



From 2014 to 2023: Evolution of Workplace Risks and Risk Management in Underground Mining

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Agenda

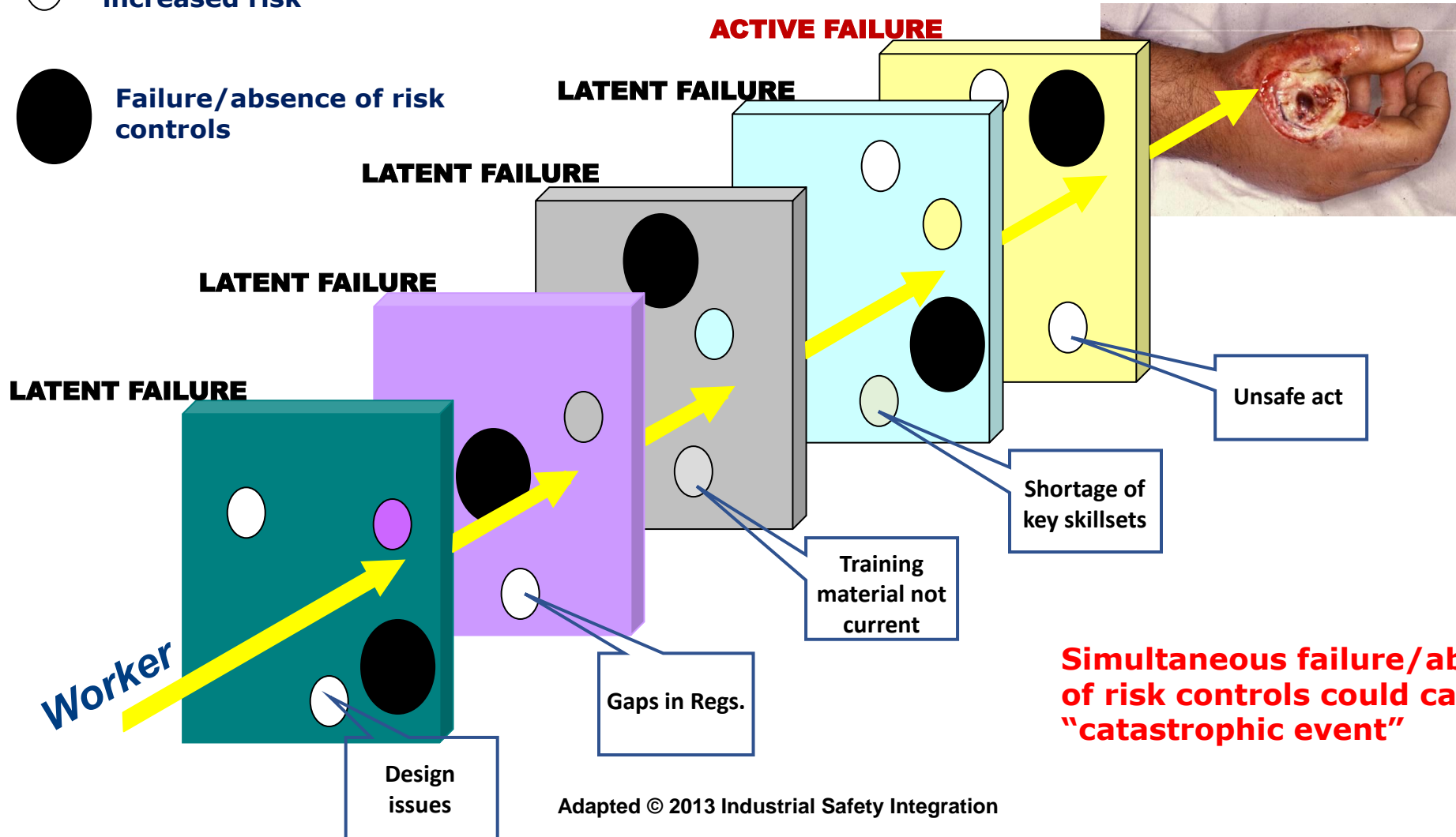


- Introduction
- Risk assessment project
- Root Cause Analysis
- Brainstorming session
- 2014 to 2023 comparison
- Summary

