

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



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NIOSH Mining Program

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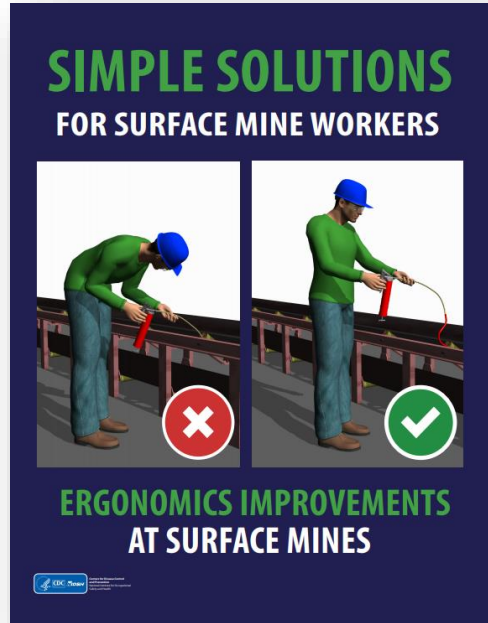
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Ashley Whitson

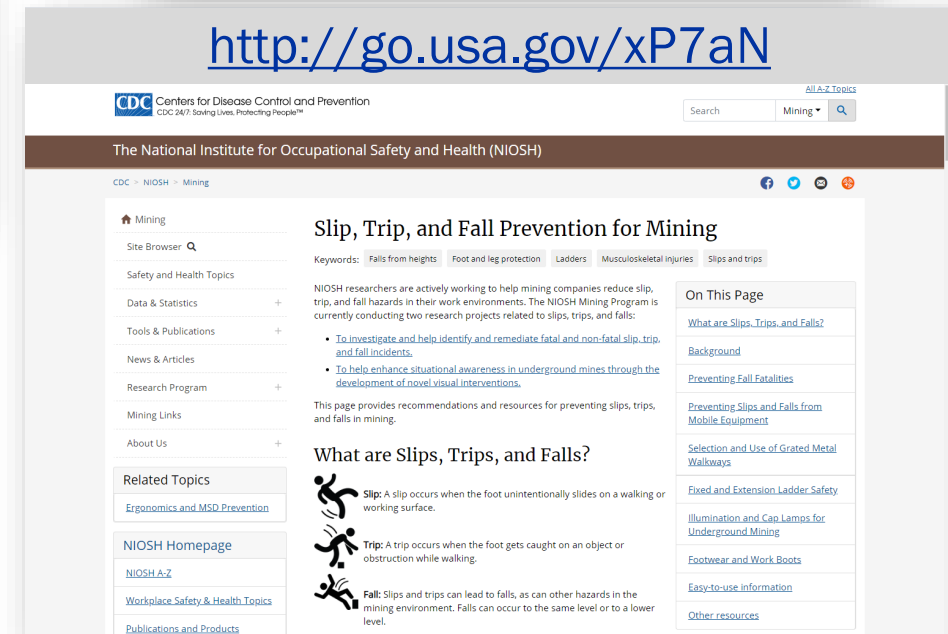
All those I “borrowed” images from



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



<http://go.usa.gov/xP7aN>



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

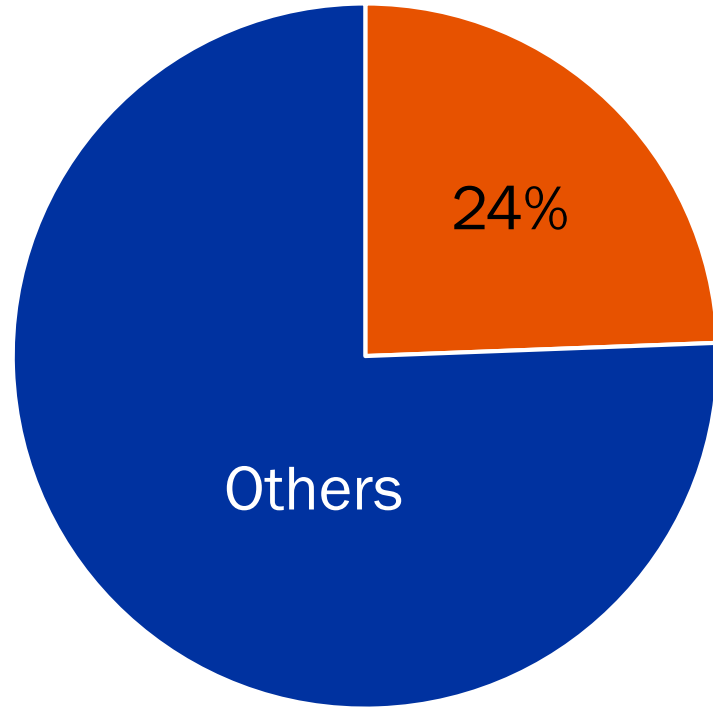


Surface mining is a hazardous occupation

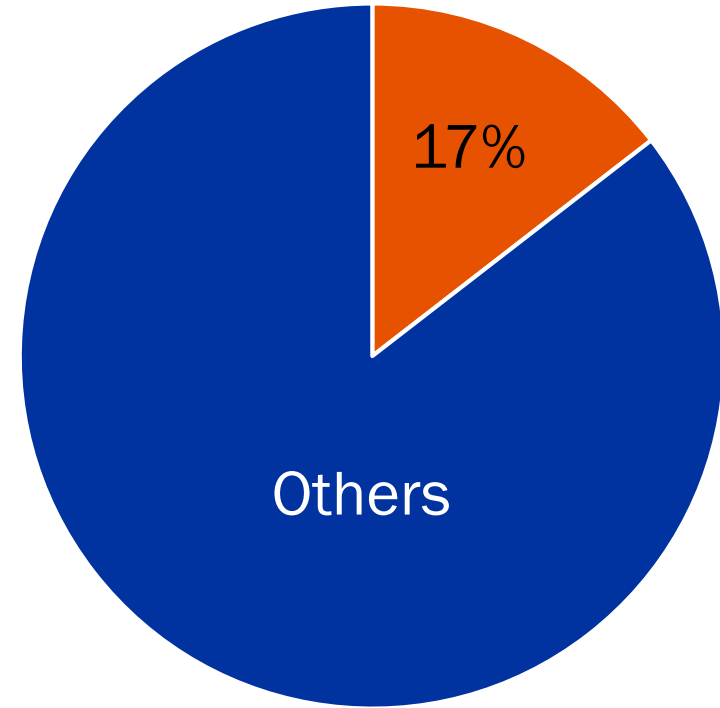


Per year 2008-2017

Slips and falls are a significant contributor



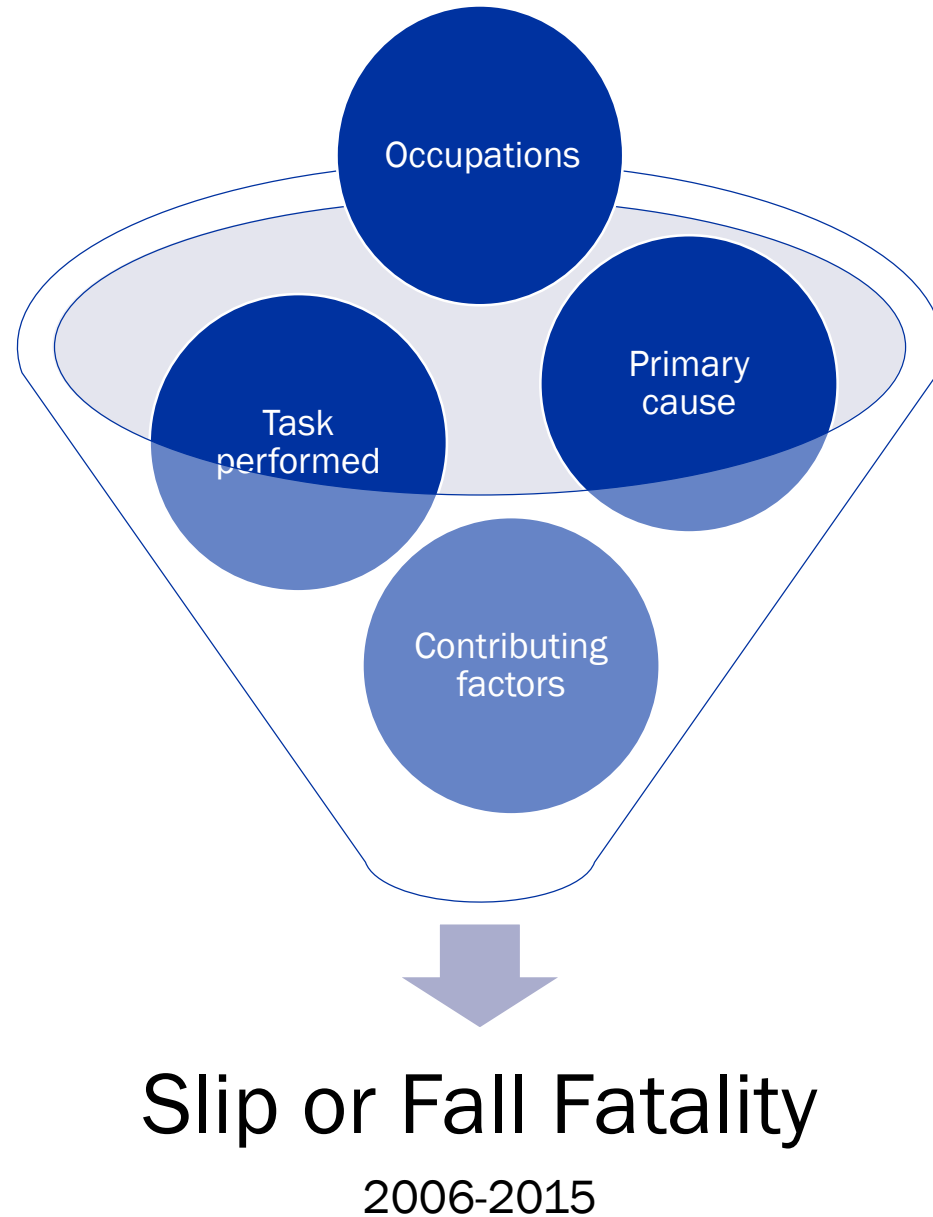
Non-fatal injuries
(surface mines)



