Underground Mining Risk Assessment

Results of the June 13th 2014 Workshop

September 10, 2014

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Risk Assessment Project

- The Ministry launched in 2013 a project to put in place an integrated risk management methodology:
  - To identify risks to worker health and safety and to work with employers and workers on reducing those risks
  - To provide more information to employers and to workers and their representatives about risks at the sector level

- The idea is that we work together to understand risks in a sector so that the partners in prevention – the ministry, the HSAs, employers, workers and their representatives – can discern the components of each risk and get insight into what it will take to unravel and reduce the risk (mitigation)

- The approach developed for this project draws on the empirical insights of risk management, operations research, and decision science

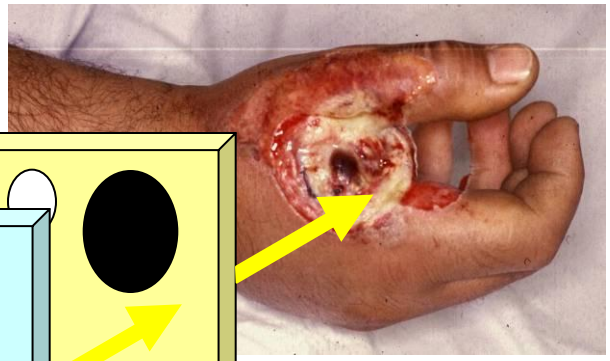
- The Chief Prevention Officer selected the underground mining sector as the first sector within which to operationalize this methodology

- The ministry is proceeding to conduct risk assessment in other sectors (E.g. Construction)

Risk Assessment Project: The Subject Of Inquiry

Examples that could lead to increased risk

Failure/absence of risk controls



ACTIVE FAILURE

LATENT FAILURE

LATENT FAILURE

LATENT FAILURE

LATENT FAILURE

Unsafe act

Shortage of key skillsets

Training material not current

Gaps in Regs.

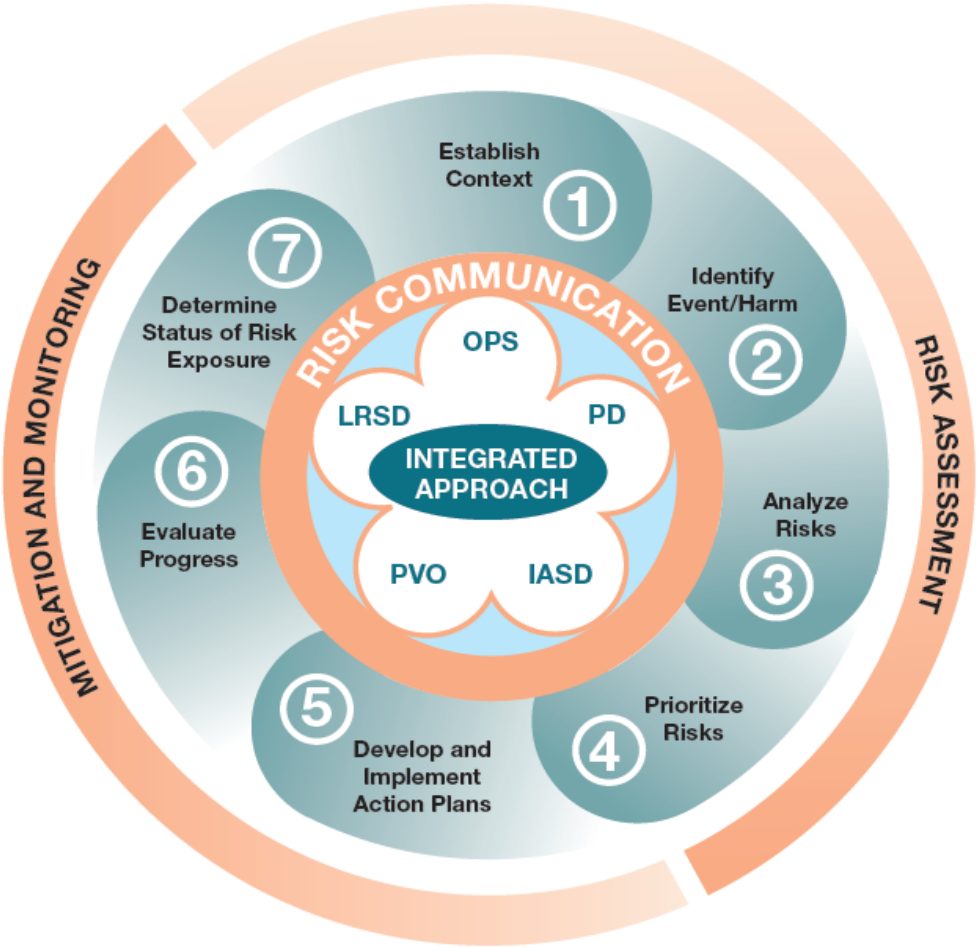
Design issues

Worker

Simultaneous failure/absence of risk controls could cause a "catastrophic event"

