A toolkit to help recognize and remediate slip, trip, and fall hazards at surface mines

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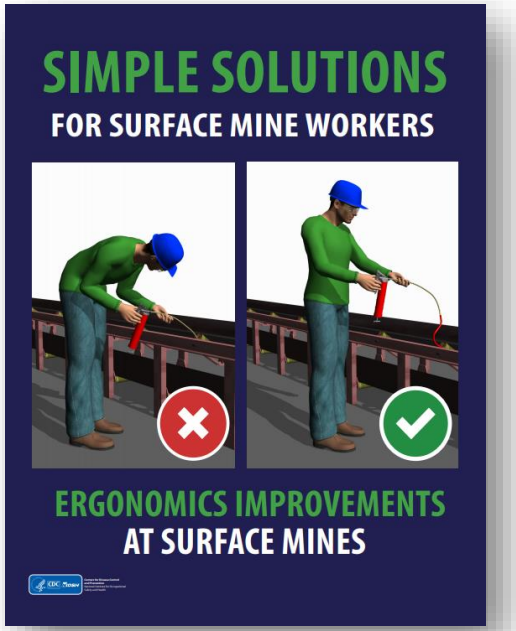
All those I “borrowed” images from

The slip, trip, and fall (STF) prevention toolkit



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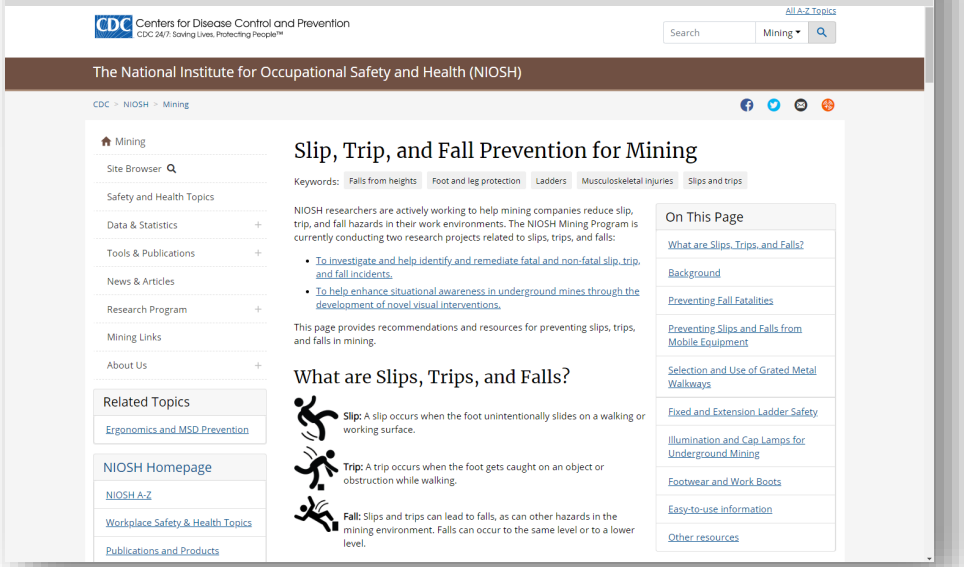


What are slips?

- A loss of traction of the foot

- If the foot slides, you slipped

What are trips?

- Something that prevents the foot from coming fully through its normal swing phase

- If the foot gets stopped/snagged, you tripped

What really matters?

- Do all slips/trips lead to falls?

  Yes / No

- Is it important if I slipped or tripped but did not fall?

  Yes / No

Types of falls

Fall to the same level

- Fall to surface you are walking/working/standing on
- Fall against object at or above the surface

Fall to a lower level

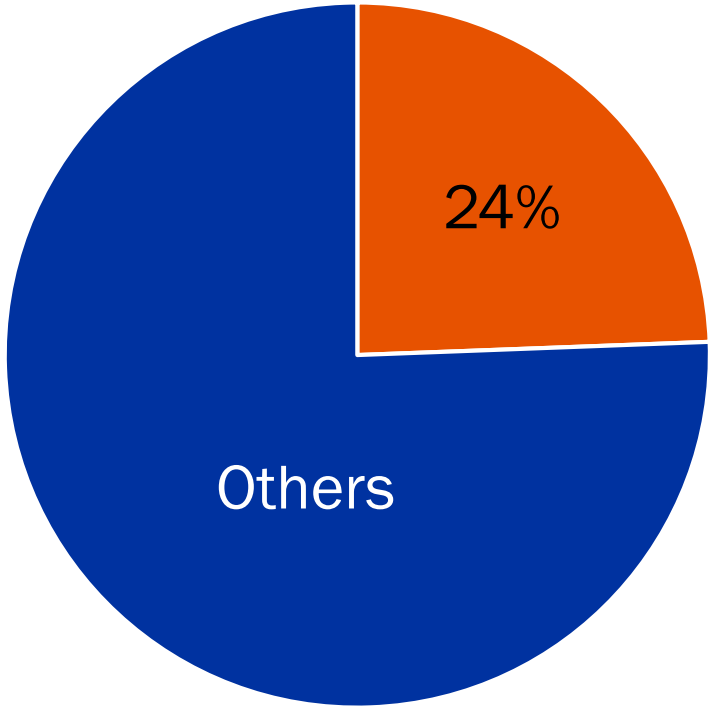
- Fall to a level below which you are walking/working/standing

Our focus was on surface mining operations

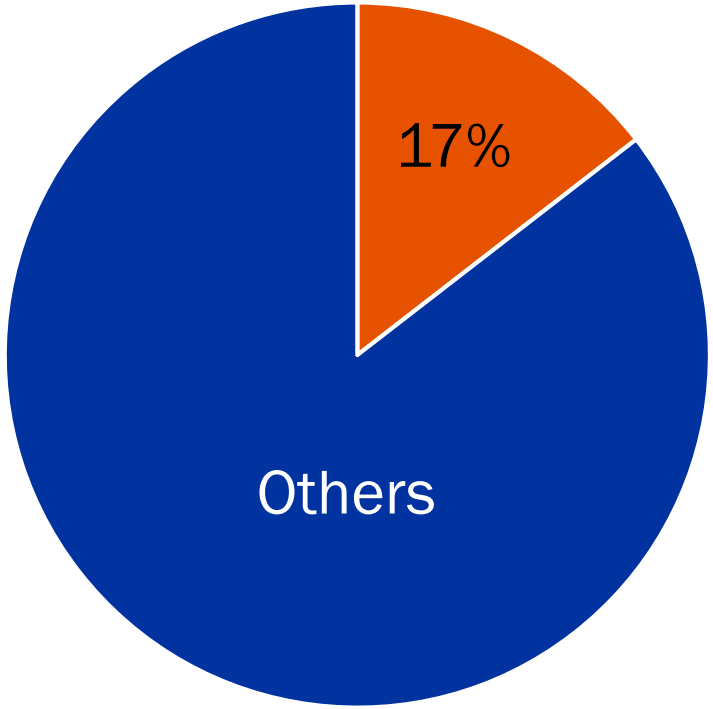
Surface mining is a hazardous occupation

Per year 2008-2017

Slips and falls are a significant contributor



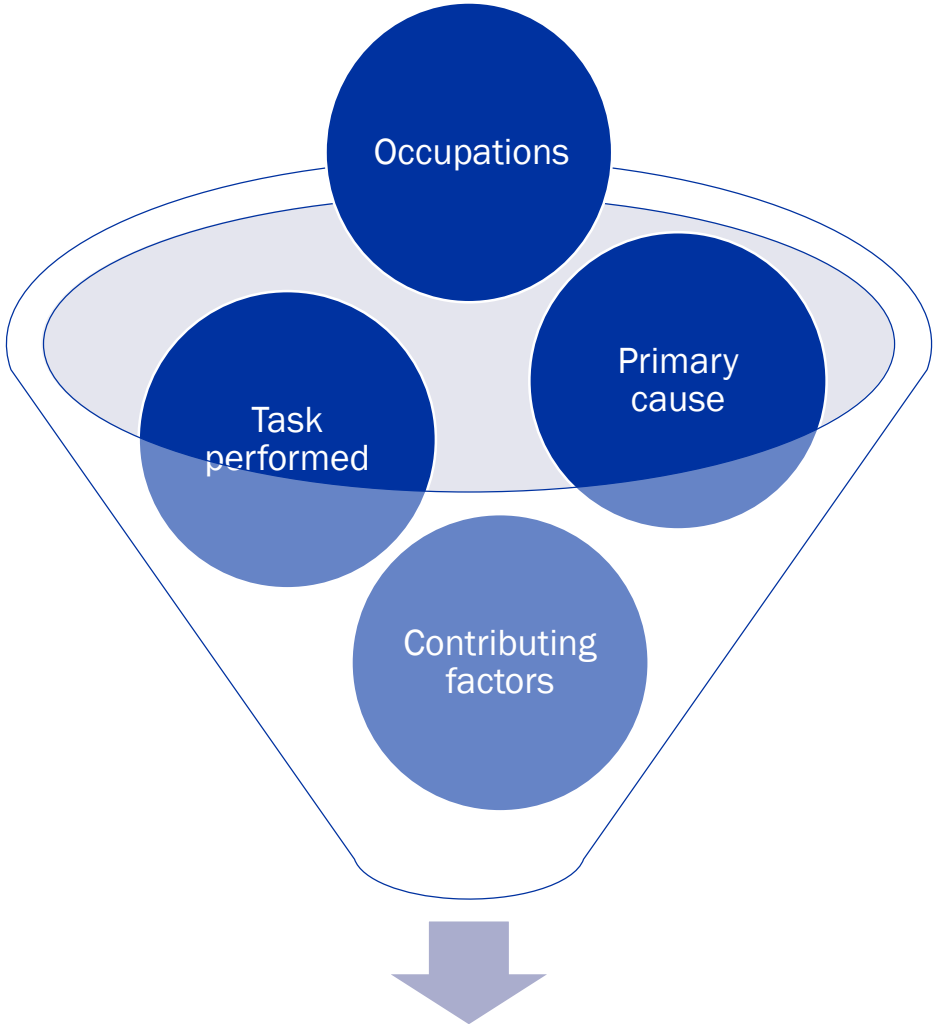
Non-fatal injuries
(surface mines)