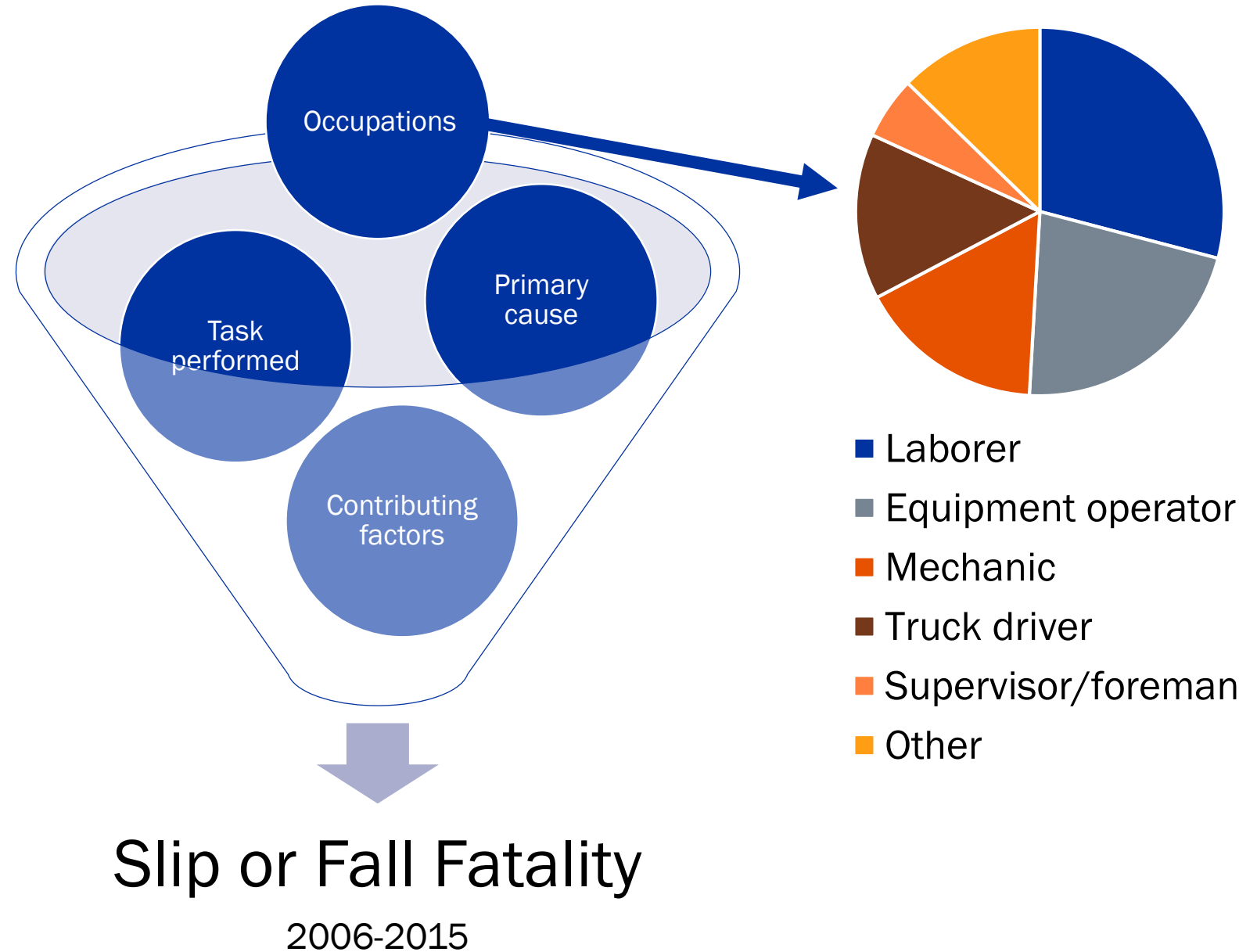
Fatalities
(surface mines)

2008-2017

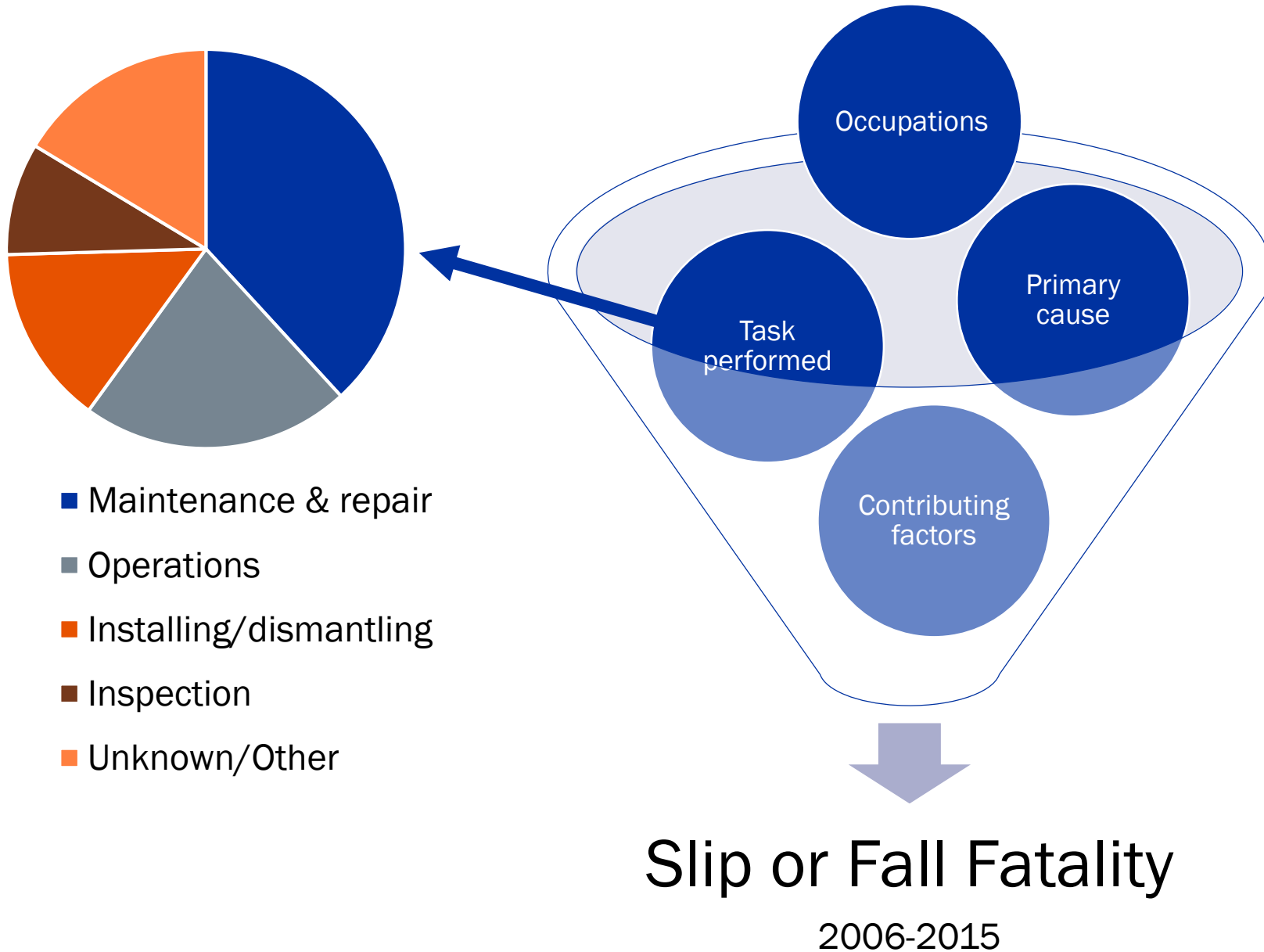
Investigating fall fatalities at surface mines



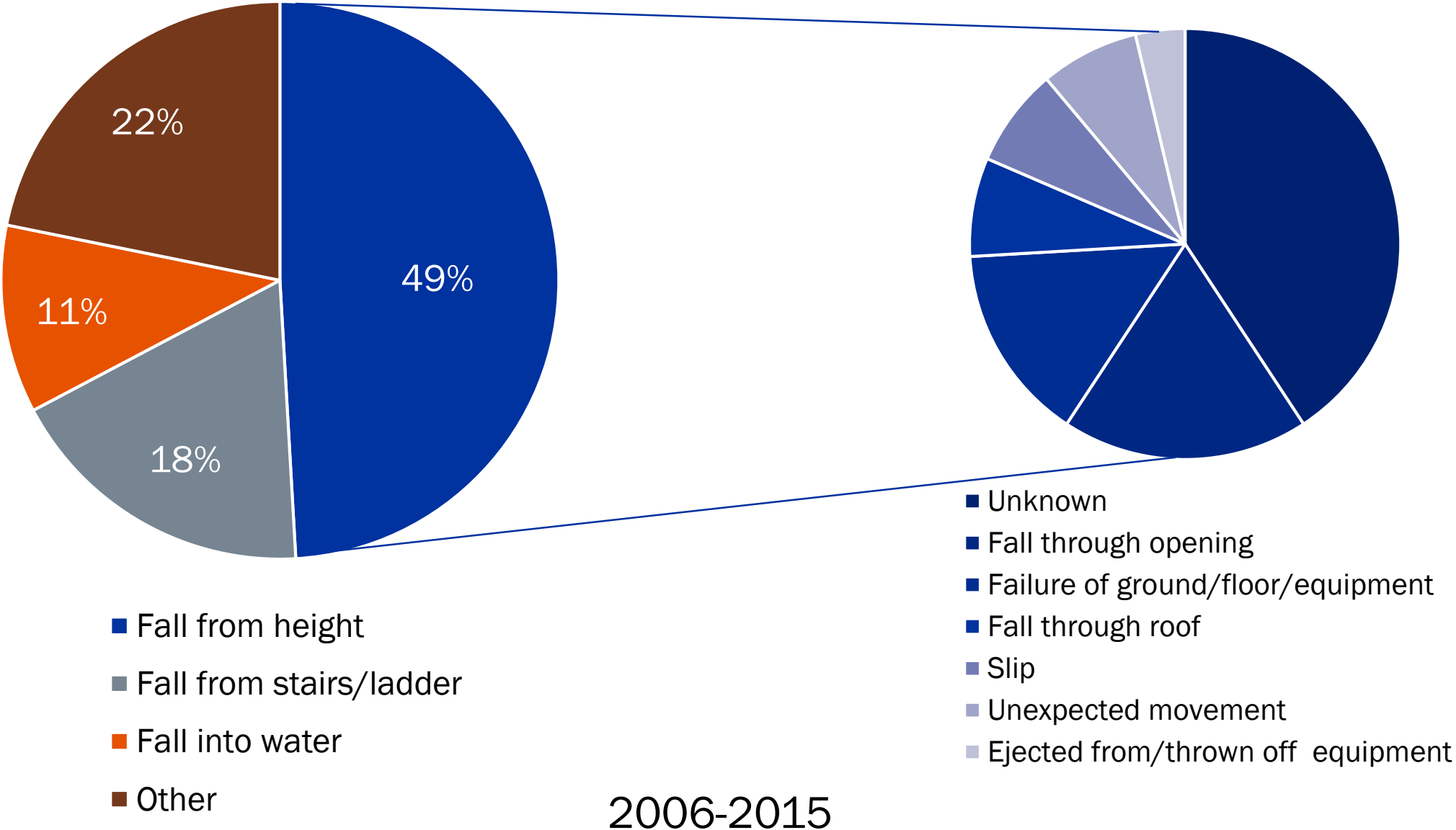
Investigating fall fatalities at surface mines