Integrated Risk Management

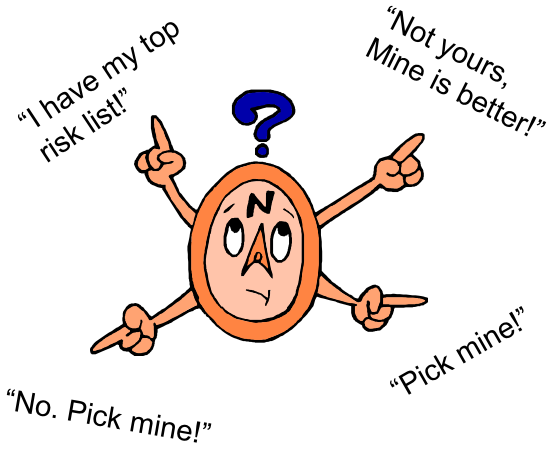
Agreement on an Integrated Risk Management (IRM) framework is the foundation for proceeding with the risk project



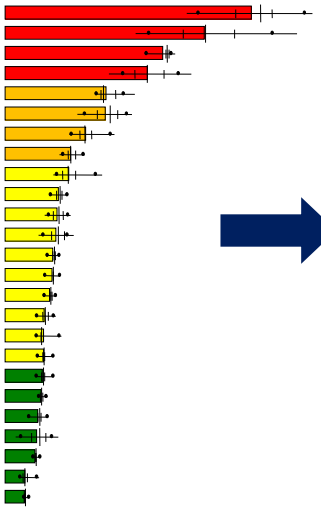
The IRM framework adopted draws from other frameworks (E.g. ISO 31000 and COSO) and is particularly suited to the role of a public regulator

Risk Assessment is at the Sector Level

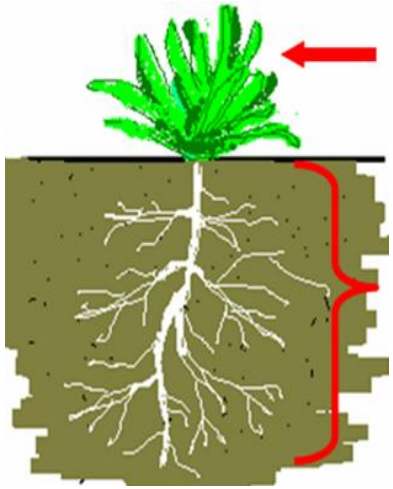
Highest Risks?



Workshop results



Root-Cause Analysis



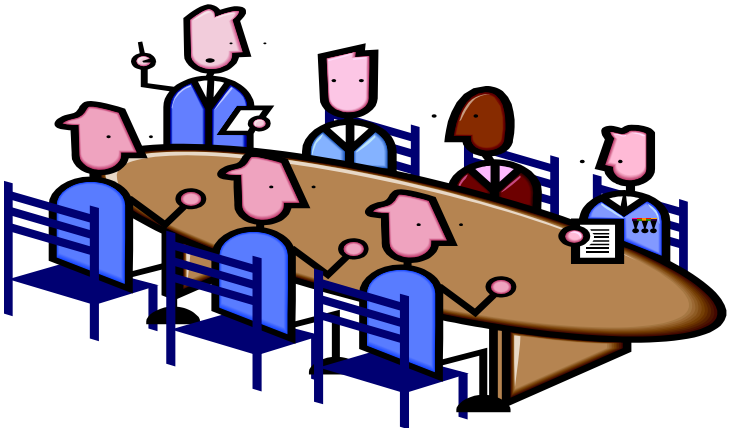
Symptom of the problem: "Weed" (Obvious)

