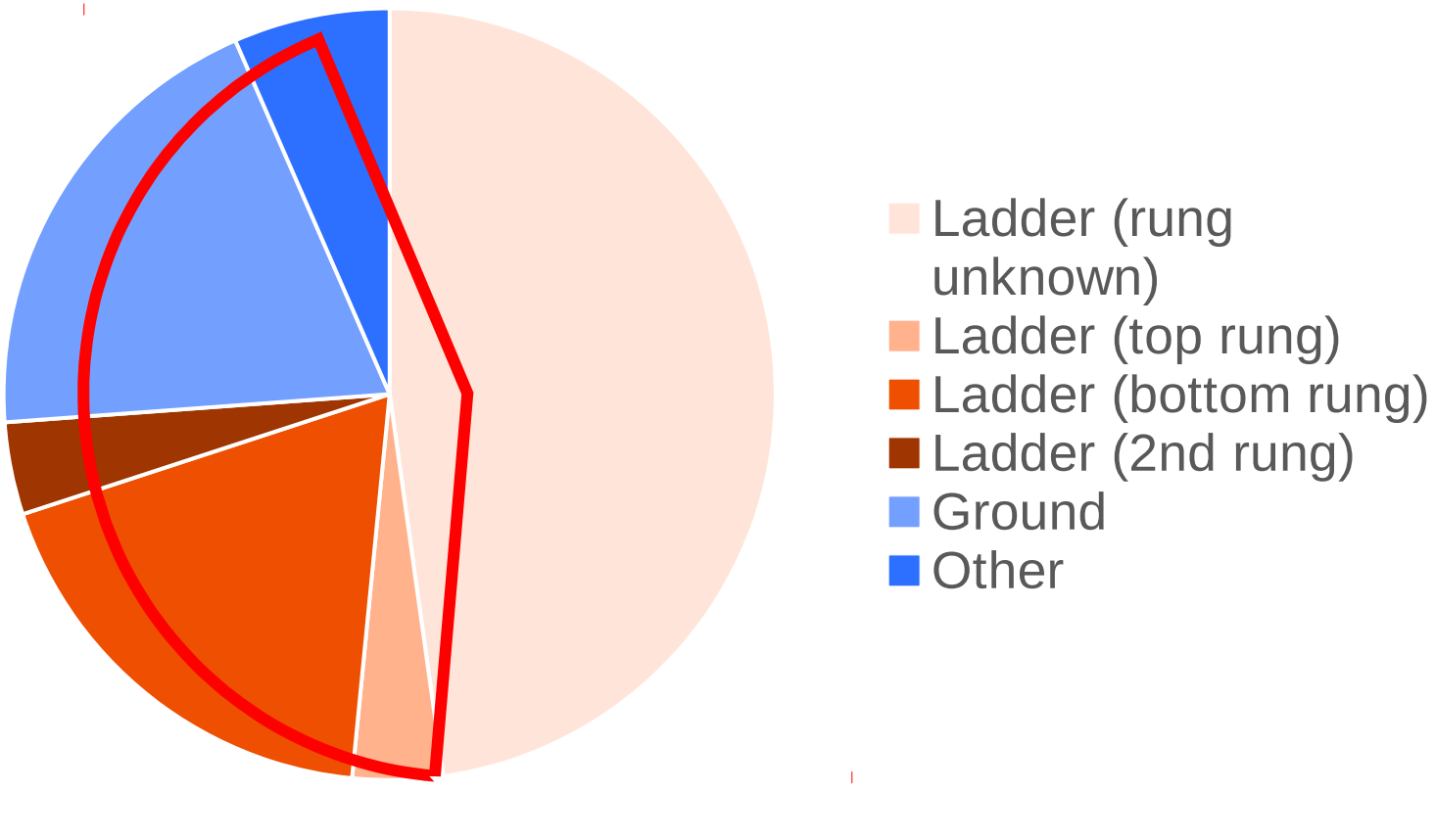
Equipment failure–
BUT not clear how it failed

Recommendations: Movement & Equipment Failure

- Conduct regular inspection and maintenance
- Design doors and other movable parts to prevent unexpected movement

Bottom rungs with flexible rails may contribute to the issue

- Most loaders had bottom rungs with flexible rails
- Transition zone may be bigger than anticipated



Flexible rails were also mentioned in the interviews

Currently looking into ladder transitions…

Recommendations: Ladder Transitions and Flexible Rungs

- Ensure consistent rung spacing (even for the bottom rung)
- Ensure that adequate handholds are provided for the length of the ladder into the cab
- Use backpacks or shoulder straps to carry tools, equipment, lunch bags, and water bottles **(recommended by operators)**
- Use the “buddy system” to transport large items to the equipment **(recommended by operators)**

Summary of Ingress/Egress Recommendations

- Provide a designated parking area that is well maintained and free of rocks, ruts, and debris
- Increase illumination on and around the ingress/egress system
- Provide deeper ladder treads with a non-slip coating (similar to linings used on truck beds). Build a boarding platform with stairs that allow operators to access the cab of the equipment without climbing a ladder
- Provide shoe cleaning station on the equipment and on the ground
- Conduct regular inspection and maintenance
- Design doors and other movable parts to prevent unexpected movement
- Ensure consistent rung spacing (even for the bottom rung)
- Ensure that adequate handholds are provided for the length of the ladder into the cab
- Provide backpacks or shoulder straps to carry tools, equipment, lunch bags, and water bottles
- Use the “buddy system” to transport large items to the equipment

For more information...

http://go.usa.gov/x96XT

Questions?

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Mahiyar Nasarwanji and
all those I ‘borrowed’ images from