Fatalities
(surface mines)

2008-2017

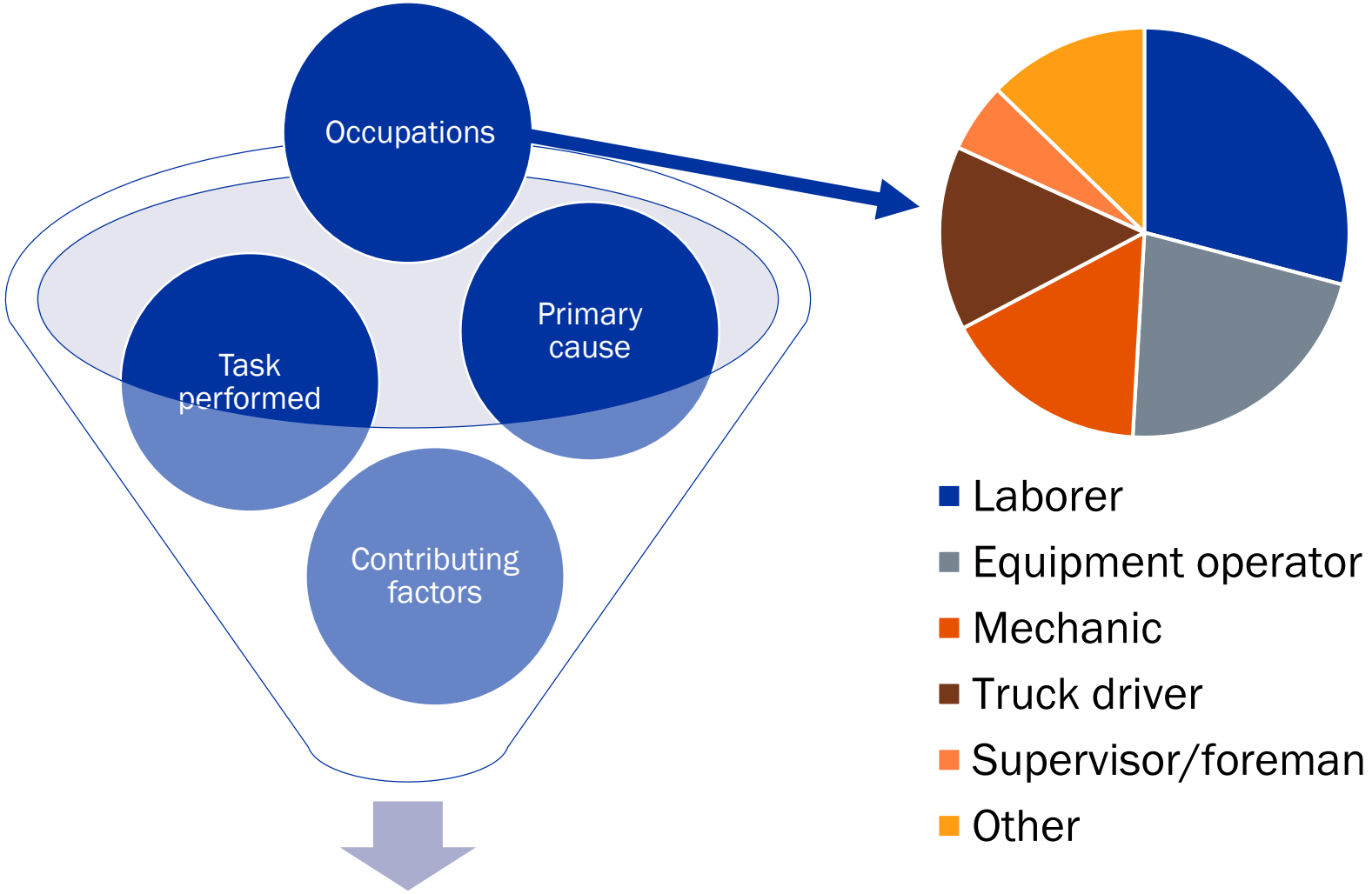
Investigating fall fatalities at surface mines



Slip or Fall Fatality

2006-2015

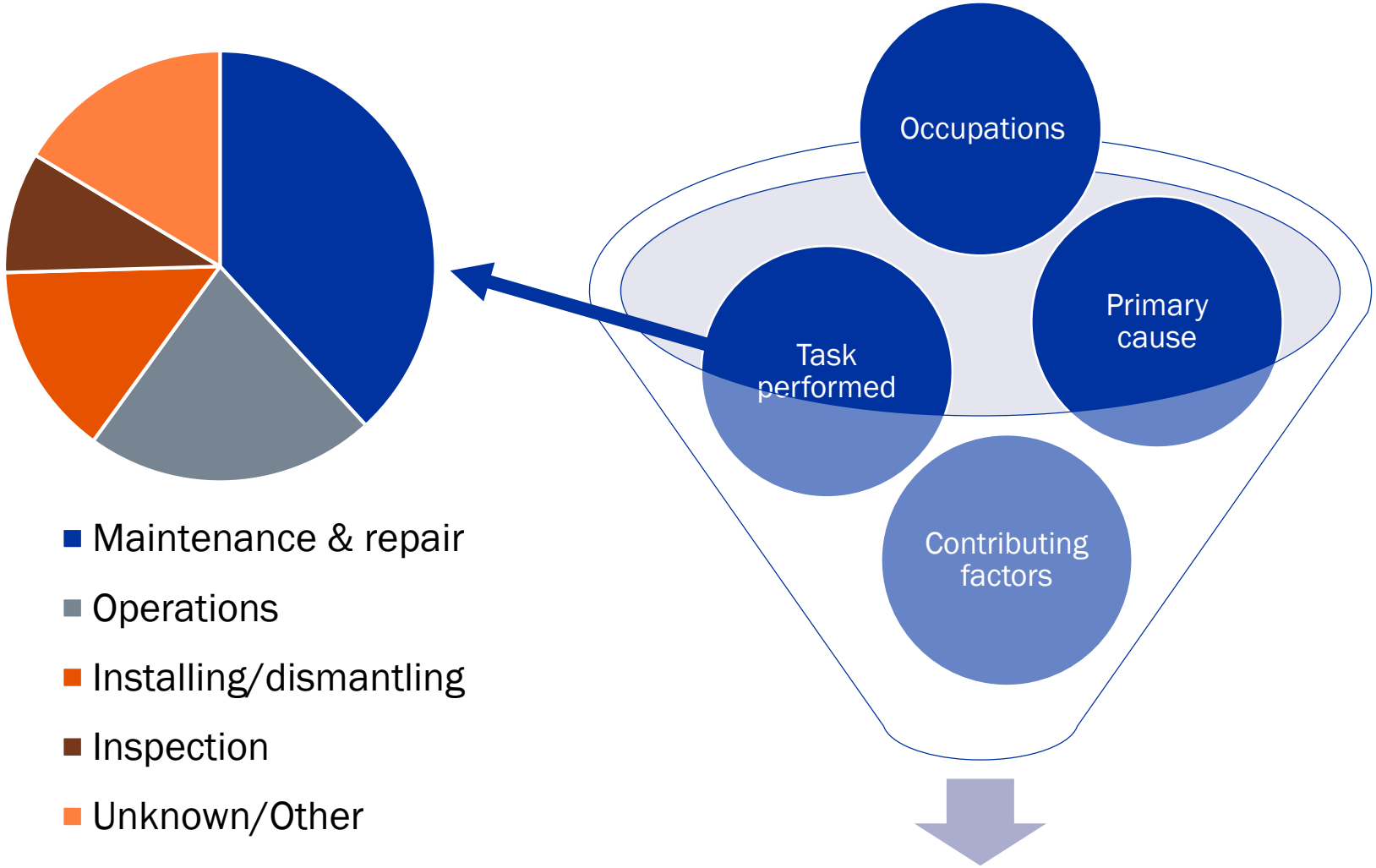
Investigating fall fatalities at surface mines