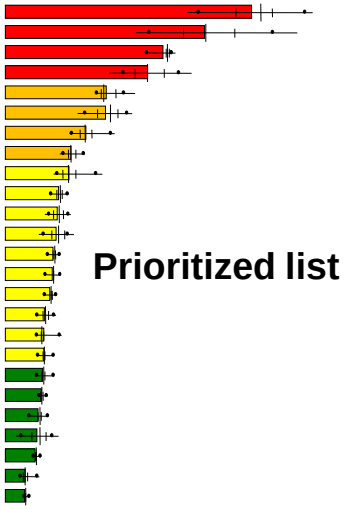
Underlying causes: "Root" – Below the surface (Not Obvious)

- **Harness collective wisdom across the sector in a bipartite process to focus the industry, workers and their representatives, HSAs, and the regulator on the most important risks to health and safety**
- **This approach draws on industry, labour, HSA, and ministry knowledge of risk and recognizes that one-size does not fit all**
- **We have identified and prioritized the risks to the sector. The real work starts NOW!**

Risk Assessment Workshop: Process

Sector Selection ⇨ SMEs Identified ⇨ Events Identified ⇨ Events Analyzed ⇨ Events Prioritized





Workshop is face-to-face. No teleconferencing.

Risk Assessment Workshop: A Bipartite & Collective Process

- **Workshop participants were peer-recognized subject matter experts:**
  - Participant list shared with and approved by Committee
- **Workshop process was open, transparent, and collaborative:**
  - Ensured that any perspective or viewpoint was heard
  - Each response received was respected and not freely edited
  - Final list shared with workshop participants before the workshop
- **Finding acceptable solutions that all members can support:**
  - Only Labour and Employer participants voted, not MOL or WSN
  - Process was NOT about consensus, although the results demonstrate a significant degree of convergence

Participant List: Subject Matter Experts

#	Name	Company/Representation
1	Bob Barclay	MOL
2	Gerald Allen	MOL
3	Pierre Lefebvre	MOL
4	Harsim Kalsi	MOL
5	Dwayne Plamondon	WSN
6	Robert Bianchin	Glencore/Employer*
7	John Daigle	Vale/Employer*
8	Dan Laing	First Nickel/Employer*
9	Jamie Mortson	Lake Shore/Employer*
10	Craig Allair	USW Local 6500/Labour*
11	Dave Stewart	Mine Mill Local 598/Labour*
12	Nick Larochelle	USW 6500/Labour*
13	Al Robb	Unifor/Labour*