Risk Assessment Project

○ Examples that could lead to increased risk

● Failure/absence of risk controls



Workshop: A tripartite and collective process



Risk assessment workshop attendees

SUBJECT MATTER EXPERTS		
#	Name	Company/Representative
1	Craig Allair	Vale
2	Richard Claveau	Newmont
3	Nav Gill	KGHM
4	Billy Smith	Glencore
5	Jerry Thibeault	Vale
6	Chris Betsill	Redpath
7	Loye Halteman	Barrick
8	Jake Hughes	Technica
9	Michelle Hulme	Vale
10	Darren Raymond	Compass Minerals

Worker Representation

Employer Representation

WORKSHOP PARTICIPANTS		
#	Name	Company/Representative
1	Derek Budge	Mining Legislative Review Committee
2	Malcom Mills	Mining Legislative Review Committee
3	Rick Legree	Barrick: Worker Advisor
4	Scott Secord	MLITSD: Inspector
5	Tom Welton	Workplace Safety North: Tech Support
6	Robert Marin	Workplace Safety North: Facilitator
7	Sam Barbuto	Workplace Safety North: Facilitator
8	Tiana Larocque	Workplace Safety North: Tech Support
9	Tricia Valentim	Workplace Safety North: Tech Support
10	Harsim Kalsi	MLITSD: Provincial Mining Coordinator

MLITSD: Ministry of Labour, Immigration, Training, and Skills Development

Top 10 risk categories based on highest risk within that category

Rank	Category	Event (Situation/Condition) that could result in Injury or Illness OR <i>“What could keep you up at night?”</i>
1	Equipment, materials, machinery	Interaction with mobile equipment – equipment collision with other equipment (large vs small) – traffic control
2	Equipment, materials, machinery	Interaction with mobile equipment and pedestrian
3	Fire and explosion	Adoption of new technology: battery electric vehicle fires – battery electric vehicle overheats, catches fire, or explodes underground (injuring operators, miners and/or mine rescue personnel)
4	Musculoskeletal Disorder Hazards	Worker suffers manual handling or repetitive strain injury
5	Ground Control	Ground control failure causing injury
6	Occupational illness/disease	Exposure to airborne substances
7	Equipment, materials, machinery	Interaction with mobile equipment – collision with infrastructure (conveyors, towers, etc.)
8	Equipment, materials, machinery	Inadvertent contact with stored energy
9	Occupational illness/disease	Hearing loss
10	Fire and explosion	Major fire underground from mobile equipment

Top 10 Health and Safety Risks in Underground Mines

Interaction with mobile equipment is top risk

As identified by workers, supervisors, and employers in the Ontario mining industry through a Ministry of Labour, Immigration, Training and Skills Development-facilitated risk assessment workshop in partnership with Workplace Safety North.