Slip or Fall Fatality

2006-2015

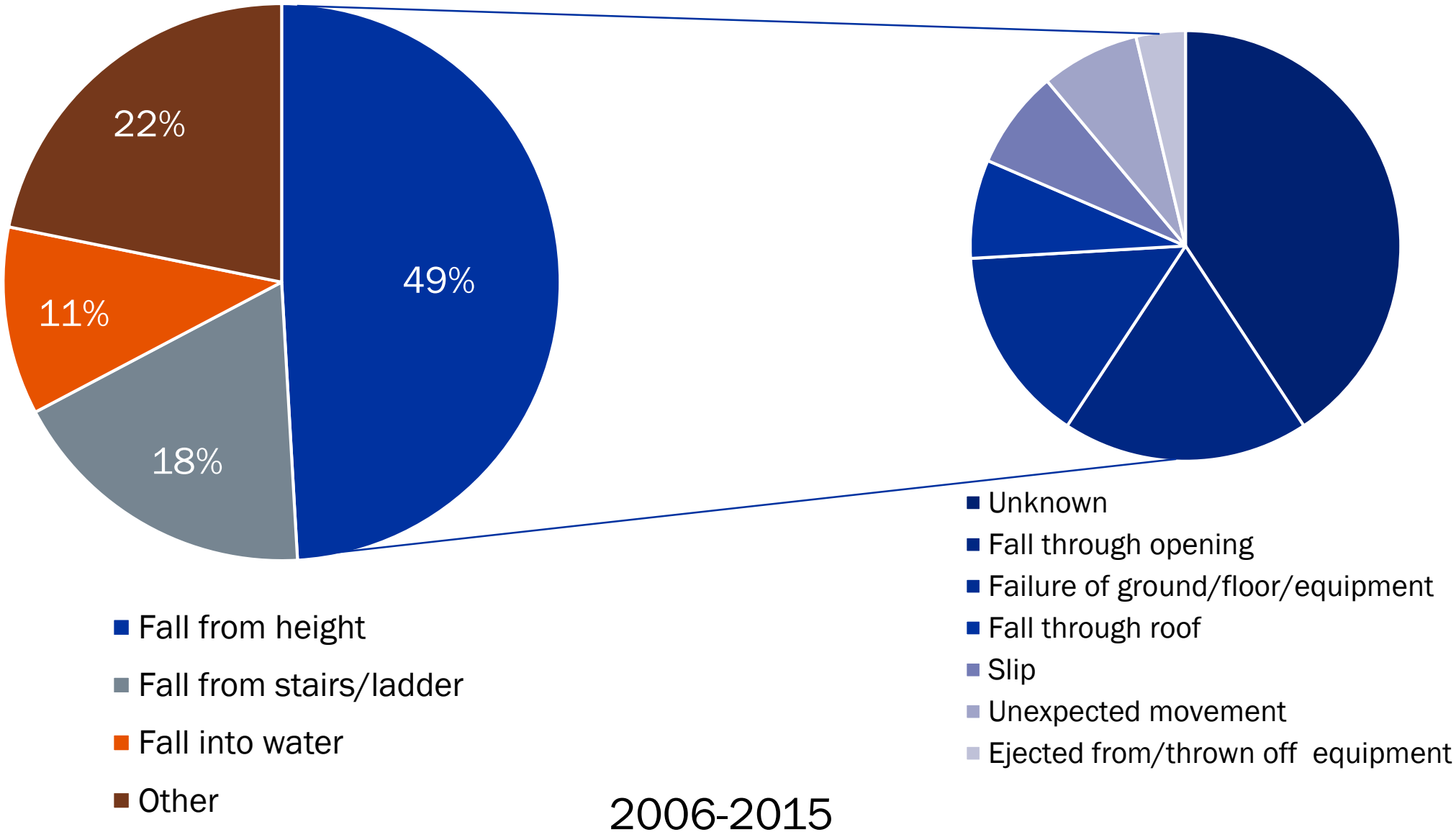
Investigating fall fatalities at surface mines