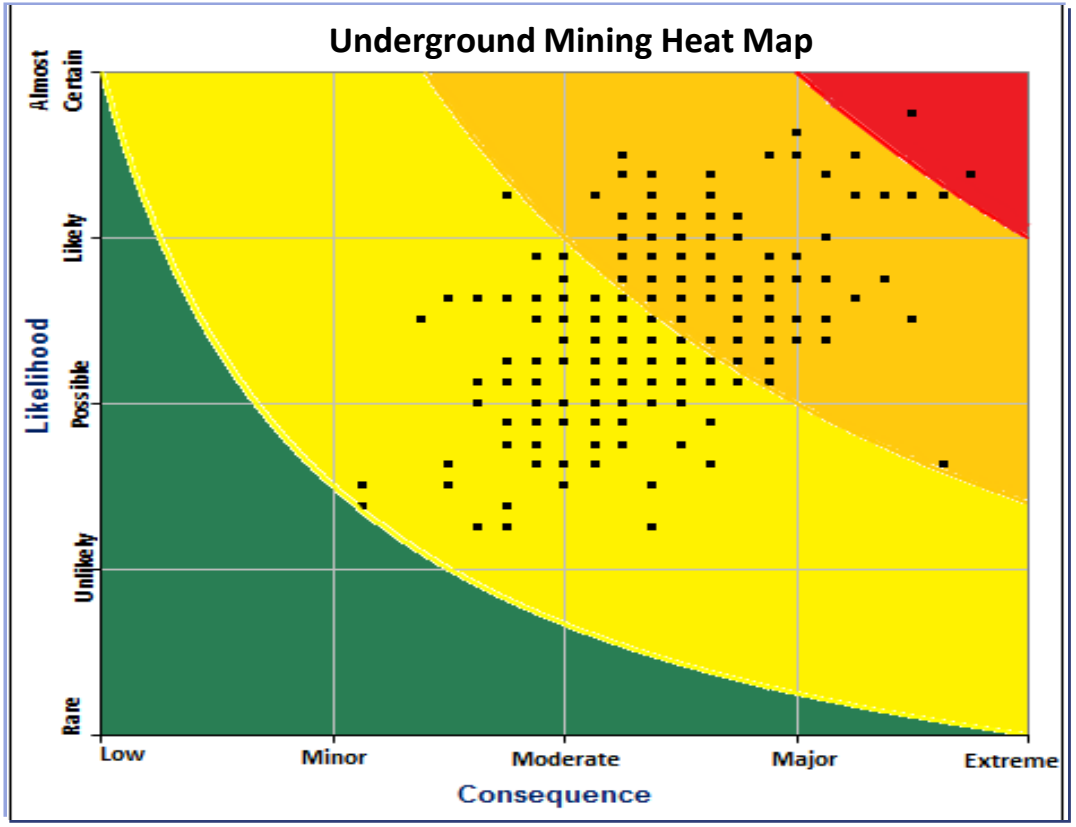
*** Voting Participant**

Events grouped into Categories: 29 Categories

1. Ground Control
2. Mobile Equipment
3. Mine Design
4. Water Management
5. Lockout/ Guarding
6. Occupational Disease
7. Ventilation
8. Electrical
9. Emergency Preparedness
10. Explosives/ Blasting
11. Falls
12. Shaft Work
13. Hoisting
14. Training
15. Ergonomics
16. Infrastructure
17. Fatigue
18. Inquest
19. IRS
20. JHSC
21. Lighting
22. Management of Change/ New Technology
23. Mine Services
24. MLRC
25. MOL
26. Raise Development
27. Reporting
28. Research
29. Stockpiles

*** This list is not in any order of priority**

Underground Mining: Heat Map (Labour+Employer)



Risk Rating
Critical
High
Moderate
Low

LIKELIHOOD	DESCRIPTION
Almost Certain (5)	**Expected to Occur** [more than once per year]
Likely (4)	**Will Probably Occur** [every 1 to 5 years]
Possible (3)	**Might Occur** [every 5 to 10 years]
Unlikely (2)	**Could Occur** [every 10 to 100 years]
Rare (1)	**May Occur** [once ever]

CONSEQUENCE	DESCRIPTION
Extreme (5)	**Fatality or Permanent Disability**
Major (4)	**Lost Time Injury/ Illness or Extensive Injury/ Illness**
Moderate (3)	**Restricted Work Injury/ Illness or Medical Treatment Required**
Minor (2)	**First Aid Treatment Injury/ Illness**
Low (1)	**No injury/ Illness**

Underground Mining: Top 10 Categories

- **These are the top 10 categories and their highest risk within that category**

#	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?
1	**Ground control**	Rock bursts underground
2	**Mobile Equipment**	Large vehicle and pedestrian or small vehicle interaction is common and lethal
3	**Occ. Disease**	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)
4	**Fatigue**	Working Shiftwork resulting in disrupted sleeping patterns.
5	**Training**	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.
6	**Ventilation**	Little in the way of controls on diesel equipment operating in certain areas. No way for workers to know how much equipment is working in any given area. Diesel emissions now a recognized cause of cancer.
7	**Lockout/ Guarding**	Failure to isolate energy as a result of inappropriate lockout/tagging
8	**Mine Services**	Working from a scoop-tramp bucket (i.e.. For fan installation and the provision of other services)
9	**Water Management**	Run of muck due to water in an ore pass
10	**Hoisting**	Lack of proper signals when hoisting

Underground Mining: Top 10 Risks (Labour+Employer)

- **These are the top 10 risks out of a total of 263 identified events**

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
1	Ground control	Rock bursts underground	4.75	0.66	4.50	0.50	**21.38**
2	Mobile Equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	4.38	0.70	4.75	0.43	**20.81**
3	Ground control	Loose rock at the face continues to kill and injure workers UG	4.25	0.97	4.63	0.48	**19.68**
4	Ground Control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability	4.50	0.71	4.25	1.09	**19.13**
5	Ground control	High faces not scaled and secured to protect workers	4.25	0.97	4.50	0.50	**19.13**
6	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	4.25	0.66	4.38	0.48	**18.62**
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	4.63	0.70	4.00	0.71	**18.52**
8	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns	4.63	0.48	4.00	0.87	**18.52**
9	Ground control	Fall of ground while installing ground support	4.38	0.86	4.13	0.60	**18.09**
10	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	4.38	0.70	4.13	1.05	**18.09**