1. Interaction with mobile equipment - collision with other equipment
(large vs small) - traffic control



6. Exposure to airborne hazardous substances



2. Interaction with mobile equipment and pedestrian



7. Interaction with mobile equipment - collision with infrastructure
(conveyors, towers, etc.)



3. Adoption of new technology: Battery electric vehicle fires or explosions injure workers or mine rescue personnel



8. Inadvertent contact with stored energy



4. Worker suffers manual handling or repetitive strain injury



9. Hearing loss



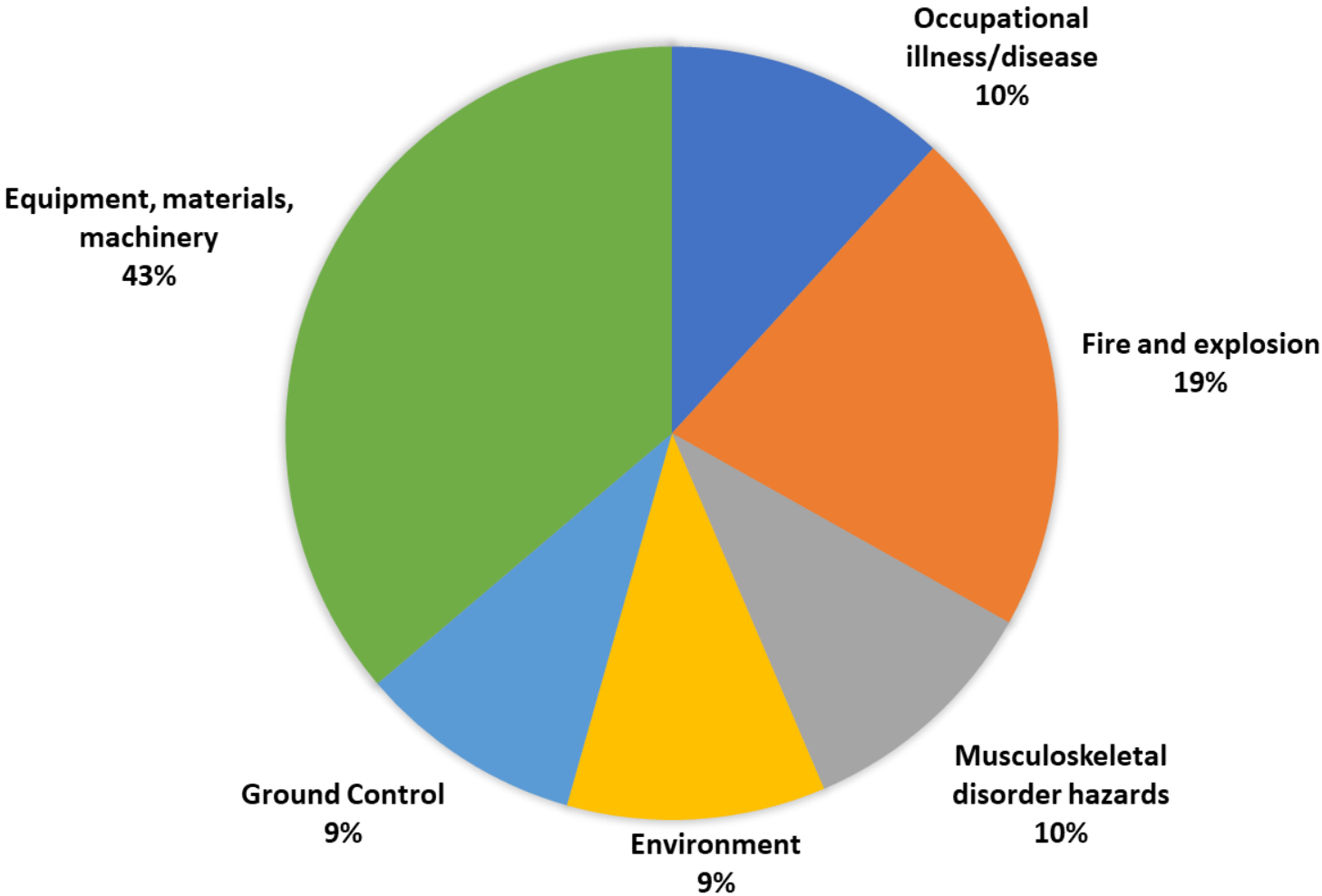
5. Ground control failure causing injury



10. Major fire underground from mobile equipment

For more information, please contact your WSN Health and Safety Specialist or visit workplacesafetynorth.ca

Top 10 underground mining sector risk categories



Analyses of the top 10 risks and their desired outcomes (three factors per top five)