Slip or Fall Fatality

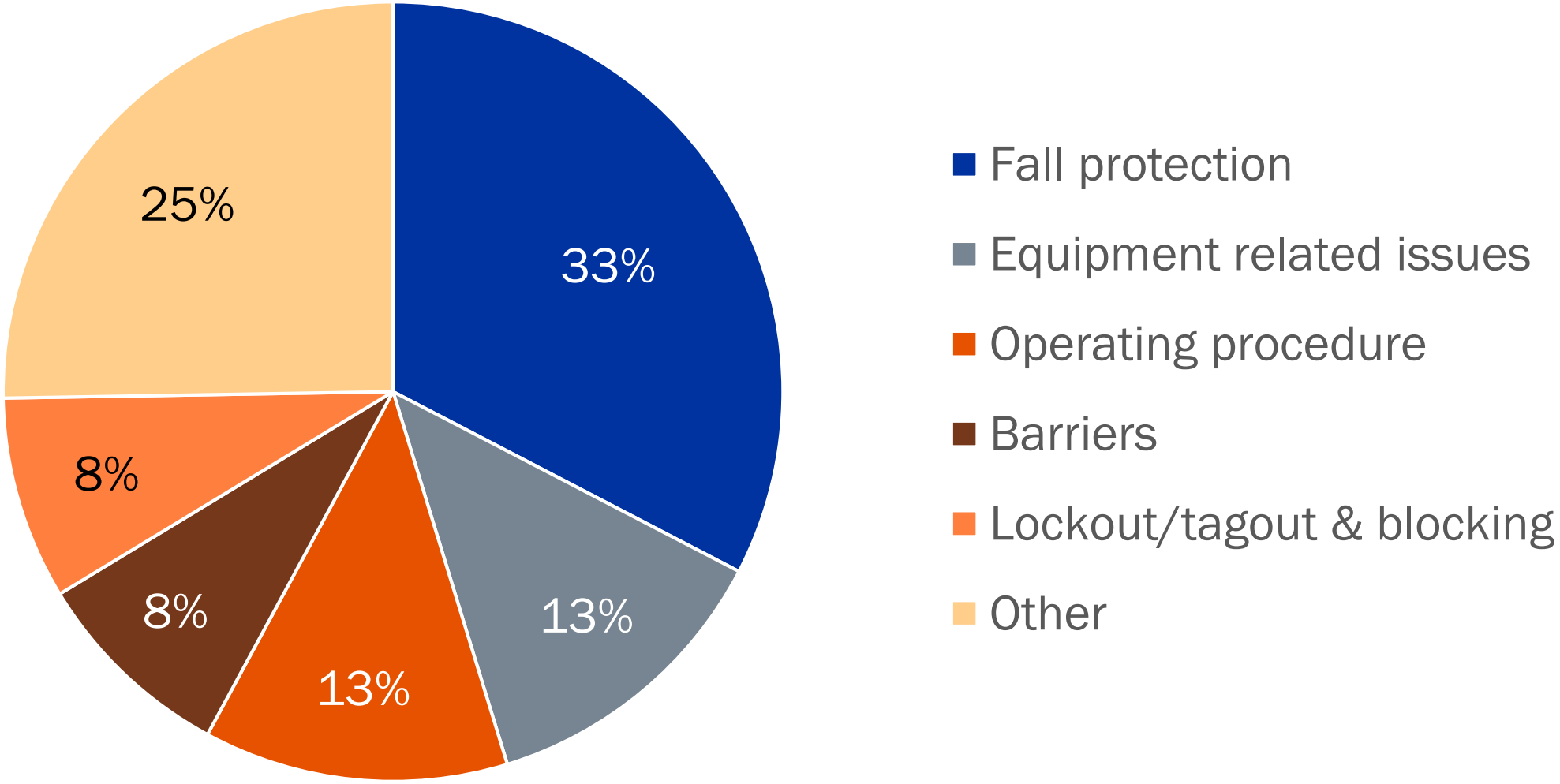
2006-2015

Primary and secondary cause of fall fatalities



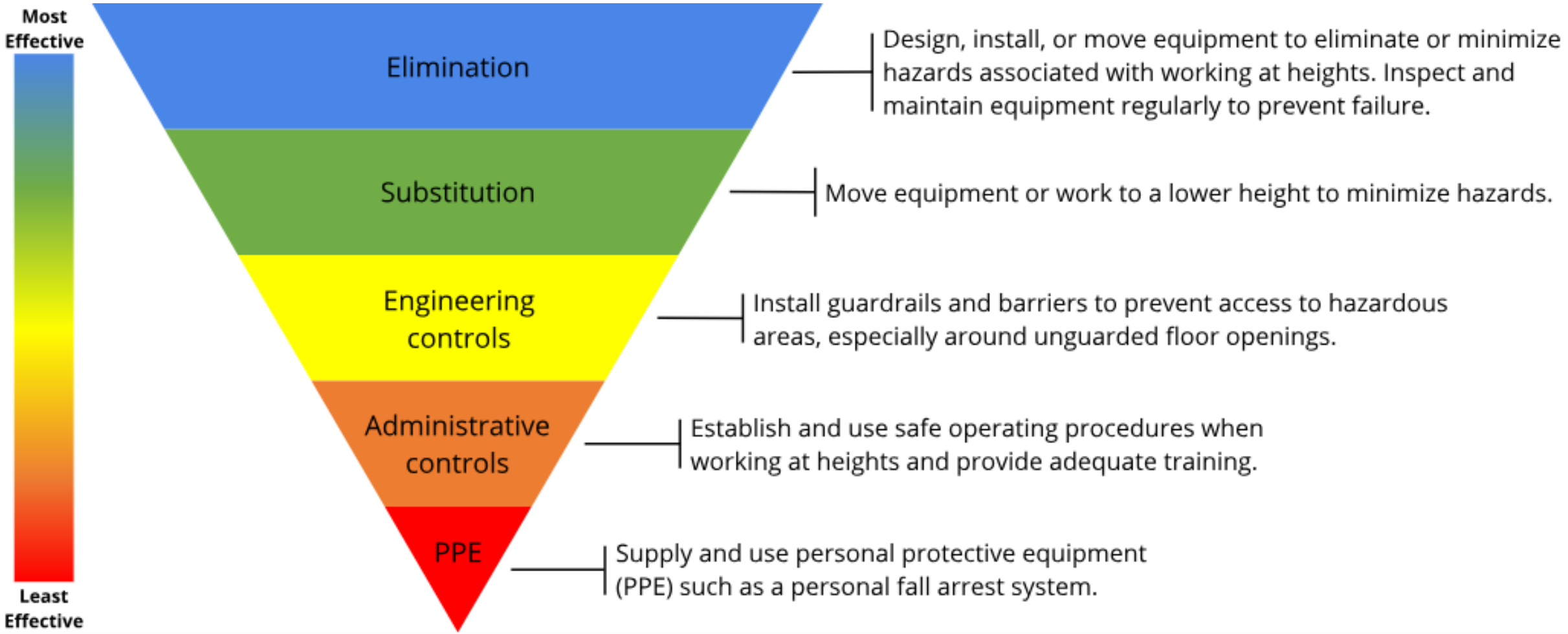
2006-2015

5 factors contributed to 75% of the fatalities

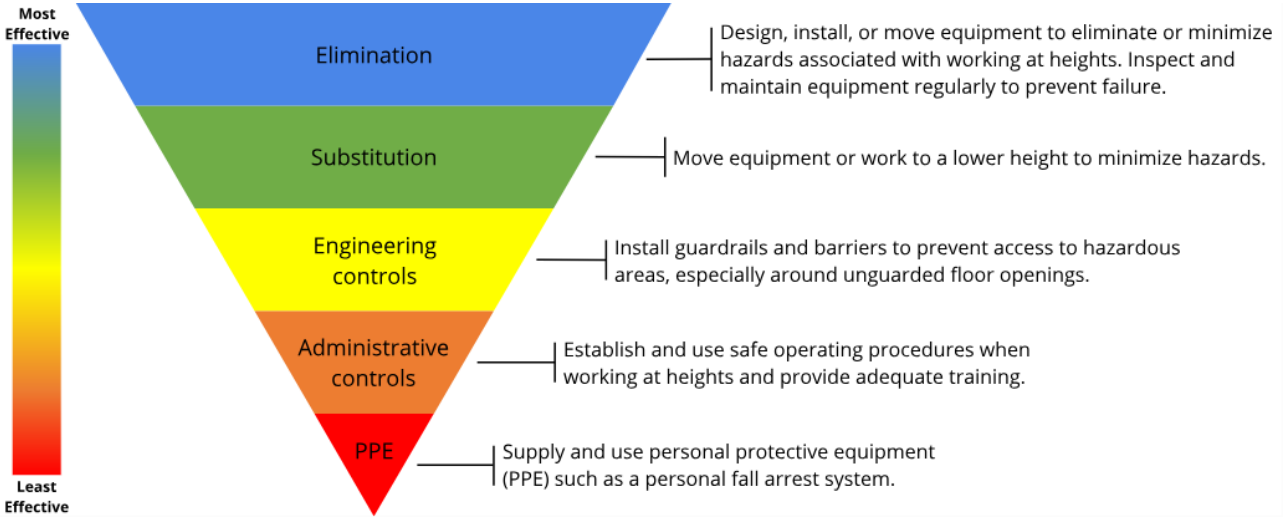


2006-2015

Recommendations based on NIOSH's Hierarchy of Hazard Controls



Falls Can Kill!



STF hazards in the work environment

STF taxonomy

STF hazard list

Ladder safety

Steps to Ladder Safety

STF hazard assessment

Simple solutions

RRR stickers

STF checklist & recommendations

ErgoMine 2.0

Steps to Ladder Safety

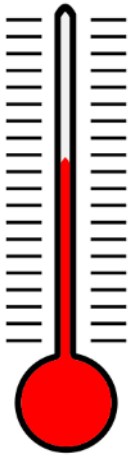
Most standards recommend:

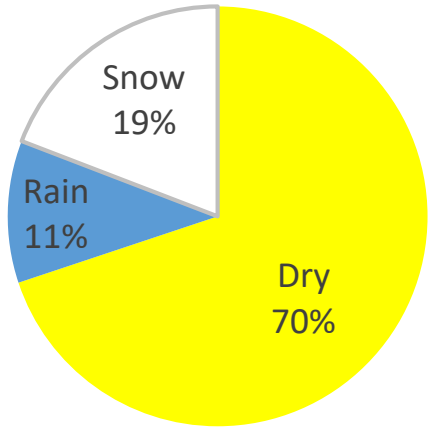
1. Wearing appropriate shoes
2. Cleaning the ladder
3. Inspecting the ladder
4. Facing the ladder
5. Never jumping off ladders
6. Always using three points of contact

STF hazard assessment at surface SSG mines

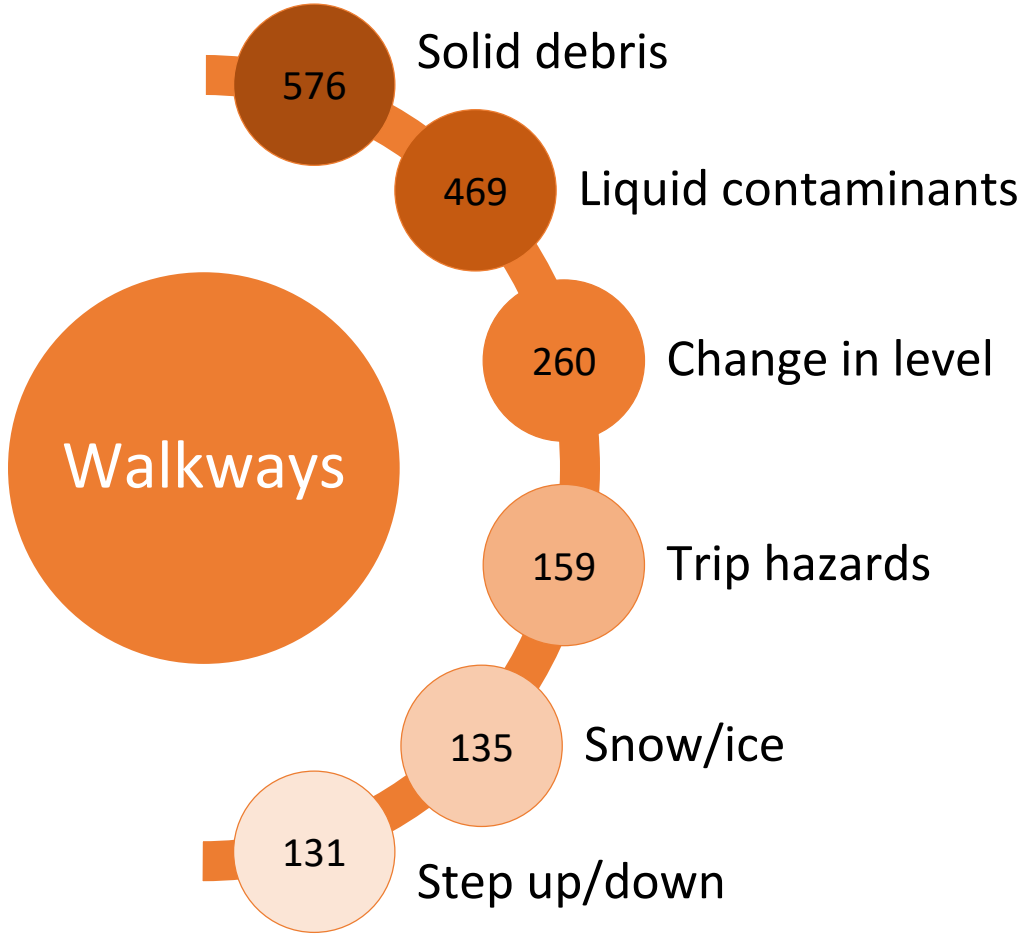
- We shadowed workers
- We observed their working environment