sd = Standard Deviation

Underground Mining: Top Risks by Category

1. Ground Control: Top 10 of 28 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
1	Ground control	Rock bursts underground.	**4.75**	0.66	**4.50**	0.50	**21.38**
3	Ground control	Loose rock at the face continues to kill and injure workers UG	**4.25**	0.97	**4.63**	0.48	**19.68**
4	Ground control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability.	**4.50**	0.71	**4.25**	1.09	**19.13**
5	Ground control	High faces not scaled and secured to protect workers.	**4.25**	0.97	**4.50**	0.50	**19.13**
9	Ground control	Fall of ground while installing ground support.	**4.38**	0.86	**4.13**	0.60	**18.09**
11	Ground control	High faces not supported for ground falls.	**4.25**	0.97	**4.25**	0.66	**18.06**
18	Ground control	Exposure to unsupported ground while working on a scissor lift.	**3.88**	0.93	**4.00**	0.87	**15.52**
24	Ground control	Lack of procedures related to ground support installation, or poorly trained workers.	**3.75**	1.09	**4.00**	0.71	**15.00**
25	Ground control	Rehab of damaged areas.	**4.00**	0.87	**3.75**	0.83	**15.00**
29	Ground control	No legislated protection of workers at face. Face is not required to be bolted and screened like walls and back.	**3.75**	1.71	**3.88**	1.17	**14.55**

Underground Mining: Top Risks by Category

2. Mobile Equipment: Top 10 of 23 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
2	Mobile equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	**4.38**	0.70	**4.75**	0.43	**20.81**
6	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	**4.25**	0.66	**4.38**	0.48	**18.62**
95	Mobile equipment	Mobile Equipment contact with Personnel	**3.25**	0.66	**3.88**	0.78	**12.61**
115	Mobile equipment	Driving a scoop into an open stope & falling into the stope.	**2.63**	0.99	**4.63**	0.99	**12.18**
116	Mobile equipment	Wheels and rims, multi-piece rim assembly hazards	**3.13**	1.17	**3.88**	0.78	**12.14**
131	Mobile/ stationary equipment *	Improper tugger hoist inspections.	**3.38**	0.99	**3.38**	0.99	**11.42**
134	Mobile equipment	Lack of proper maintenance of brakes and fire suppression systems	**3.25**	0.83	**3.50**	0.71	**11.38**
141	Mobile equipment	Lack of traffic control systems.	**3.63**	1.22	**3.13**	0.60	**11.36**
150	Mobile equipment	Poor road conditions.	**3.88**	1.05	**2.88**	0.78	**11.17**
159	Mobile equipment	Lack of FOPs fall on protection and maintenance of. No established remote control program	**3.13**	0.78	**3.50**	1.00	**10.96**

* Mobile/ stationary equipment

Underground Mining: Top Risks by Category

3. Mine Design: Top 10 of 23 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
55	Mine design	Intersection of diamond drill holes, improper notification, improper plugging and labelling.	**4.00**	1.00	**3.38**	0.86	**13.52**
81	Mine design	Lack of Break through warnings.	**3.63**	0.48	**3.50**	1.00	**12.71**
85	Mine Design	No secondary egress	**3.38**	1.11	**3.75**	1.20	**12.68**
86	Mine design	Poor backfill quality or improper practices when mining under or against backfill.	**3.75**	1.20	**3.38**	1.32	**12.68**
96	Mine design	Accesses/Egress are too small for emergency personnel to remove an injured worker or if required wear breathing apparatus.	**3.25**	0.83	**3.88**	0.93	**12.61**
104	Mine design	Poor selection of equipment for mining processes (i.e. insufficient clearances)	**3.50**	1.00	**3.50**	0.71	**12.25**
153	Mine design	Failure of fill fences due to inadequate design or installation.	**3.38**	1.32	**3.25**	1.09	**10.99**
154	Mine design	Lack of required De-stressing techniques	**3.25**	0.83	**3.38**	0.70	**10.99**
167	Mine Design	Reliance on non-current standards	**3.13**	0.78	**3.38**	0.86	**10.58**
168	Mine design	Lack of engineering standards and lack of information on prints.	**3.13**	0.60	**3.38**	0.70	**10.58**