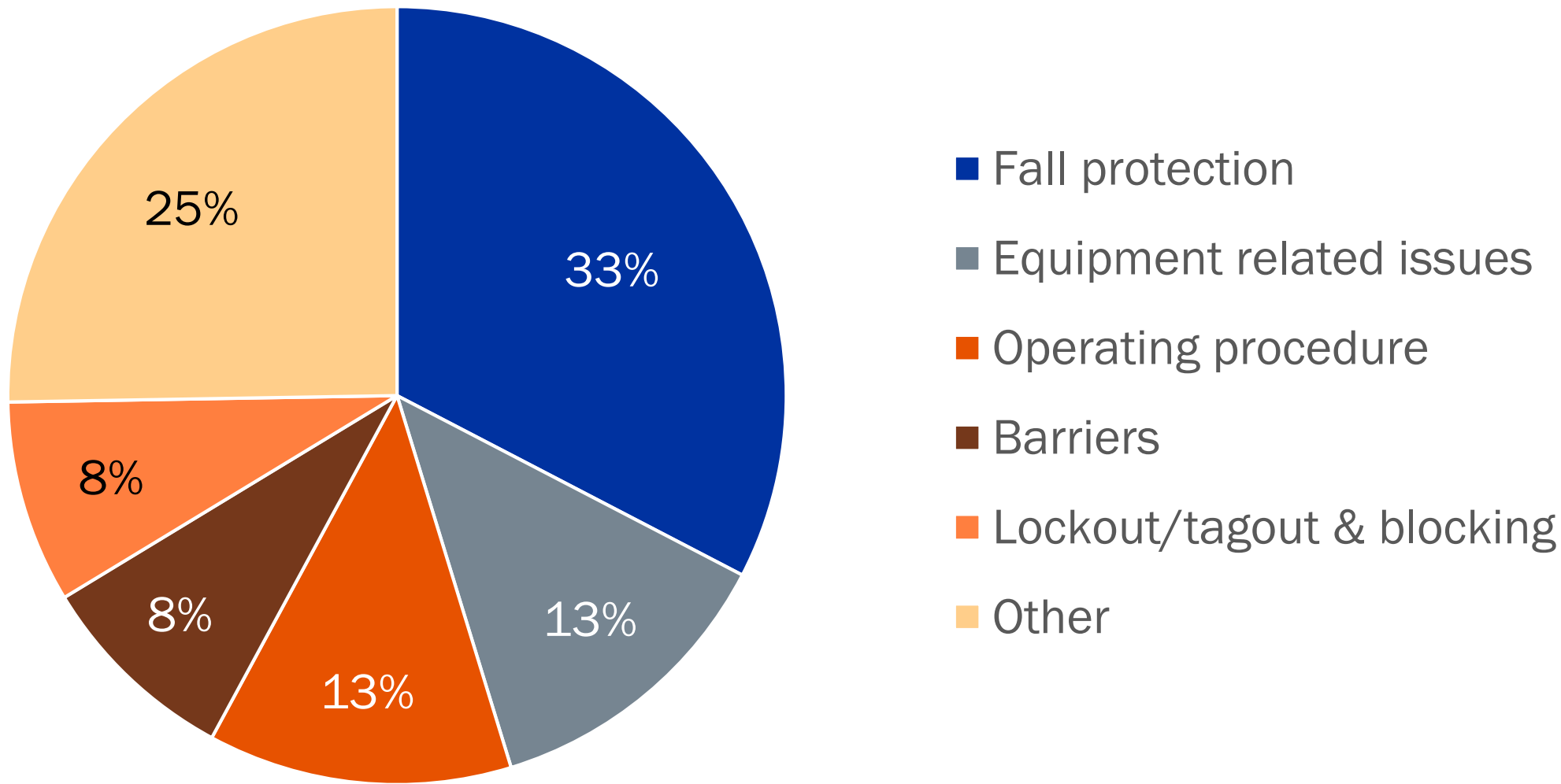
Investigating fall fatalities at surface mines



Primary and secondary cause of fall fatalities

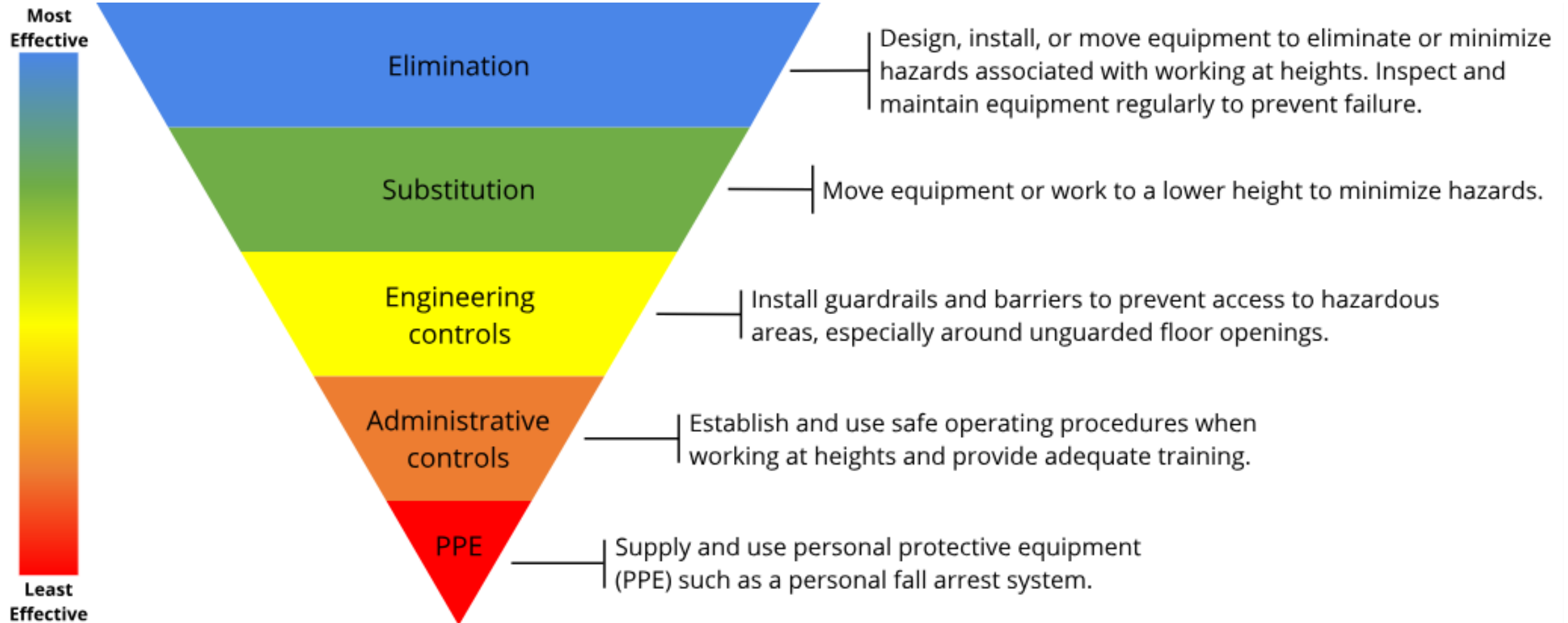


5 factors contributed to 75% of the fatalities

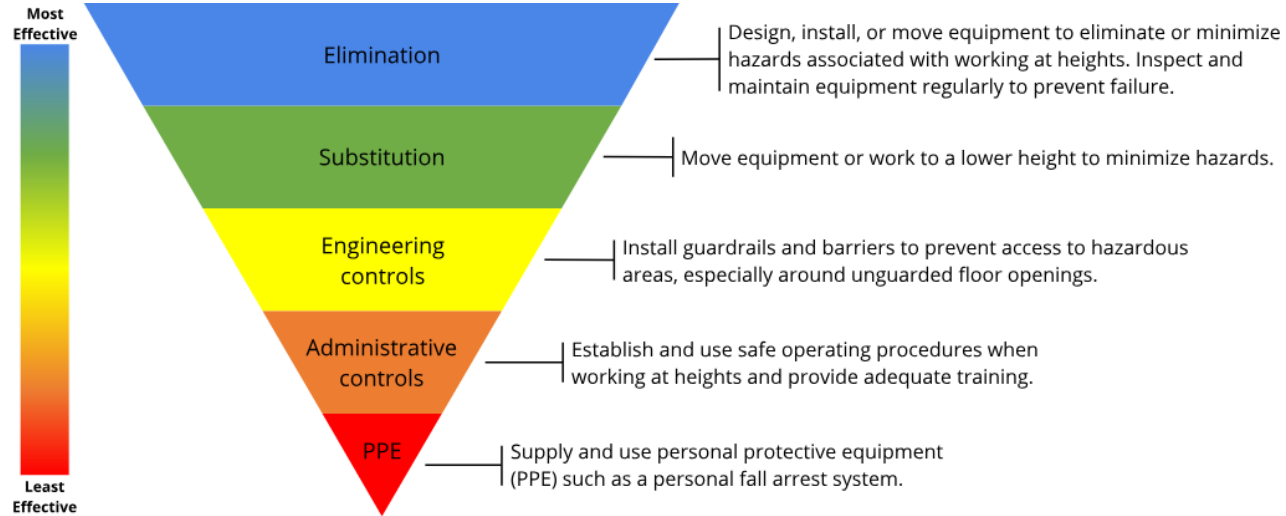


2006-2015

Recommendations based on NIOSH's Hierarchy of Hazard Controls



Falls Can Kill!