36 hours (~4 days) of observation



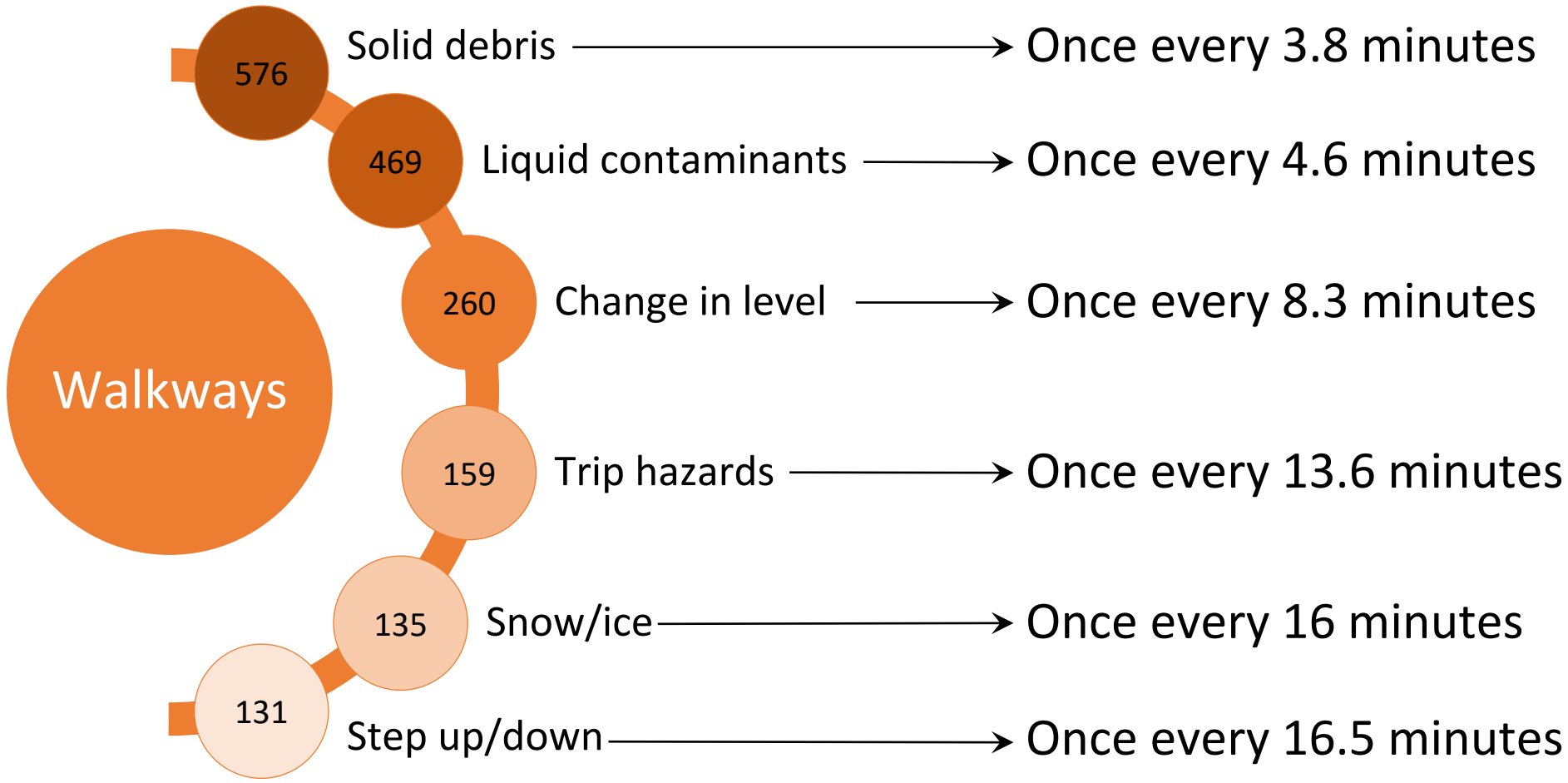


Common STF hazards along the path of travel or on walkways



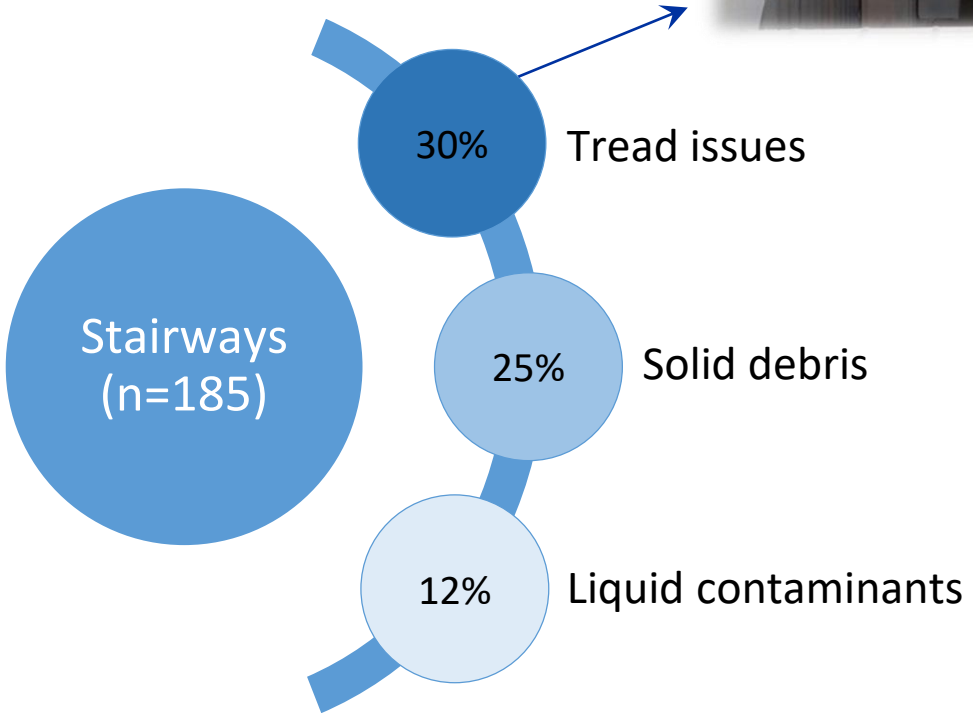
Number of times a hazard was encountered during the 36 hours of observation

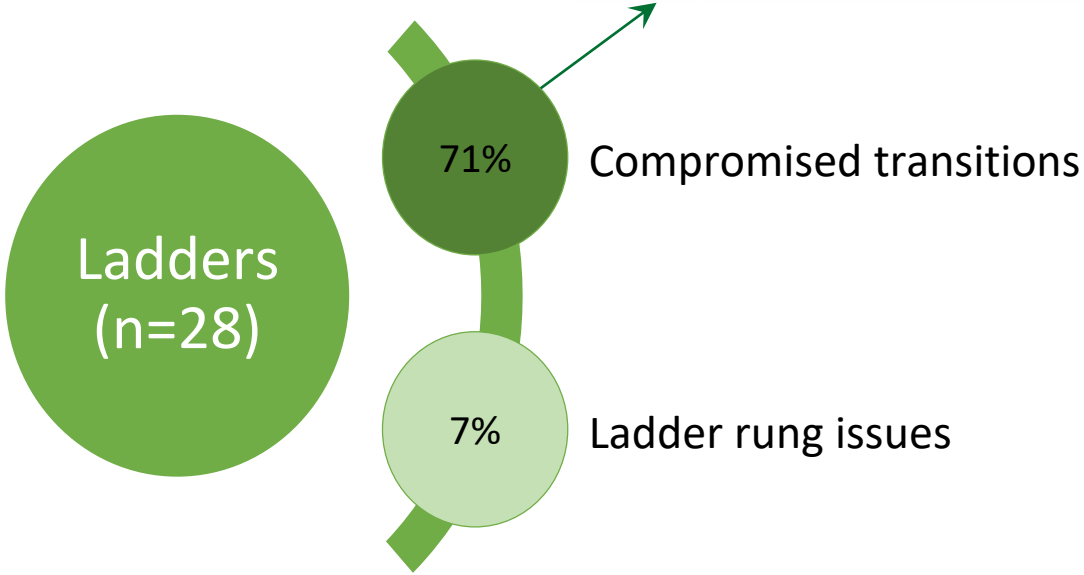
Common STF hazards along the path of travel or on walkways



Number of times a hazard was encountered during the 36 hours of observation

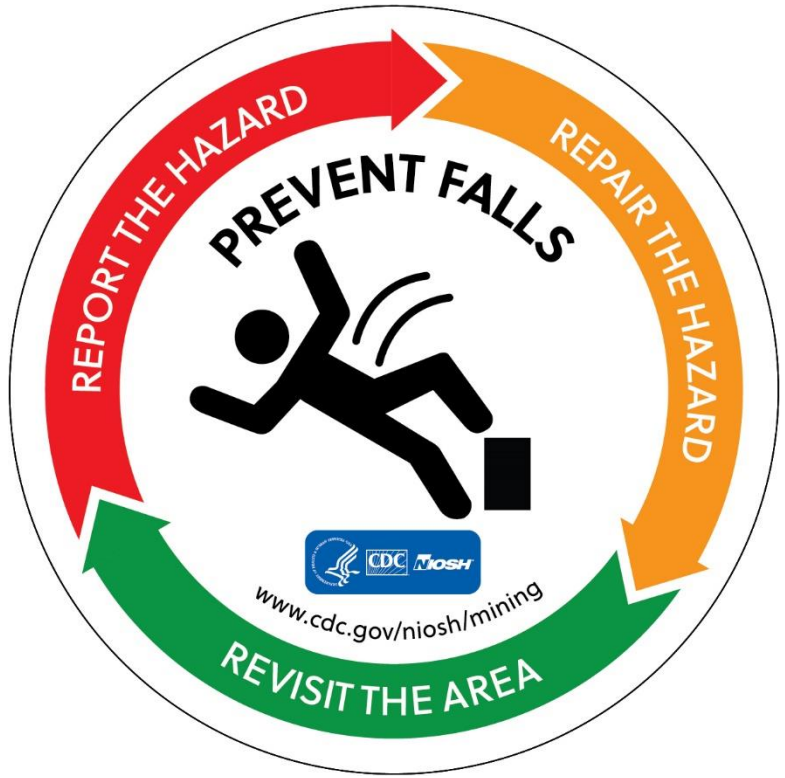
We also identified common hazards on stairs and ladders





n = number of times hazard was encountered during the 36 hours of observation

Just remember R–R–R: Report – Repair – Revisit

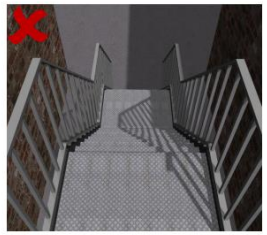


There are “Simple Solutions”

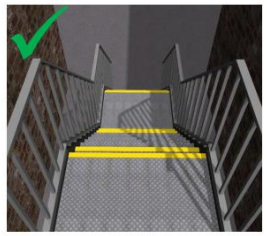
Visibility of Stair Edges

When the edges of stairs (nosing) are not clearly discernible, workers can misstep, trip, or fall. This is especially true when descending stairs, and in conditions when ambient lighting is not ideal.

Risk Factors: poor visibility of walking surface



Problem: When the edge of the stairs (nosing) is not clearly visible, it can lead to trips, missteps, and falls.



Solution: Clearly mark and highlight the edge of the stairs (nosing) using caution yellow or other high-contrast paint to increase the visibility of the nosing.

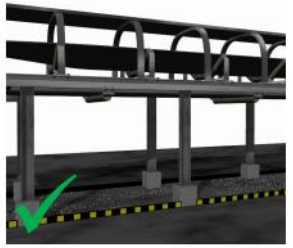
Additional Improvements: Increase ambient lighting to ensure visibility of all walking surfaces. Additionally, install a high-contrast non-skid/non-slip plate or use abrasive paint to highlight the nosing on stairs while increasing traction.