Underground Mining: Top Risks by Category

4. Water Management: Top 9 of 9 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
17	Water management	Run of muck due to water in an ore pass.	**3.50**	0.71	**4.50**	1.00	**15.75**
32	Water management	Water and slimes accumulation in drifts making it possible for it to enter ore/waste passes.	**3.50**	1.22	**4.13**	1.05	**14.46**
72	Water management	Ineffective water management program.	**3.88**	0.93	**3.38**	0.99	**13.11**
105	Water management	Insufficient pumping capacity	**3.50**	0.71	**3.50**	1.00	**12.25**
192	Water management	Diamond drill holes intersecting ore/waste passes	**3.13**	1.17	**3.25**	1.09	**10.17**
196	Water management	Poor procedures for placing hydraulic backfill leading to failure of bulkead or fill fence.	**3.00**	1.12	**3.38**	0.70	**10.14**
202	Water management	Lack of control over effluent discharge from workings.	**3.13**	1.17	**3.13**	1.17	**9.80**
214	Water management	Insufficient planning for spring run-off	**3.00**	0.87	**3.13**	0.78	**9.39**
245	Water management	Ineffective underground dams to hold settling water.	**2.75**	0.97	**2.88**	0.78	**7.92**

Underground Mining: Top Risks by Category

5. Lockout/ Guarding: Top 10 of 15 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
14	Lockout/ Guarding	Failure to isolate energy as a result of inappropriate lockout/tagging	**4.00**	0.71	**4.13**	0.60	**16.52**
15	Lockout/ Guarding	Workers caught by or impacted by release of stored energy	**3.75**	0.66	**4.38**	0.70	**16.43**
40	Lockout/ Guarding	Lack of lockout practices in relation to conveyors, operation and maintenance.	**3.75**	0.66	**3.75**	0.43	**14.06**
41	Lockout/ Guarding	Caught in rotating or moving equipment	**3.50**	0.87	**4.00**	1.00	**14.00**
46	Lockout/ Guarding	Plugged backfill lines – sudden rupture or hazards during removal of pipe blockages.	**3.75**	1.20	**3.63**	0.86	**13.61**
52	Lockout/ Guarding	Lack of guarding for conveyors.	**3.50**	0.87	**3.88**	0.93	**13.58**
66	Lockout/ Guarding	Lack of lockout and tagging related to installation of mine services (i.e. air, water, ventilation, and backfill lines)	**3.50**	0.71	**3.75**	0.43	**13.13**
67	Lockout/ Guarding	Lack of machine guarding (i.e. at all points of contact with moving parts have been identified and controlled)	**3.50**	0.71	**3.75**	0.66	**13.13**
73	Lockout/ Guarding	Insufficient fail safe measures for Lockout /Guarding	**3.38**	0.70	**3.88**	0.33	**13.11**
118	Lockout/ Guarding	Lack of design and procedures related to operation of jaw crushers dealing with tramp material.	**3.38**	0.99	**3.50**	1.00	**11.83**

Underground Mining: Top Risks by Category

6. Occupational Disease: Top 10 of 18 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	**4.63**	0.70	**4.00**	0.71	**18.52**
42	Occ. Disease	Lack of dust control, water, dust suppressants, improper maintenance of dust collectors.	**4.00**	0.71	**3.50**	0.71	**14.00**
47	Occ. disease	Designated substances list is not expanding with science. Many substances have been proven to be harmful in recent years and are not tested for. Also hard for workers to get a control program in place once designated substances are known to be in the workplace.	**3.75**	0.83	**3.63**	1.11	**13.61**
87	Occ. disease	Whole body vibration on modern equipment is resulting in long term illnesses with workers underground	**3.38**	1.32	**3.75**	0.97	**12.68**
98	Occ. Disease	The majority of the underground mines currently operating in Ontario are gold mines. Gold ores are typically hosted in geological environments characterized by high silica content. Excessive exposure to dust generated in such mining environments can result in silicosis.	**3.38**	1.22	**3.63**	0.86	**12.27**
132	Occ. Disease	Lack of medical surveillance program.	**3.38**	0.99	**3.38**	0.70	**11.42**
135	Occ. Disease	Lack of adherence to the designated substance program.	**3.25**	1.09	**3.50**	0.87	**11.38**
142	Occ. Disease	Mucking dry causing dust issues	**3.63**	1.32	**3.13**	0.78	**11.36**
148	Occ. Disease	Ministry of Labour Mining Health and Safety Inspectors do not have access to the same level of technical (i.e. engineering and hygienist) support that they had in the past. In many cases, they do not have sufficient technical support to be able to adequately fulfill their inspection and enforcement responsibilities.	**3.75**	1.30	**3.00**	1.22	**11.25**
184	Occ. Disease	Areas not identified for adequate hearing protection.	**3.63**	0.99	**2.88**	0.60	**10.45**