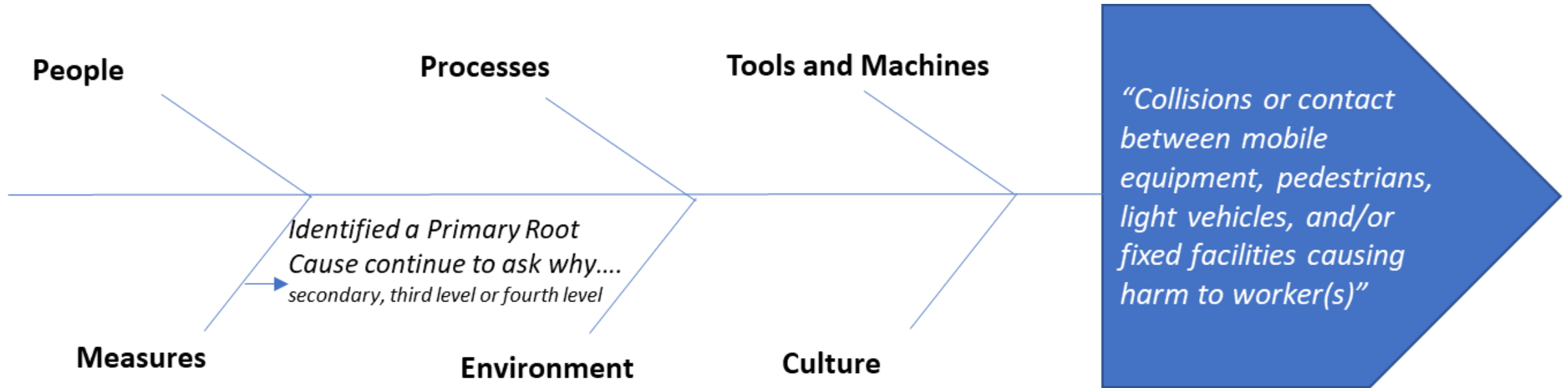
Rank	Category	Contributing factor	Result
1	Equipment, materials, machinery	<ul style="list-style-type: none"> • Larger equipment with reduced sightlines • Brighter ambient lighting and equipment headlights washing out lights of oncoming vehicles • Lack of collision avoidance technology 	Collision with people/other equipment
2	Fire and explosion	<ul style="list-style-type: none"> • Autonomous equipment • Specialized explosives • Inadequate preventative maintenance programs 	Injury to worker, damage to equipment, loss of process
3	Occ. Disease	<ul style="list-style-type: none"> • Lack of or inadequate engineering or ventilation plan • Mobile equipment in disrepair • Inconsistent diesel emissions testing 	Injury to worker, long-term effects resulting in occ. disease
4	MSDs	<p>Inexperienced workforce</p> <p>Inadequate planning and supervision</p> <p>Worker shortage contributes to overloading personnel</p>	Injury to worker, long-term effects of injury
5	Ground control	<p>Mining at depth</p> <p>Mining in high-stress ground</p> <p>Changes in mining plan with improper risk review</p>	Injury to worker, damage to equipment, loss of process