Falls Can Kill!

In 10 years, 55 mine workers died from falls.

| Occupation | Number of Deaths |
|---------------------|------------------|
| Laborers | 16 |
| Equipment operators | 12 |
| Mechanics | 9 |
| Truck drivers | 8 |
| Others | 10 |

Minimize working at heights

Design, install, or move equipment to reduce or eliminate fall risk.

Install barriers

Prevent access to hazardous areas and clearly identify hazards.

Use a personal fall arrest system

Use harnesses of the correct size, designed for the task, and with substantial tie-off points. Ensure you inspect, maintain, and are trained to use fall arrest systems.

Inspect and maintain equipment

Look for defects, fix damaged and improperly modified equipment, and use equipment as intended.

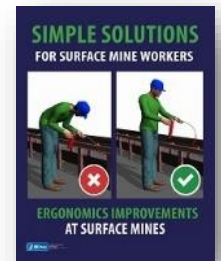
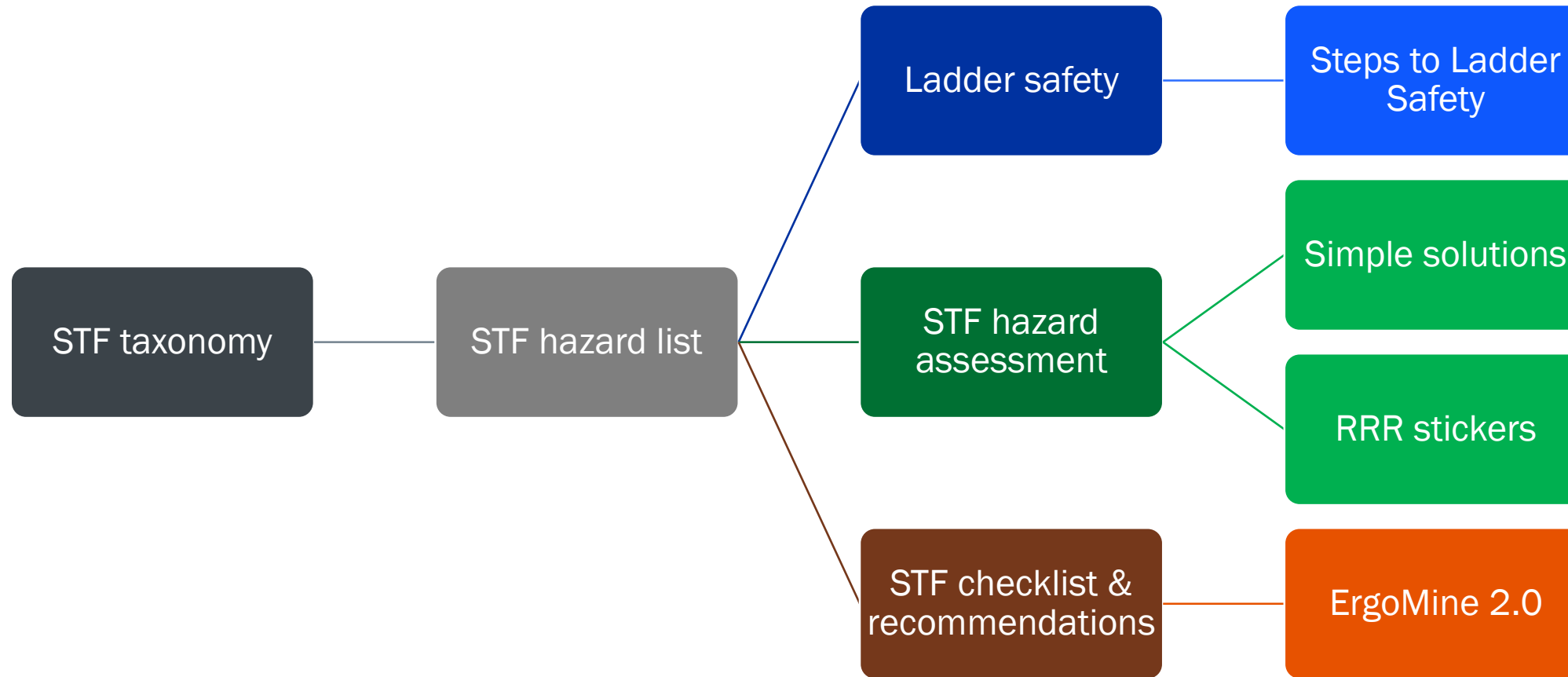
Pay special attention

Be especially cautious during maintenance and repair and installation, construction, or dismantling activities.

To learn more, visit www.cdc.gov/niosh/mining

Data based on an analysis of fatal incidents investigated by MSHA between 2006 and 2015 involving slips and falls. To read the full trade publication, please visit: <http://me.smenet.org/reader.cfm?webArticleID=2118>

STF hazards in the work environment



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

Steps to Ladder Safety

Each year, 121 miners are injured on ladders.

21 days lost per injury

Wear safe shoes
Wear shoes that have heels with a defined front edge.

Remove contaminants
Clean debris, mud, ice, or grease from the ladder and from your gloves and shoes.

Inspect the ladder
Check for defects such as broken, loose, or bent parts before climbing.

Face the ladder
Face the ladder when climbing up and down.

Climb and descend carefully
Never jump from a ladder or climb more than one rung at a time.

Maintain three points of contact
When climbing, don't carry anything in your hands. Use a backpack or shoulder strap for tools and personal items.

To learn more, visit [cdc.gov/niosh/mining](https://www.cdc.gov/niosh/mining)
To download the NIOSH Ladder Safety App, visit go.usa.gov/xRQH8

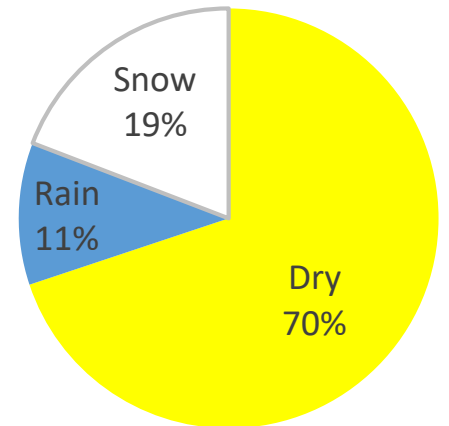
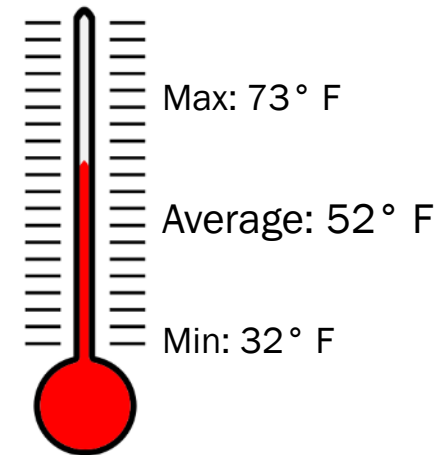
Reported data based on an analysis of nonfatal injuries reported to MSHA between 2010 and 2015 involving ladders. Recommendations are based on CFR 30.56.1101.1, CFR 29.1926.1053, and ANSI ASC A14.3-2008.

STF hazard assessment at surface SSG mines

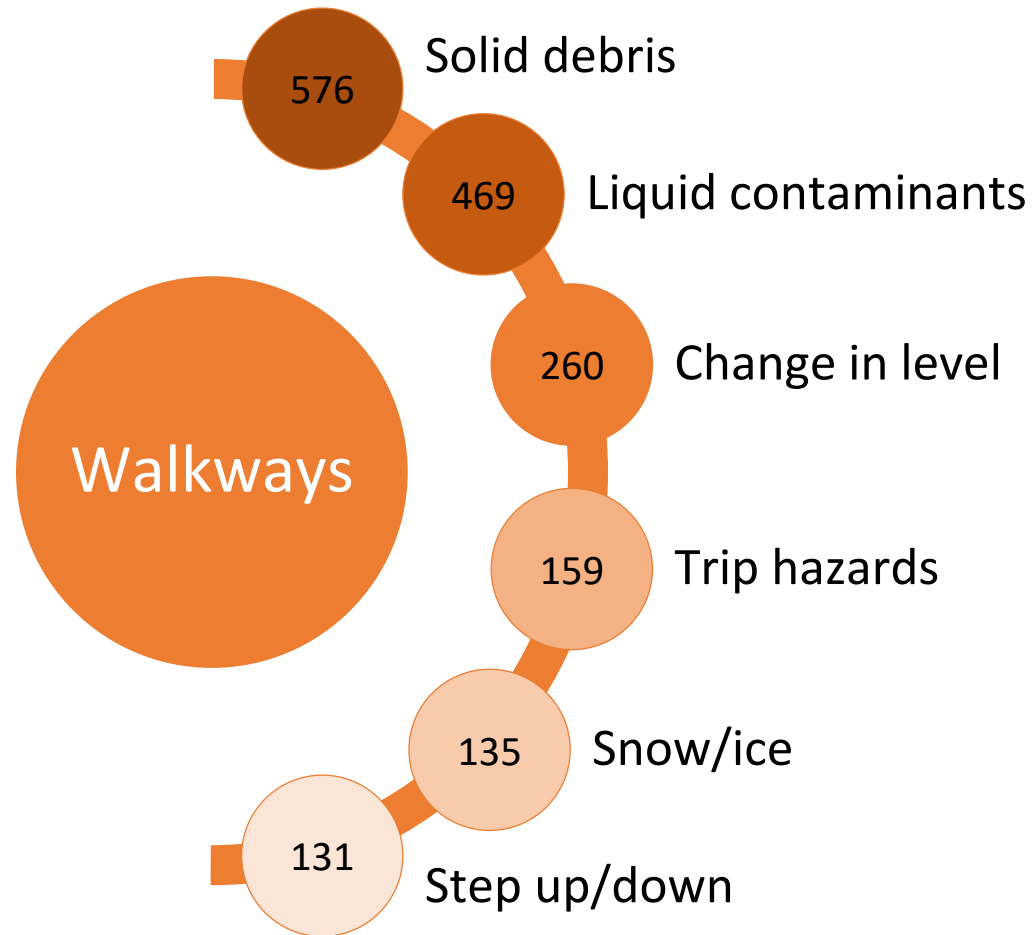
- We shadowed workers
- We observed their working environment