Underground Mining: Top Risks by Category

7. Ventilation: Top 9 of 9 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
12	Ventilation	Little in the way of controls on diesel equipment operating in certain areas. No way for workers to know how much equipment is working in any given area. Diesel emissions now a recognized cause of cancer.	**4.50**	0.87	**4.00**	0.87	**18.00**
62	Ventilation	Heat and Humidity at lower mining depths	**4.25**	0.66	**3.13**	0.60	**13.30**
68	Ventilation	Improper closure of unventilated manways, drifts and access ways that pose a danger to a worker.	**3.50**	0.71	**3.75**	0.83	**13.13**
133	Ventilation	With increasing electricity costs in Ontario, at present, one of the biggest expenditures incurred by underground mines operating in the province is that of electric power. One of the biggest uses of electricity in underground mines involves operating fans for ventilation purposes. In an effort to reduce power consumption, some mine operators may be tempted to reduce air flows to active areas of mines. Reduced air flows can result in poor air quality. Prolonged worker exposure to poor air quality can lead to a number of industrial diseases.	**3.38**	0.86	**3.38**	0.70	**11.42**
136	Ventilation	Ineffective fire drills.	**3.50**	0.87	**3.25**	1.20	**11.38**
176	Ventilation	Lack of ventilation i.e. over reliance on natural ventilation	**3.25**	1.09	**3.25**	0.66	**10.56**
185	Ventilation	Lack of controls for encounters with explosive gases, methane.	**2.88**	0.93	**3.63**	1.11	**10.45**
208	Ventilation	Worker exposure to noxious atmosphere	**3.25**	0.66	**3.00**	0.71	**9.75**
241	Ventilation	Asphyxiation in backfilled areas.	**2.63**	0.86	**3.13**	1.36	**8.23**

Underground Mining: Top Risks by Category

8. Electrical: Top 5 of 5 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
56	Electrical	Worker contact with electricity or arc flash	**3.38**	0.70	**4.00**	1.00	**13.52**
57	Electrical	Contact with overhead power lines.	**3.38**	0.48	**4.00**	1.00	**13.52**
143	Electrical	Outdated electrical equipment.	**3.63**	0.99	**3.13**	0.93	**11.36**
161	Electrical	Location of electrical cable/trolley being struck by machinery.	**3.50**	0.71	**3.13**	0.78	**10.96**
249	Electrical	Use of new power feeders in the absence of armour	**2.63**	1.11	**3.00**	1.00	**7.89**

Underground Mining: Top Risks by Category

9. Emergency Preparedness: Top 10 of 15 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
21	Emergency Preparedness	Serious U/G fire resulting in fatalities.	**3.63**	1.11	**4.25**	1.30	**15.43**
23	Emergency Preparedness	Lack of second means of egress or second egress can be kilometers away from work areas with only one way in and out.	**3.88**	0.93	**3.88**	0.93	**15.05**
44	Emergency Preparedness	Inadequate Emergency preparedness in remoter work sites such as surface Diamond Drills, exploration work and gravel pits can turn a lesser injury into a fatality from mere delayed response.	**3.38**	0.99	**4.13**	0.93	**13.96**
69	Emergency Preparedness	Poor housekeeping leading to possible mine fires.	**3.75**	0.83	**3.50**	1.00	**13.13**
88	Emergency Preparedness	No Critical injury protocol in place (transportation).	**3.38**	0.70	**3.75**	0.83	**12.68**
89	Emergency Preparedness	Insufficient number of refuge stations in expanding mines	**3.38**	0.70	**3.75**	0.97	**12.68**
119	Emergency Preparedness	Insufficient working alone program.	**3.38**	0.99	**3.50**	0.87	**11.83**
122	Emergency Preparedness	Suitable number of fire extinguishers strategically located.	**3.63**	0.86	**3.25**	0.97	**11.80**
137	Emergency Preparedness	Welding without appropriate burning permits.	**3.50**	1.12	**3.25**	0.97	**11.38**
144	Emergency Preparedness	Not Meeting all requirements for regulation 854 section 281.1 and Reg 1101 (First Aid).	**3.13**	0.60	**3.63**	1.22	**11.36**