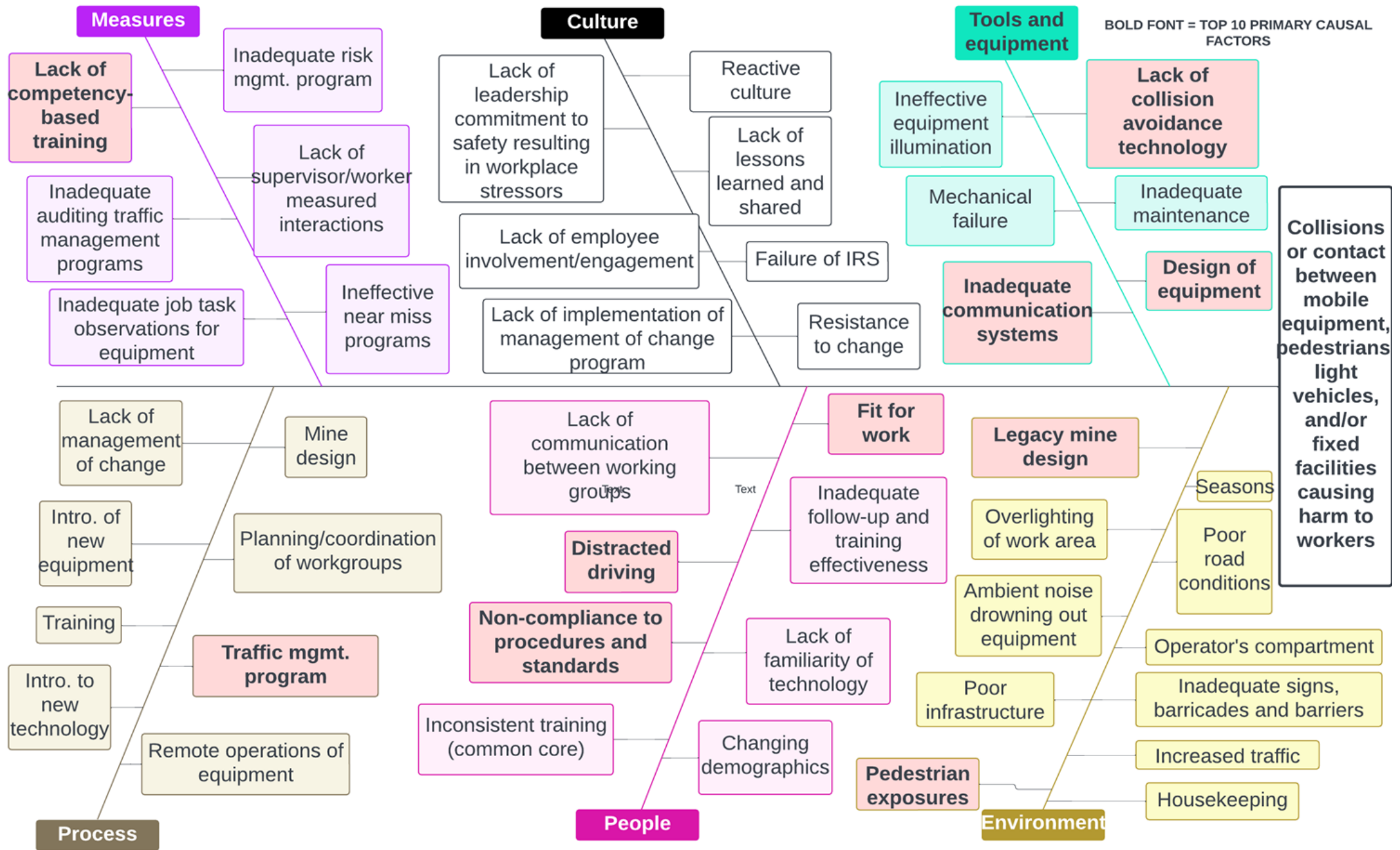
Root Cause Analyses: Risk Statement

Based on risk assessment results and further analysis, the Root Cause Analysis working group confirmed and developed the following risk statement using the “**Fishbone**” approach addressing

“Collisions or contact between mobile equipment, pedestrians, light vehicles, and/or fixed facilities causing harm to worker(s).”

Fishbone diagram





Top primary casual factors

Ranking	Category	Primary Root-Cause
1	Tools and Equipment	Design of equipment
2	Environment	Historic mine workings mismatched with modern equipment
3	People	Non-compliance to procedures and standards
4	Process	Ineffective traffic management program
5	Tools and Equipment	Inadequate communication systems
6	Tools and Equipment	Lack of confidence in collision avoidance technology
7	Environment	Pedestrian exposures to mobile equipment
8	People	Distracted driving
9	People	Fit for work
10	Measures	Ineffective assessment of training competencies

Top 10 Health and Safety Risks in Underground Mines

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1. Interaction with mobile equipment - collision with other equipment
(large vs small) - traffic control



6. Exposure to airborne hazardous substances



2. Interaction with mobile equipment and pedestrian



7. Interaction with mobile equipment - collision with infrastructure
(conveyors, towers, etc.)



3. Adoption of new technology: Battery electric vehicle fires or explosions injure workers or mine rescue personnel



8. Inadvertent contact with stored energy



4. Worker suffers manual handling or repetitive strain injury



9. Hearing loss



5. Ground control failure causing injury



10. Major fire underground from mobile equipment

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List of solutions and controls for the top primary root causes

Notes:

- Scope of this exercise does not include assessment of listed controls.
- List provides information on specific controls and/or activities that support a control.
- Control performance should be specific, measurable, observable, and auditable

Next steps: Proactive efforts of the Mining Legislative Review Committee (MLRC)

Following a presentation to the MLRC, a committee specific to Underground Mining Sector will conduct a detailed review of workshop results.

Based on identified primary causal factors, several areas are being looked at to support the establishment of effective controls, including:

- Industry leading practices
- Knowledge of legislation and standards











Brainstorming session:

- How do you think the industry has changed?

Risk Landscape – U/G Mining Sector

2014 Top 10 Health and Safety Risks in Underground Mines Ground control is top risk

As identified by workers, supervisors, and employers in the Ontario mining industry through a Ministry of Labour, Immigration, Training and Skills Development-facilitated risk assessment workshop in partnership with Workplace Safety North.











- | | | | |
|--|---|--|---|
|  | 1. Ground control – rock bursts underground |  | 6. Mobile equipment – visibility/ blind spots |
|  | 2. Mobile Equipment - Large vehicle and pedestrian or small vehicle interaction |  | 7. Occupational disease - Exposure to airborne hazardous substances |
|  | 3. Ground control – loose rock at the face |  | 8. Fatigue – shift work |
|  | 4. Ground control – ground instability |  | 9. Ground control – fall of ground while installing ground support |
|  | 5. Ground control – face not scaled and secured |  | 10. Training – supervisors in some mines in Ontario lack proper training. Inexperienced or improperly trained supervisors pose a threat to themselves and others. |

For more information, please contact your WSN Health and Safety Specialist or visit workplacesafetynorth.ca

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2023 Top 10 Health and Safety Risks in Underground Mines Interaction with mobile equipment is top risk

As identified by workers, supervisors, and employers in the Ontario mining industry through a Ministry of Labour, Immigration, Training and Skills Development-facilitated risk assessment workshop in partnership with Workplace Safety North.