36 hours (~4 days) of observation



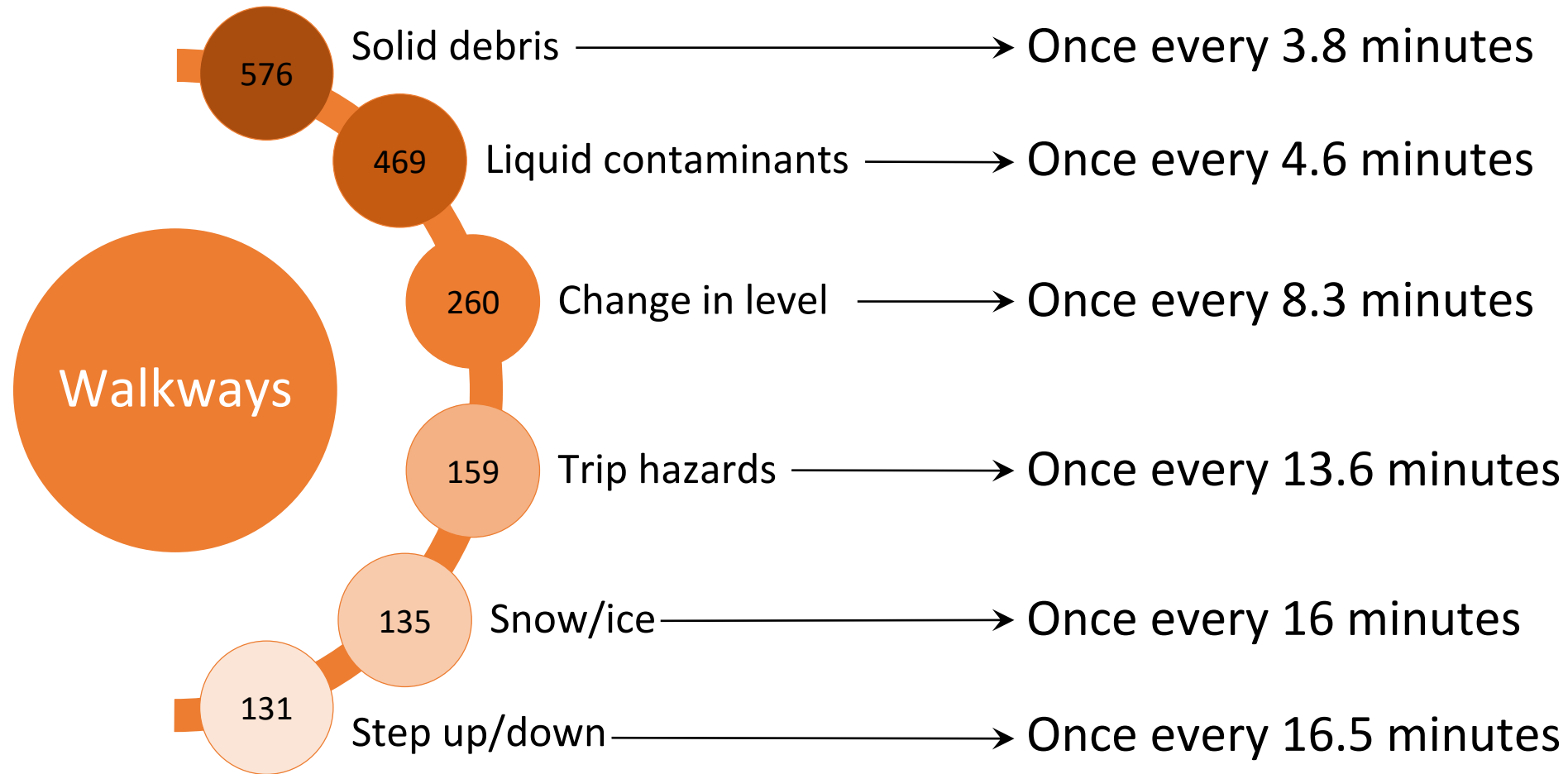
Common STF hazards along the path of travel or on walkways