Maintaining Clear Walkways

When using a mechanical system such as a conveyor or belt to transfer materials, there is a potential for some spillage, resulting in contamination of neighboring walkways with debris or loose product. Spillage of material into designated walking areas poses a significant risk for a slip, trip, or fall accident.

Risk Factors: contaminants on walking surface, poor visibility of walking surface

Problem: Spillage from conveyers and belts can encroach onto neighboring walkways or paths of travel and lead to a slip or fall. When wet, some materials can be especially dangerous in that these materials may increase the likelihood of slips.



Solution: Add a barrier adjacent to the walkways to prevent spillage from entering walkways and causing slips. For example, a toe plate added along a conveyor and adjacent to the walkway could stop conveyor spillage from entering the walkway. If the toe plate is brightly colored and clearly marked, it helps prevent tripping when working close to or under the conveyor.

Additional Improvements: Fix spillage at the source to prevent it from collecting on the walking surface.

A lot more than just STF issues: Prevention of musculoskeletal disorders and overexertion injuries

There is an App for that… ErgoMine

GET IT ON Google Play

http://go.usa.gov/x9Qnw

Mining equipment ingress/egress systems

Ingress and egress systems

- Ingress – getting on

  Ground ⟶ Cab

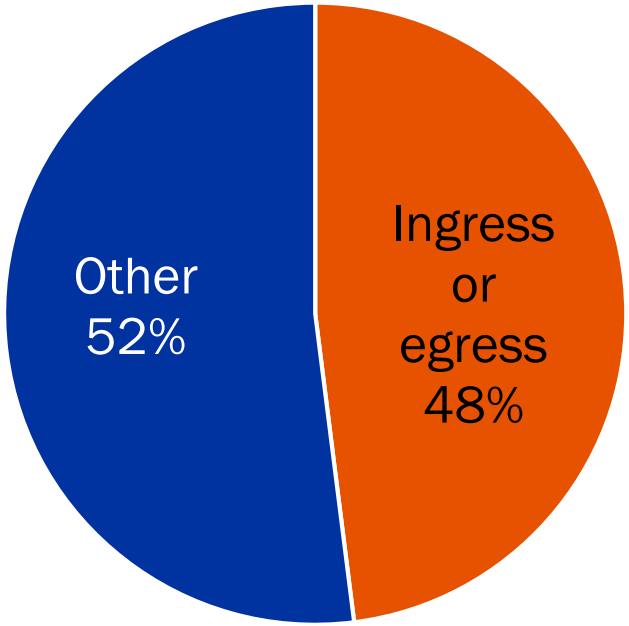
- Egress – getting off

  Cab ⟶ Ground

- Includes
  - Platforms
  - Ladders
  - Stairs

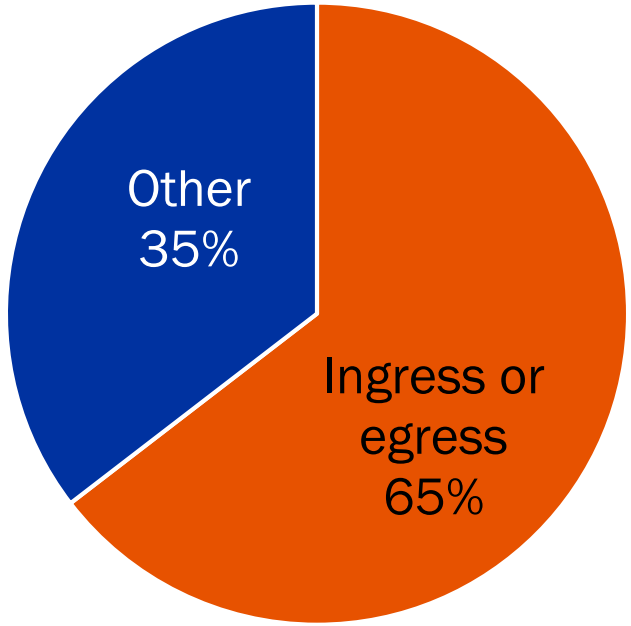
Ingress and egress from mobile equipment

Falls from all equipment
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
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.

Injuries during ingress and egress

Based on an analysis of 20 years of MSHA non-fatal injuries data 1996-2015

We used two approaches to help corroborate evidence

Analysis of MSHA non-fatal injury data

For front-end wheel loaders

Interviews with equipment operators

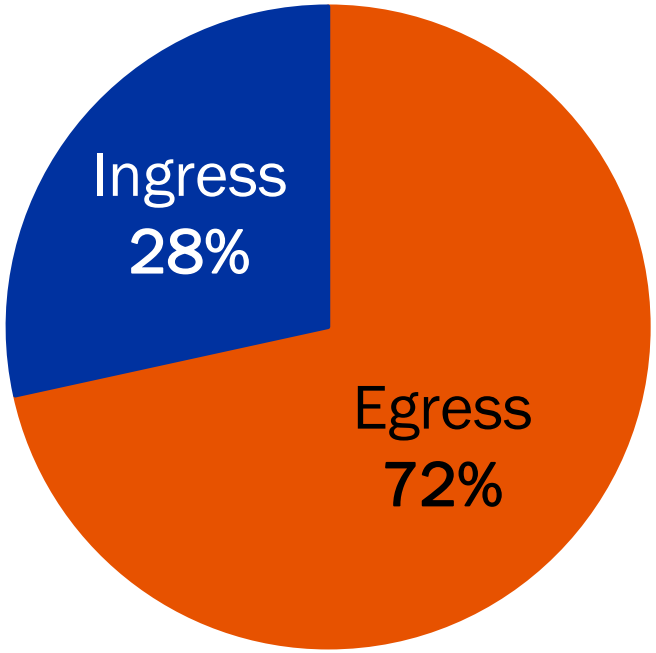
Any mobile equipment

Egress is more dangerous than ingress

Ingress

vs

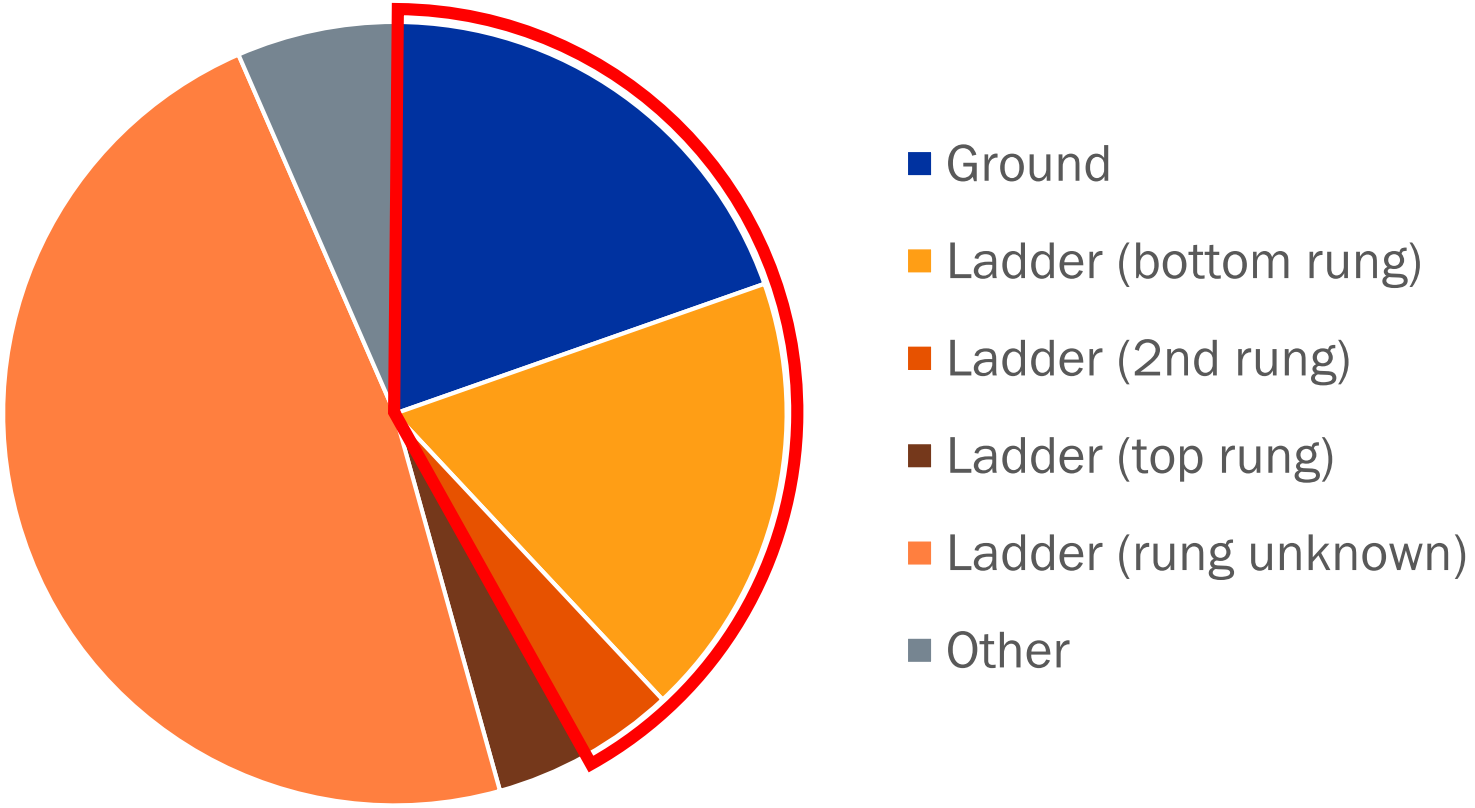
Egress



Activity at the time of the incident

Based on an analysis of 20 years of MSHA non-fatal injuries data for front end loaders 1996-2015