- | | | | |
|--|---|--|--|
|  | 1. Interaction with mobile equipment - collision with other equipment (large vs small) - traffic control |  | 6. Exposure to airborne hazardous substances |
|  | 2. Interaction with mobile equipment and pedestrian |  | 7. Interaction with mobile equipment – collision with Infrastructure (conveyors, towers, etc.) |
|  | 3. Adoption of new technology: Battery electric vehicle fires or explosions injure workers or mine rescue personnel |  | 8. Inadvertent contact with stored energy |
|  | 4. Worker suffers manual handling or repetitive strain injury |  | 9. Hearing loss |
|  | 5. Ground control failure causing injury |  | 10. Major fire underground from mobile equipment |

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BEV Symposium
Feb 15 2024
Sudbury

Supervisor
Common
Core Refresher
Training

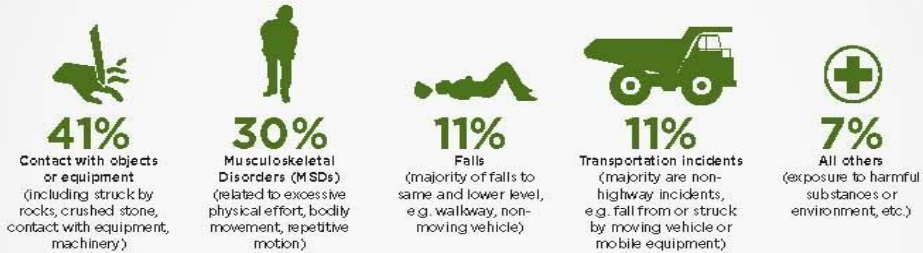
Workplace Health and Safety Snapshot for Ontario Mining Sector in 2014

22,226
Full-time employees

3 Injury Work-related fatalities
11 Disease*
933 Total injuries
121 Lost-time injuries
4.20 Total injury rate per 100 workers
-17% Change in injury rate from previous year

Events Resulting In Lost-time Injury or Illness

Injury or illness severe enough to require one or more days lost from work



Most Common Lost-Time Injuries

- 40** Struck by object, or caught in or compressed by equipment injuries, including being struck by rocks, crushed stone, falling, flying, or slipping object; slammed in swinging door or gate; compressed or pinched by rolling, sliding, or shifting objects; caught in or compressed by equipment or machinery.
- 33** Musculoskeletal Disorders (MSDs), including repetitive motion, bending, climbing, crawling, reaching, twisting, slipping, overexertion in lifting, throwing, pulling, pushing or throwing objects.
- 13** Falls, majority of falls to same or lower level, such as floors, walkways, and other surfaces, falls onto or against objects, and falls from non-moving vehicle.
- 13** Transportation incidents, e.g. fall from or struck by moving vehicle or mobile equipment, overturn, loss of control, sudden start or stop, shifting load.

Top 3 Occupational Diseases

Based on approved WSIB claims for healthcare, being off work, loss of wages, or permanent disability.

- 80** Noise-induced hearing loss
- 16** Hand-arm vibration syndrome
- 15** Symptoms, signs, and conditions of disease, including tearing eyes, respiratory irritations or abnormalities, sneezing, halitosis, nausea and vomiting, headache, facial pain, dizziness, giddiness, and rash.