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

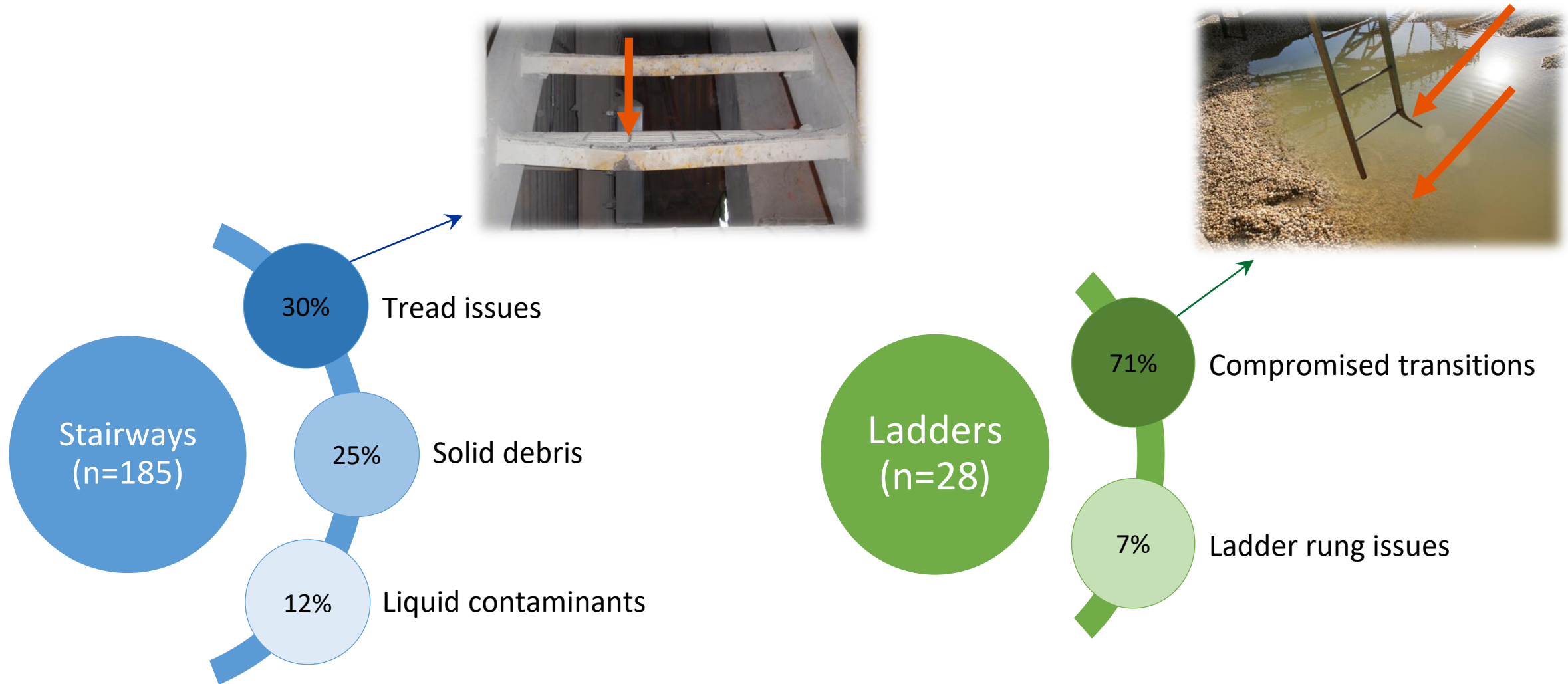


Common STF hazards along the path of travel or on walkways



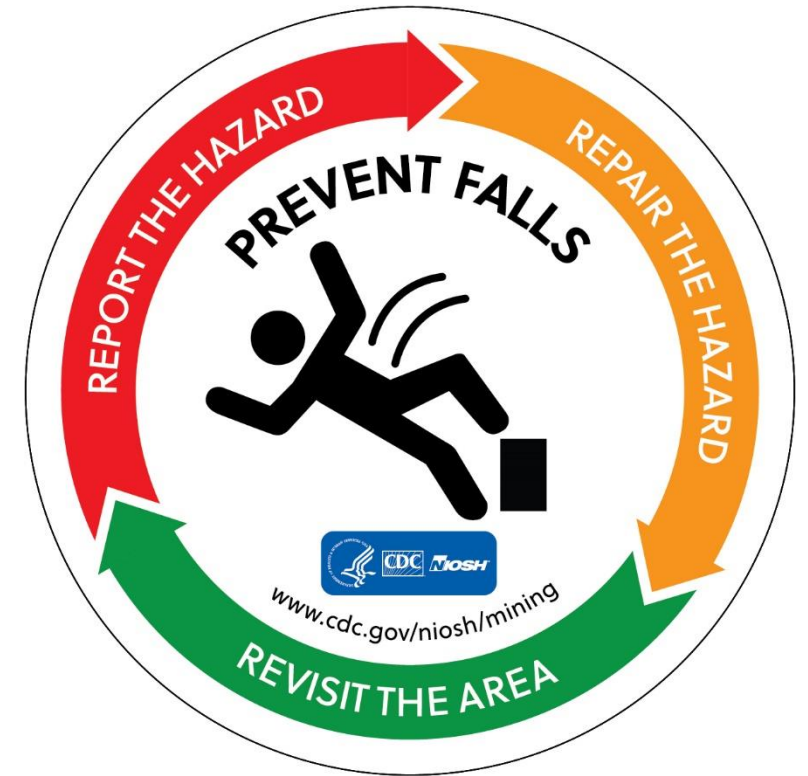
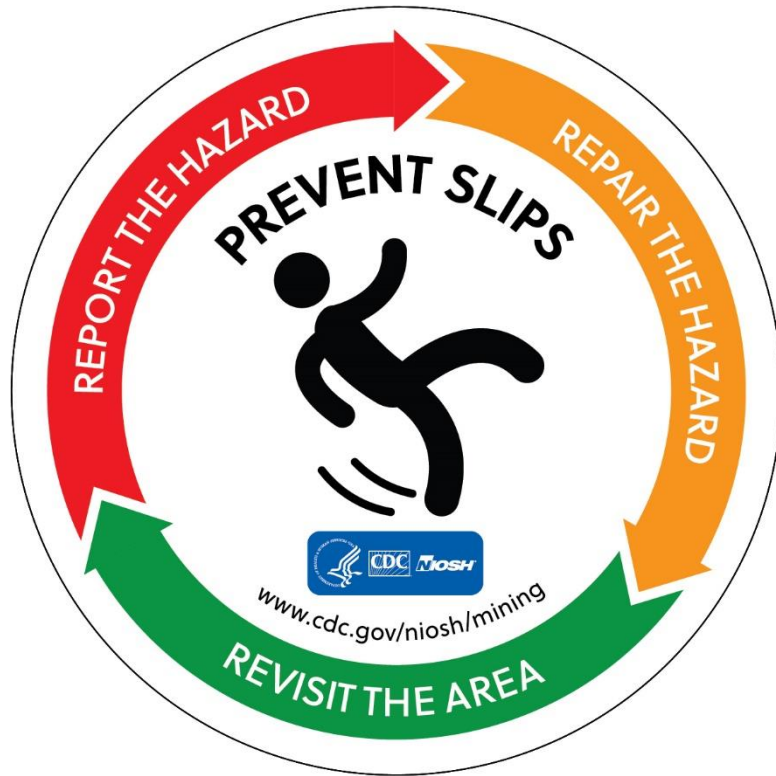
Number of times a hazard was encountered
during the 36 hours of observation

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”



SIMPLE SOLUTIONS FOR SURFACE MINE WORKERS




ERGONOMICS IMPROVEMENTS AT SURFACE MINES

  Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health


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



<http://go.usa.gov/x9Qnw>

Mining equipment ingress/egress systems



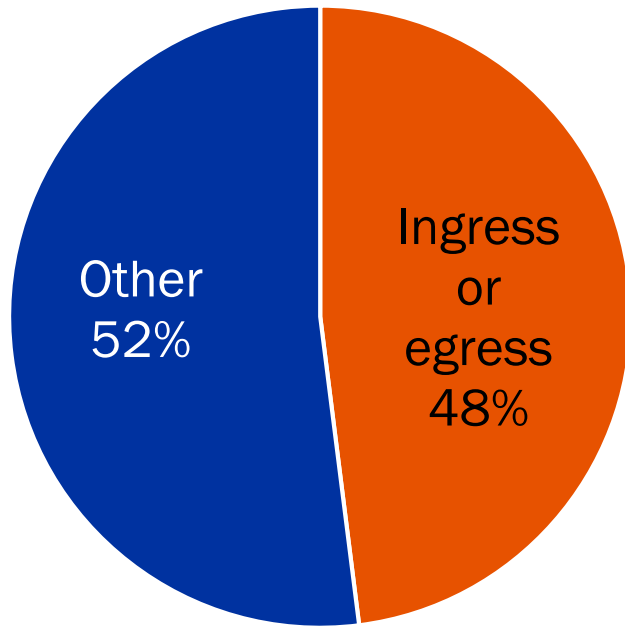
Ingress and egress systems

- Ingress – getting on
Ground → Cab
- Egress – getting off
Cab → Ground
- Includes
 - Platforms
 - Ladders
 - Stairs

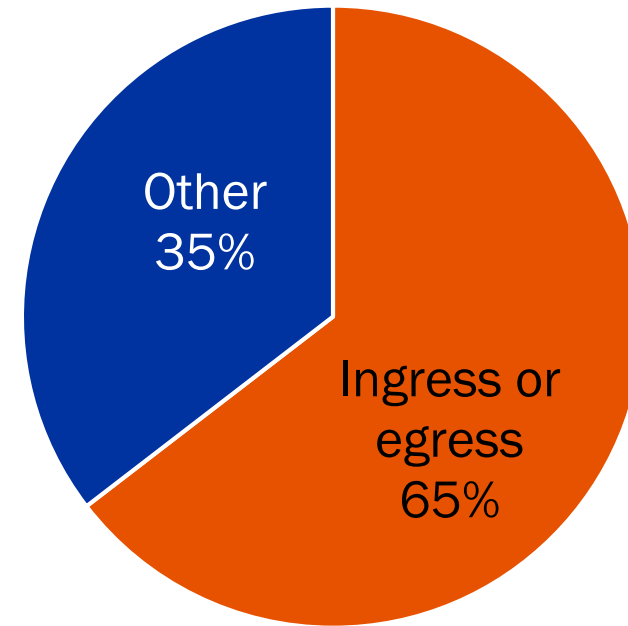


Ingress and egress from mobile equipment

Falls from all equipment
2006-2007



Slips and falls from haul trucks
2004-2008



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.

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

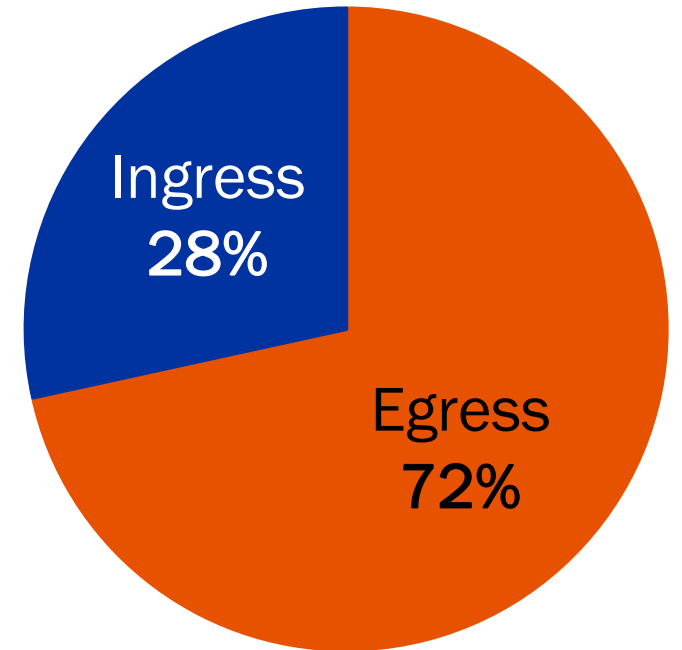
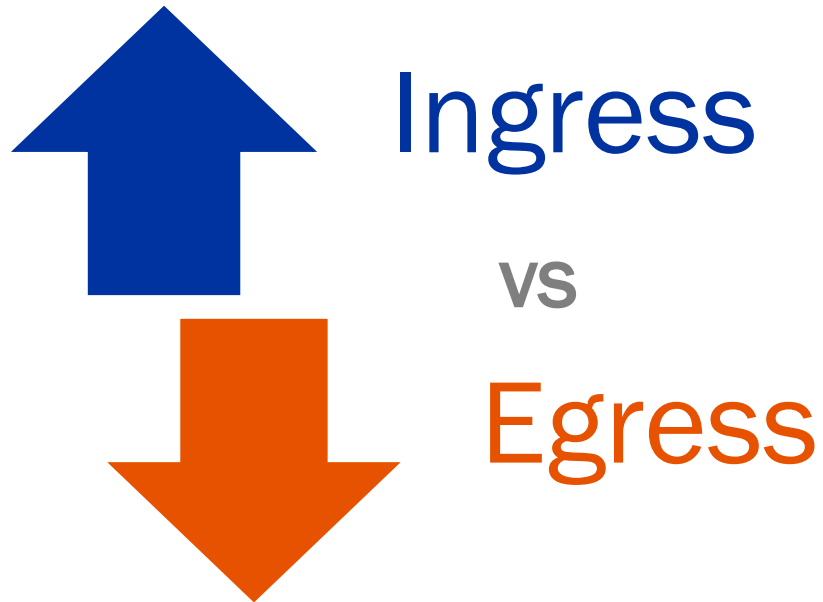
For front-end wheel loaders