Bottom rungs with flexible rails may contribute to the issue



Location of the foot
at the time of the incident

Based on an analysis of 20 years of MSHA non-fatal injuries data for front end loaders 1996-2015

Poor ground conditions: Step on or step in

Look out for…

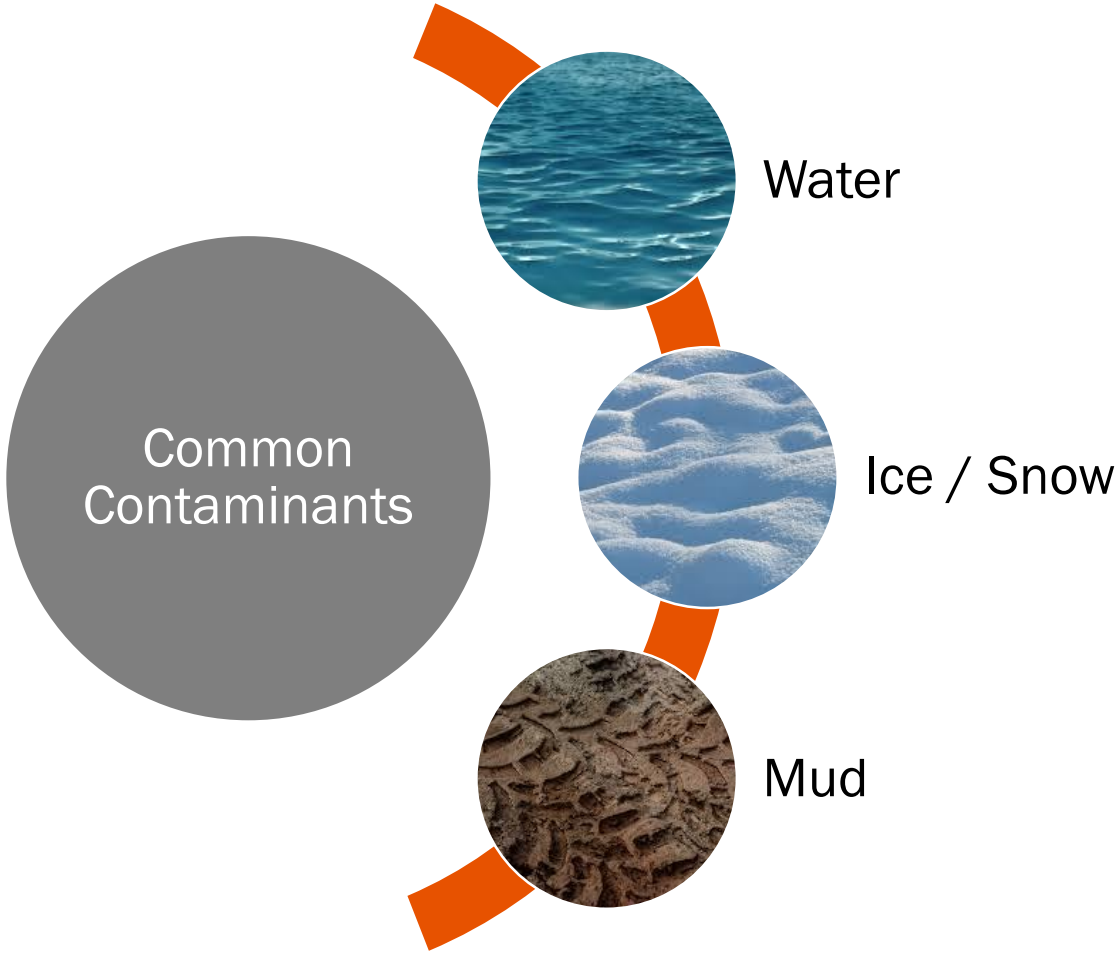
Hoses/pipes and other materials

Rocks

Uneven surface, ruts and holes

Based on an analysis of 20 years of MSHA non-fatal injuries data for front end loaders 1996-2015

Contaminants: slips were common



Based on an analysis of 20 years of MSHA non-fatal injuries data for front end loaders 1996-2015

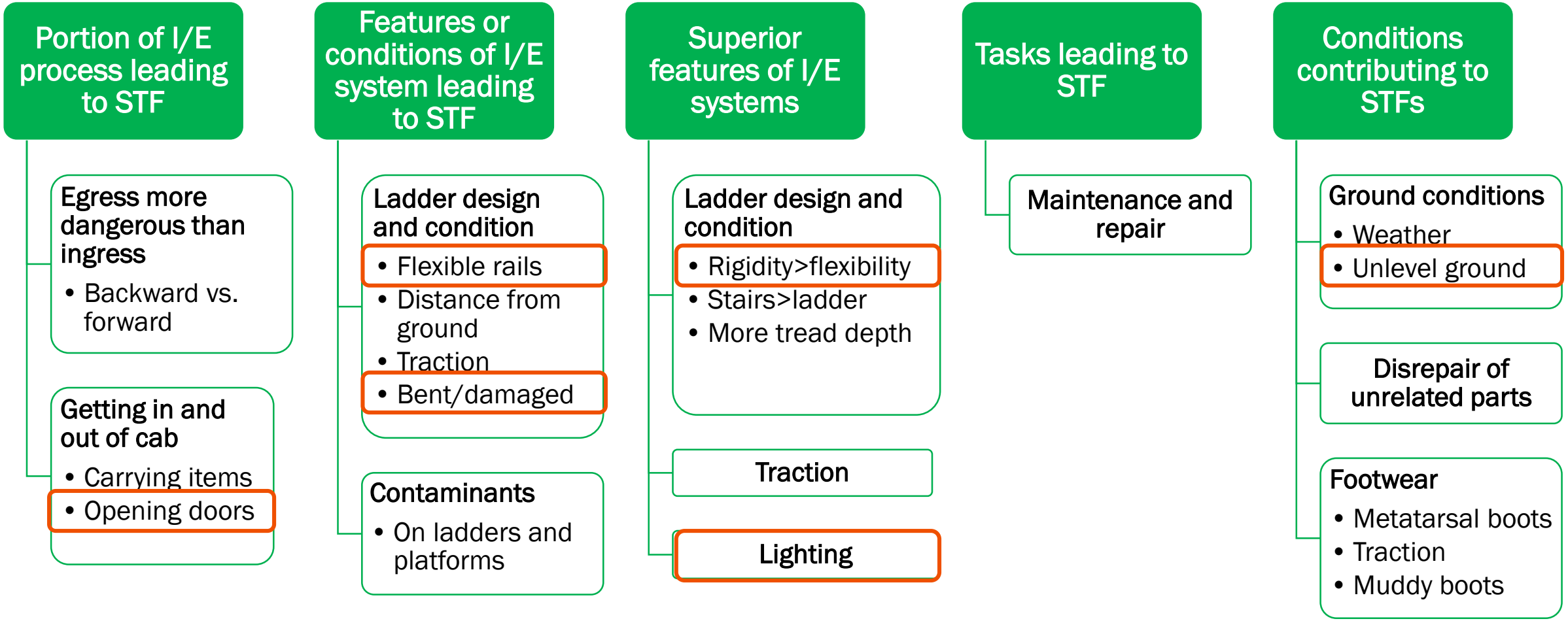
Unexpected movement and equipment failure

Unexpected movement
associated with blowing wind

Equipment failure–
But not clear how it failed

Based on an analysis of 20 years of MSHA non-fatal injuries data for front end loaders 1996-2015

Themes from interviews and focus groups with mobile equipment 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