*Disease fatality claims approved by WSIB in 2014

Source: WSIB Enterprise Information Warehouse as of March 31, 2015. RG 110, 115, 119 WSN OCT2015

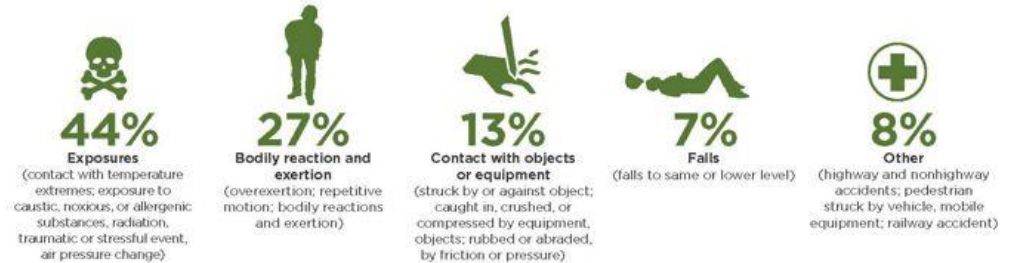
Workplace Health and Safety Snapshot for Ontario Mining Sector in 2022

23,894
Full-time employees

2 Injury Work-related fatalities
4 Disease*
1,317 Total injuries
299 Lost-time injuries
5.51 Total injury rate per 100 workers
+8.64% Change in injury rate from previous year

Events resulting in lost-time Injury or Illness

Injury or illness severe enough to require one or more days lost from work



Most common lost-time injuries

- 130** Exposures, from contact with hot objects or substances; exposure to caustic, noxious, or allergenic substances, environmental heat; ingestion or inhalation of substance; witnessing or hearing a traumatic or stressful event, emotional reaction; contact with skin, eyes, exposed tissue; exposure to radiation, air pressure change.
- 80** Bodily reaction and exertion, includes injuries resulting from overexertion in lifting, pulling, pushing, carrying, or turning objects; repetitive motion, bending, climbing, crawling, reaching, twisting, slipping, tripping; and slip, trip, twist, step on something without a fall; stepping in hole; repetitive movement, bodily reaction and conditions.
- 39** Contact with objects and equipment, from being struck by or against dislodged, falling, flying, swinging, slipping, or stationary object; struck by or slammed in swinging door; caught in, compressed by, or jarred by running equipment or machinery; rubbed or abraded by friction, pressure, foreign matter, vibration.

Top 3 Occupational Diseases

Based on approved WSIB claims for healthcare, being off work, loss of wages, or permanent disability

- 154** Hearing loss: noise effects on inner ear
- 128** Diseases of the respiratory system: viral infection, food poisoning, viral conjunctivitis (pink eye)
- 29** Diseases of the circulatory system: other peripheral vascular diseases

*Disease fatality claims with a fatality effective date of 2022. Source: Workplace Safety and Insurance Board Enterprise Information Warehouse as of March 31, 2023. NAICS codes: 212392, 212397, 10200, 212220, 212332, 212333, 212299, 212314, 212315, 212317, 212326, 212393, 212394, 212395, 212396, 213117, 213119. WSN June 2023.

Access mining risk assessments and root cause analyses on WSNs website

[Mining Risk Assessment and Root Cause Analysis Overview Presentation](#)

Mining surface – Top Risks:

[Mining - Surface risk assessment](#)

[Risk categories rank](#)

[Risk categories detailed](#)

Ground Control

[Mining root cause analysis for ground control](#)

[Companion document](#)

[Control activities](#)

[Risk Assessment Management Program Reference document](#)

Mobile Equipment

[Mining root cause analysis for mobile equipment](#)

[Companion document](#)

[Mining safety webinar recording: Worker contact with motor vehicles top health and safety risk for mining operations](#)

[Pedestrian-Mobile Equipment Visibility](#)

Visit webpage for more information:

<https://www.workplacesafetynorth.ca/en/about/industries/mining>

Mining underground – Top Risks:

[Mining - underground risk assessment](#)

[Risk categories](#)

Surface diamond drilling – Top Risks:

[Poster - Top 10 Risks for Surface Diamond Drilling](#)

[Risk assessment results](#)

[Root cause analysis detailed](#)

Water Management

[Mining root cause analysis for water management](#)

[Companion document](#)

[Control activities](#)

[Guidelines for water management in mines](#)

Battery Electric Vehicles

[Mining poster - Top 10 Risks for Battery Electric Vehicles](#)

[Mining poster - Top Root Causes of Battery Electric Vehicle Fires](#)

[Battery Electric Vehicles Risk Assessment Workshop Results](#)

[Battery Electric Vehicles Root Cause Analysis Workshop Results](#)

[Recommended Practices for Battery Electric Vehicles in](#)

[Underground Mining - Global Mining Guidelines Group](#)



Thank you

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