Interviews with
equipment operators

Any mobile equipment

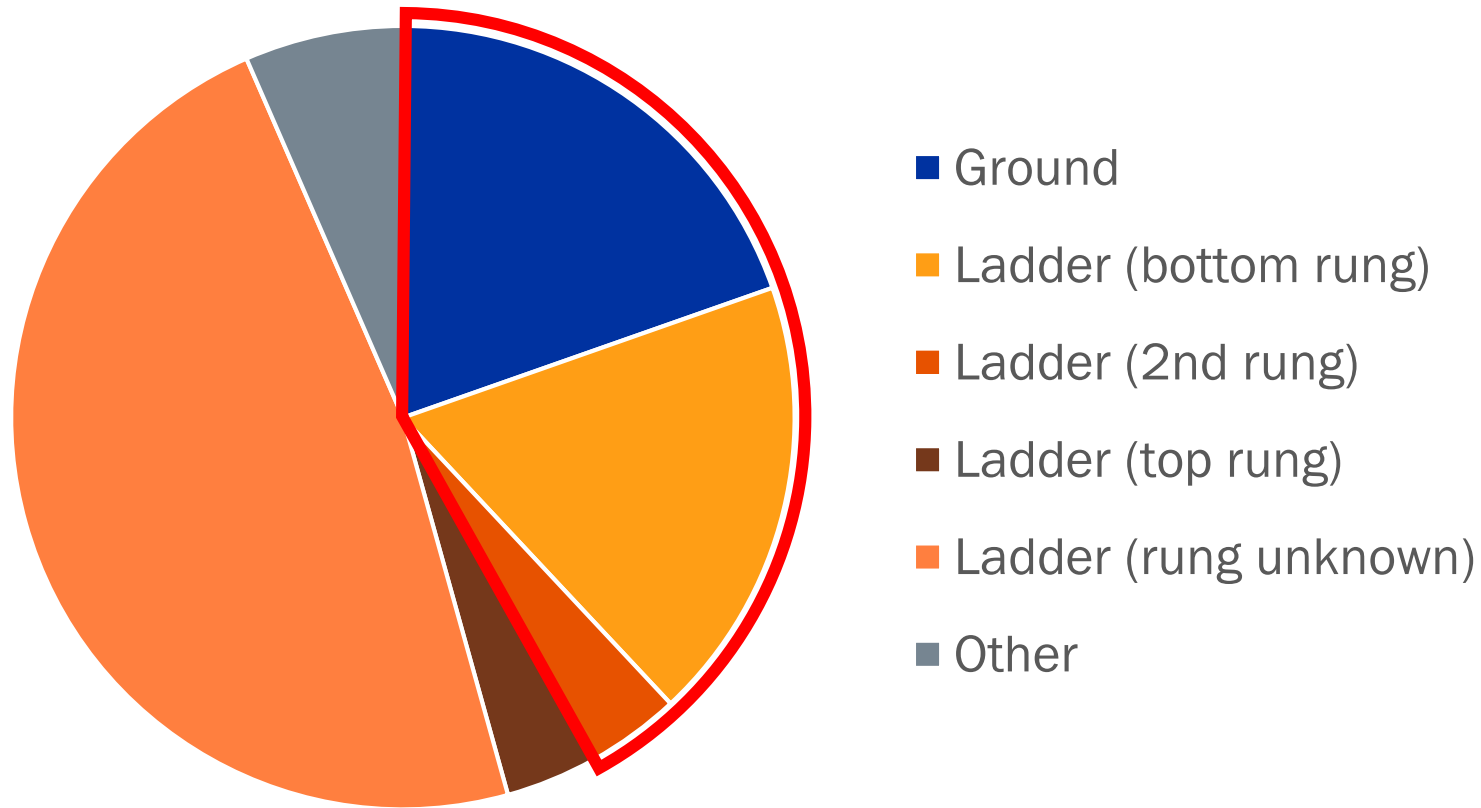
Egress is more dangerous than ingress



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...