We have a more engaging way to disseminate these recommendations

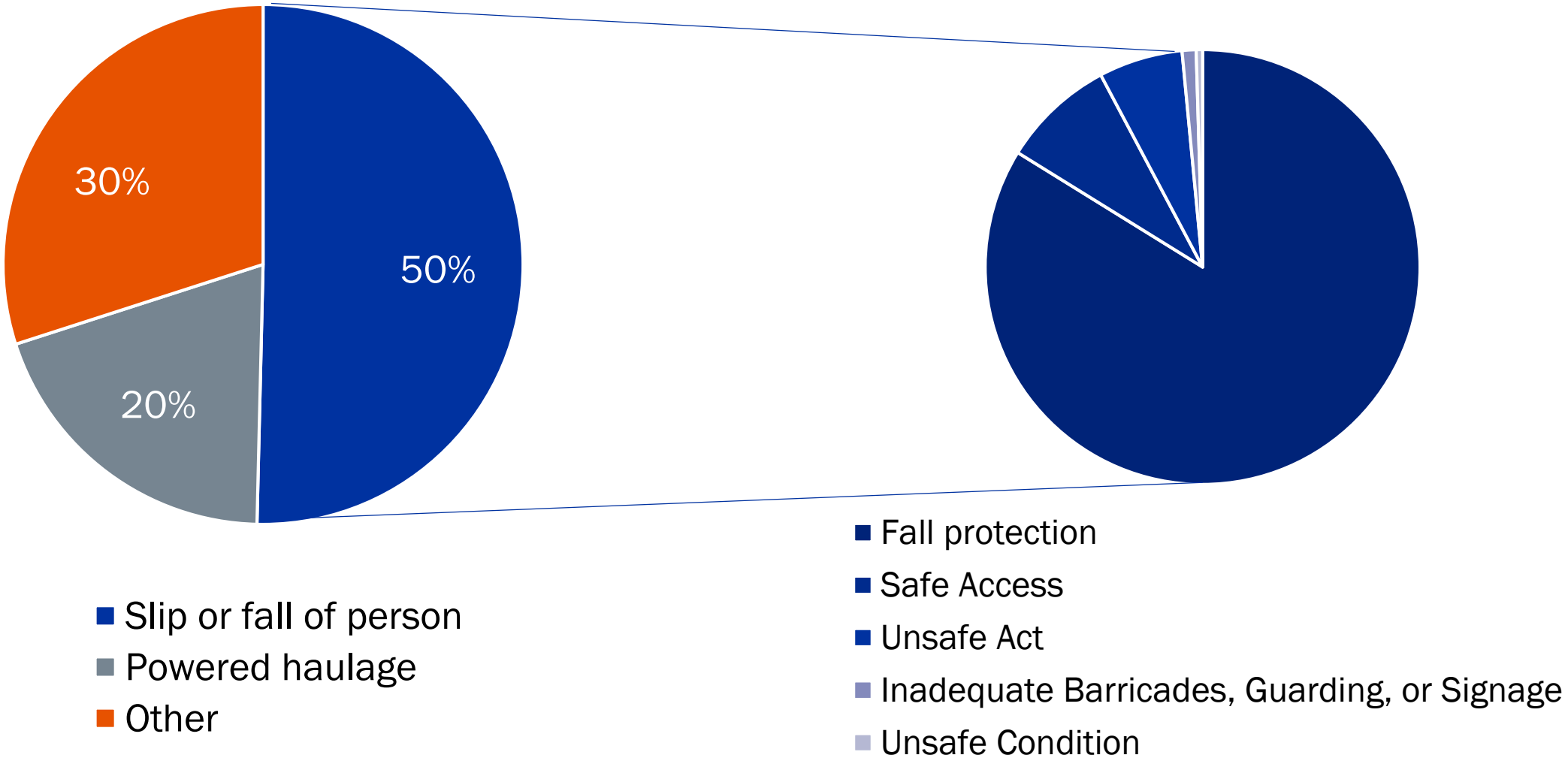
Easy to use recommendations in an interactive format

Designing safe mobile equipment access areas

Click on the highlighted areas to learn more.

I can not predict the future, but I can tell you what we are working on

Analysis of imminent danger orders



2010-2017

Studying the biomechanics of getting on and off ladders with flexible rails

Illumination measurements on ingress/egress systems and around the perimeter of mobile equipment before dawn

- 38 mobile equipment
  - 19 haul trucks
  - 12 wheel loaders
  - 3 dozers
  - 3 excavators
  - 1 motor grader

	Ground below 1st step	On 1st step	Platform
No equipment/task lighting	2.9 Lux	0.26 Lux	2.6 lux
With equipment/task lighting	8.0 Lux	11.5 Lux	23.0 Lux

Recommended value for visual tasks is 100-200 Lux (10-20 fc)

More tools in the pipeline …

ErgoMine

Mining Ergonomics Audit

2.0

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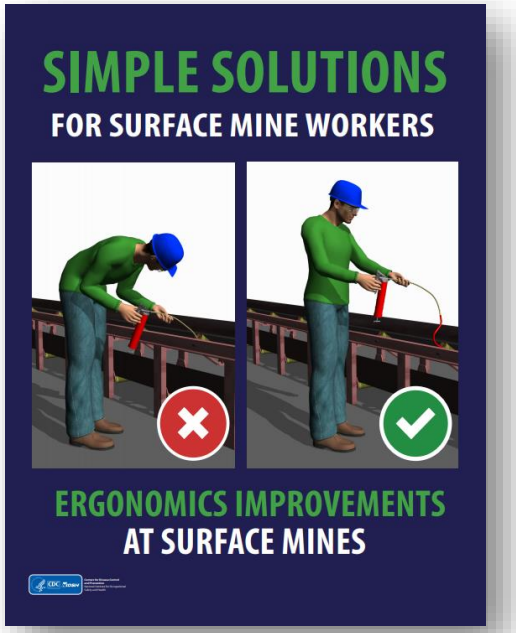
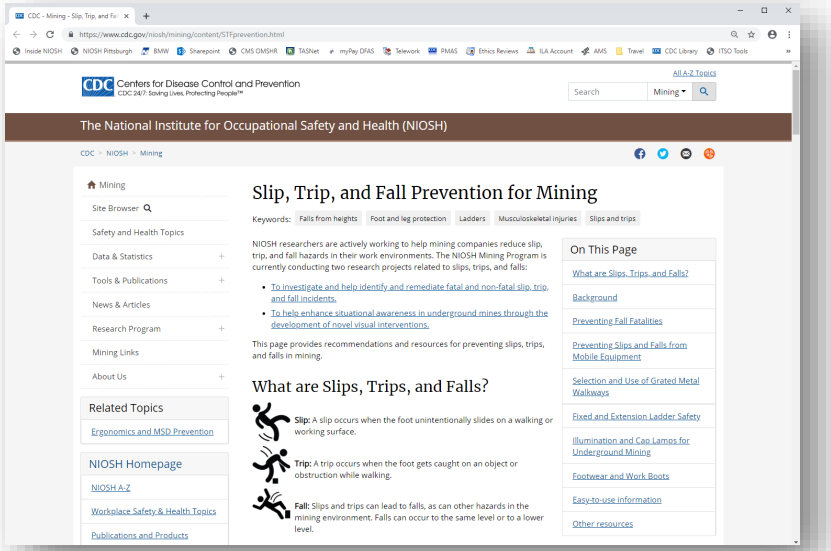
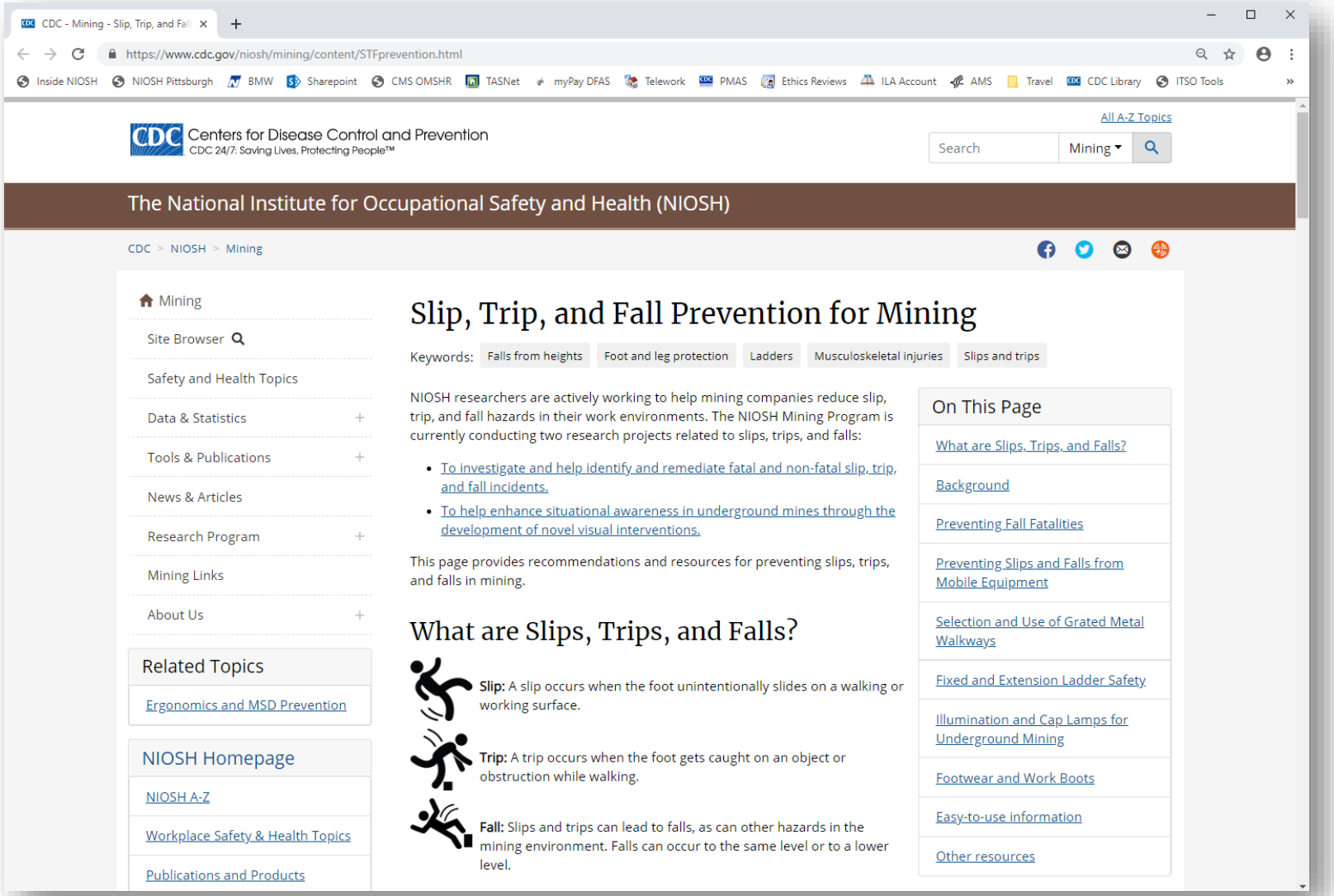
The slip, trip, and fall prevention toolkit for mining





Slip, Trip, and Fall Prevention for Mining Website

http://go.usa.gov/xP7aN



Questions?

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STF prevention: http://go.usa.gov/xP7aN