Rocks

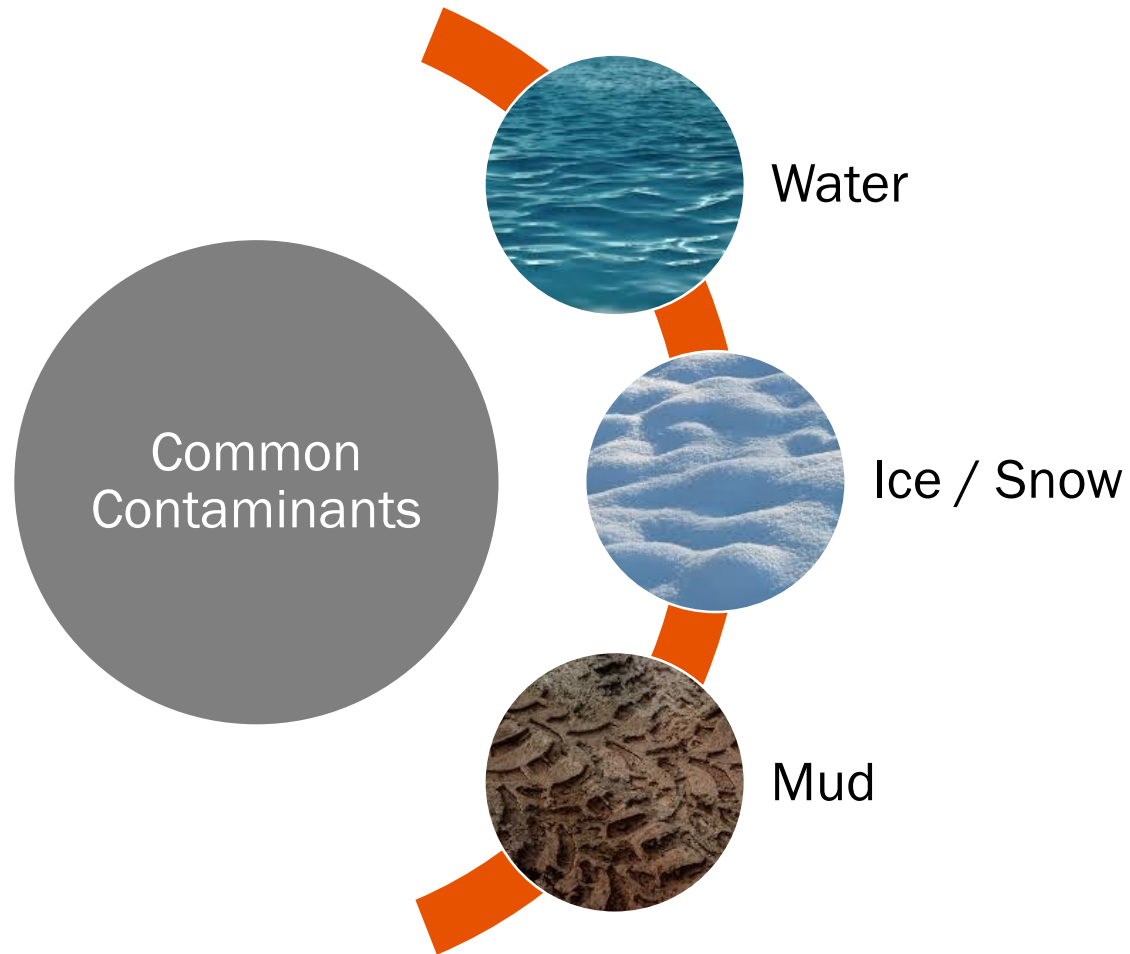
Hoses/pipes and
other materials

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

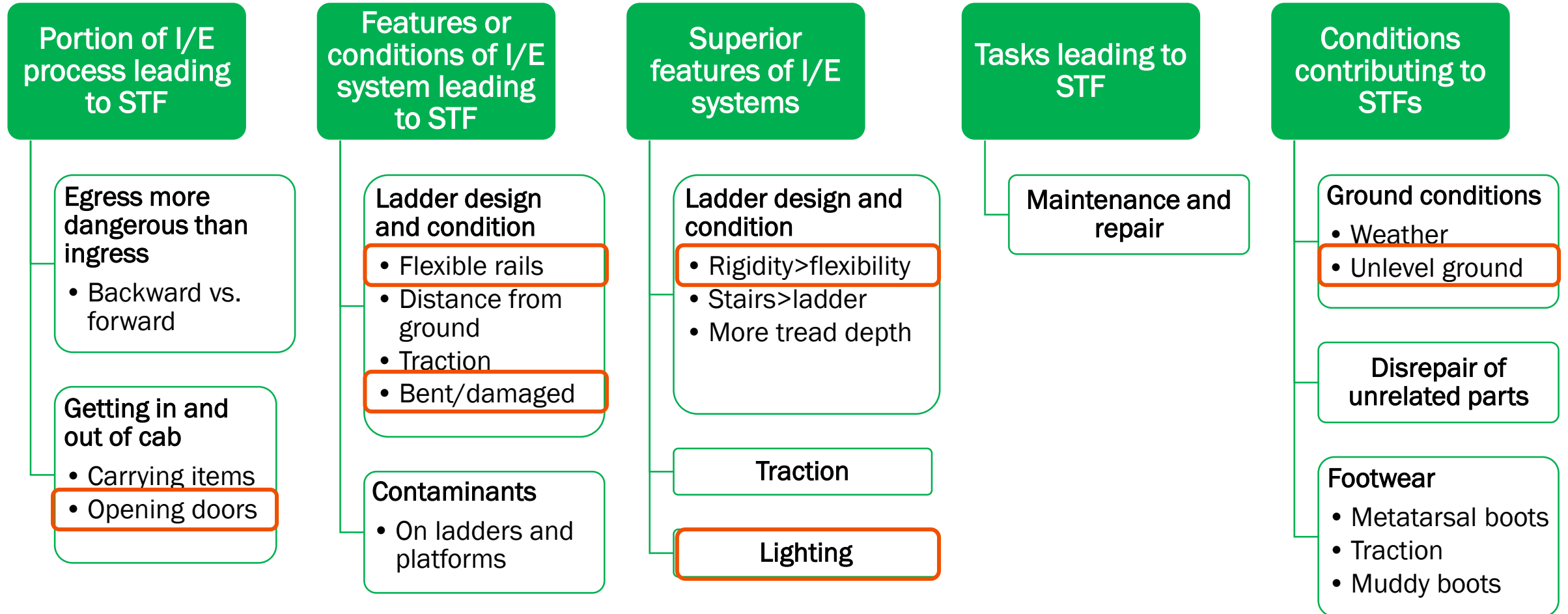


Equipment failure–
But not clear how it failed



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



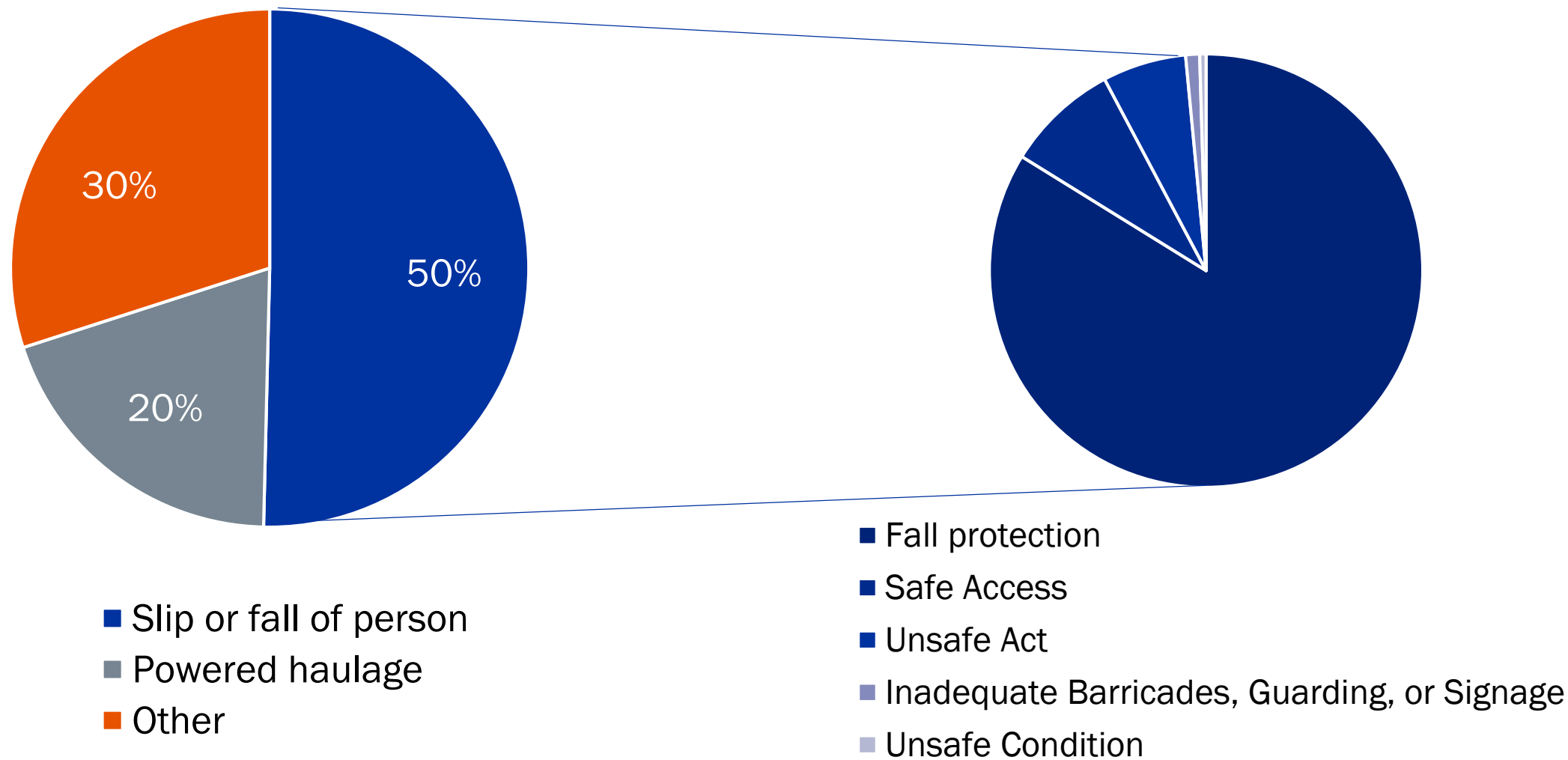
Designing safe mobile equipment access areas

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

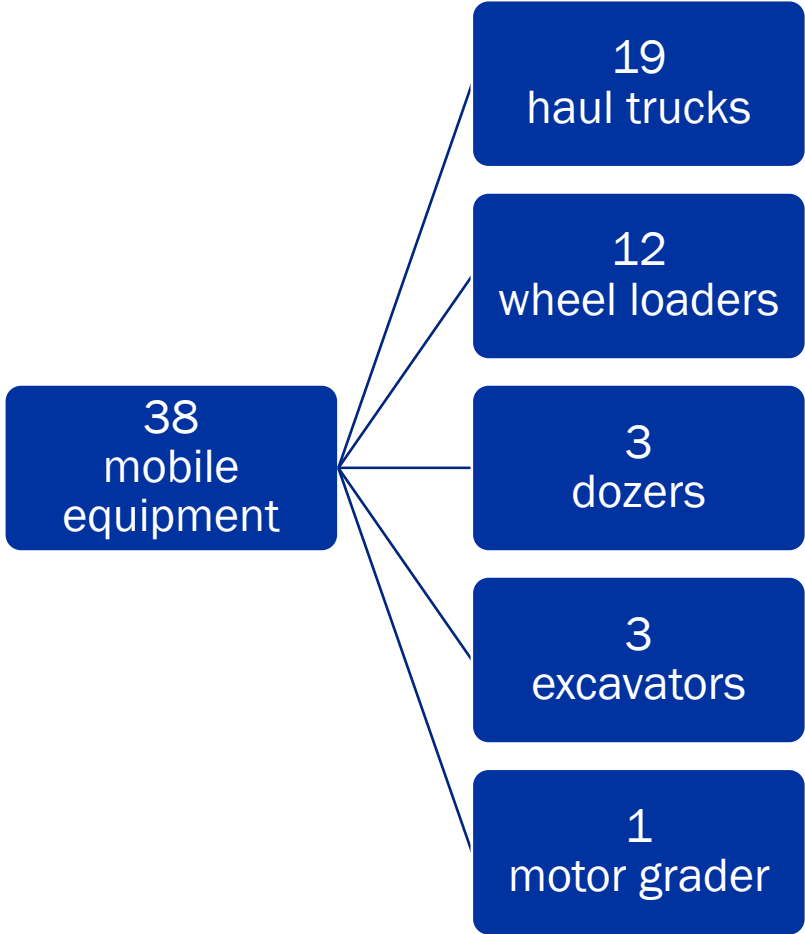


2010-2017

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



| | Ground below 1 st step | On 1 st 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 ...



Fall Protection: As Simple as A-B-C

84% of fall-related imminent danger orders issued by MSHA were for using a personal fall arrest system incorrectly or not at all*

Fall Protection: As Easy as 1-2-3

84% of fall-related imminent danger orders issued by MSHA were for using a personal fall arrest system incorrectly or not at all*

1

1. Select and Inspect

Select a stable anchor and anchorage connector with adequate strength, a harness size that fits your body, and a lanyard length based on lanyard type and fall distance.

Inspect your harness and lanyard for cuts, tears, or burn marks, and remove damaged items from service.

2

2. Put on

Be certain your body harness includes straps that distribute the fall arrest force over your thighs, pelvis, waist, chest, and shoulders.

The harness should be sized to fit your height and weight and include a D-ring on the back to attach to the connecting device.

3

3. Tie off

Secure the anchorage connector to the anchor, then attach the lanyard or lifeline to the D-ring on your back.

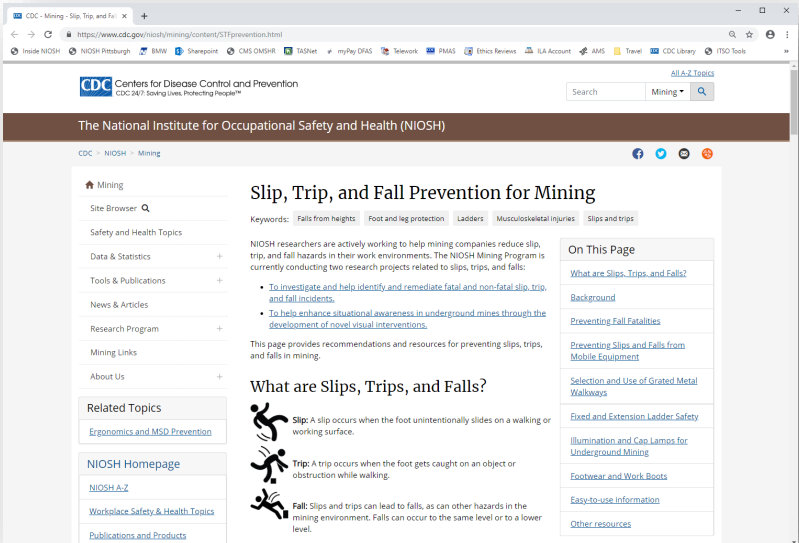
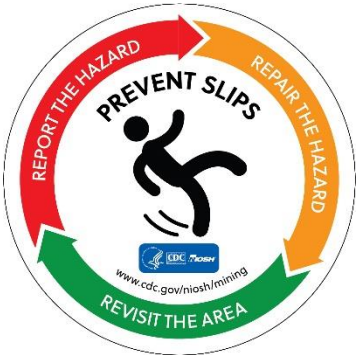
Ensure that the anchorage connector cannot slide off.

Ensure for at least 1 foot of free fall

To learn more, visit www.cdc.gov/niosh/mining

* Data from MSHA for the period 2010–2017 based on 1,057 imminent danger orders.

The slip, trip, and fall prevention toolkit for mining



Slip, Trip, and Fall Prevention for Mining Website



<http://go.usa.gov/xP7aN>

A screenshot of a web browser displaying the CDC NIOSH Mining website. The browser's address bar shows the URL https://www.cdc.gov/niosh/mining/content/STFprevention.html. The page header includes the CDC logo and the text "Centers for Disease Control and Prevention CDC 24/7: Saving Lives, Protecting People™". A search bar and a "Mining" dropdown menu are visible. Below the header, a brown banner reads "The National Institute for Occupational Safety and Health (NIOSH)". The main content area is titled "Slip, Trip, and Fall Prevention for Mining" and includes a "Keywords" section with tags for "Falls from heights", "Foot and leg protection", "Ladders", "Musculoskeletal injuries", and "Slips and trips". The text explains that NIOSH researchers are actively working to help mining companies reduce slip, trip, and fall hazards. A list of links includes "To investigate and help identify and remediate fatal and non-fatal slip, trip, and fall incidents" and "To help enhance situational awareness in underground mines through the development of novel visual interventions". A sidebar on the left contains a "Mining" section with links to "Site Browser", "Safety and Health Topics", "Data & Statistics", "Tools & Publications", "News & Articles", "Research Program", "Mining Links", and "About Us". A "Related Topics" section links to "Ergonomics and MSD Prevention". A "NIOSH Homepage" section links to "NIOSH A-Z", "Workplace Safety & Health Topics", and "Publications and Products". A right sidebar titled "On This Page" lists links to "What are Slips, Trips, and Falls?", "Background", "Preventing Fall Fatalities", "Preventing Slips and Falls from Mobile Equipment", "Selection and Use of Grated Metal Walkways", "Fixed and Extension Ladder Safety", "Illumination and Cap Lamps for Underground Mining", "Footwear and Work Boots", "Easy-to-use information", and "Other resources". At the bottom, a section titled "What are Slips, Trips, and Falls?" defines each hazard with an icon: a slip occurs when the foot unintentionally slides on a walking or working surface; a trip occurs when the foot gets caught on an object or obstruction while walking; and a fall occurs when slips and trips can lead to falls, as can other hazards in the mining environment. Falls can occur to the same level or to a lower level.

Questions?

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



NIOSH Mining Program – www.cdc.gov/niosh/mining