Underground Mining: Top Risks by Category

10. Explosives/ Blasting: Top 10 of 24 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
37	Explosives/ blasting	Lack of inspection by a supervisor when drilling and blasting are occurring.	**3.88**	0.60	**3.63**	0.86	**14.08**
53	Explosives/ blasting	Blasting hung up drawpoints resulting in a run of muck.	**3.88**	0.78	**3.50**	0.71	**13.58**
70	Explosives/ blasting	Having to contend with frozen blast.	**3.75**	0.97	**3.50**	1.12	**13.13**
74	Explosives/ blasting	Lack of controlled blasting techniques to minimize loose and improve effectiveness of ground support.	**3.88**	0.93	**3.38**	0.86	**13.11**
99	Explosives/ blasting	Not ensuring site is clear/ guarded prior to blasting.	**3.38**	0.48	**3.63**	0.99	**12.27**
106	Explosives/ blasting	Improper face preparation resulting in detonation of remaining explosives (mishole).	**3.50**	0.87	**3.50**	1.22	**12.25**
110	Explosives/ blasting	Drilling into a bootleg.	**3.75**	0.83	**3.25**	1.30	**12.19**
128	Explosives/ blasting	Fly-rock damage.	**4.25**	0.97	**2.75**	0.97	**11.69**
138	Explosives/ blasting	Improper Priming procedures (Snap, slap and shoot- reverse priming)	**3.50**	1.32	**3.25**	0.97	**11.38**
145	Explosives/ blasting	Radios and communication systems used around explosives.	**3.63**	1.32	**3.13**	1.17	**11.36**

Underground Mining: Top Risks by Category

11. Falls: Top 7 of 7 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
27	Falls	Mounting and dismounting from mobile equipment	**4.38**	0.70	**3.38**	0.99	**14.80**
28	Falls	Slipping hazards in parking lots during winter months.	**4.50**	1.00	**3.25**	0.66	**14.63**
63	Falls	Falling from an open raise while installing a work staging.	**3.63**	0.86	**3.63**	1.32	**13.18**
75	Falls	Lack of ladder safety program.	**3.88**	0.93	**3.38**	0.70	**13.11**
100	Falls	Lack of guarding at open holes.	**3.63**	0.99	**3.38**	1.11	**12.27**
111	Falls	Falls from shaft conveyances	**3.25**	0.66	**3.75**	1.48	**12.19**
156	Falls	Working on grizzlies.	**3.25**	1.20	**3.38**	0.99	**10.99**

Underground Mining: Top Risks by Category

12. Shaft Work: Top 9 of 9 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
38	Shaft work	Inappropriate hoisting and slinging of equipment in shaft.	**3.88**	0.78	**3.63**	0.99	**14.08**
48	Shaft work	Lack of protection for workers working below.	**3.75**	0.83	**3.63**	0.99	**13.61**
76	Shaft work	Poor condition of Shaft guides, conveyances, and ladders.	**3.88**	0.60	**3.38**	0.99	**13.11**
90	Shaft work	Travelling in a sinking bucket.	**3.38**	0.99	**3.75**	1.09	**12.68**
112	Shaft work	Lack of thorough shaft inspections.	**3.75**	0.83	**3.25**	0.83	**12.19**
146	Shaft work	Mucking shaft bottom.	**3.63**	1.22	**3.13**	1.05	**11.36**
157	Shaft work	Poor condition of shaft loading pockets and controls.	**3.38**	0.70	**3.25**	1.09	**10.99**
230	Shaft work	Ground instability of shaft.	**3.25**	0.83	**2.75**	0.66	**8.94**
238	Shaft work	Lack of provision for safe location of skip tenders	**2.50**	1.22	**3.38**	0.99	**8.45**

Underground Mining: Top Risks by Category

13. Hoisting: Top 9 of 9 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
19	Hoisting	Lack of proper signals when hoisting.	**4.13**	0.93	**3.75**	0.97	**15.49**
20	Hoisting	More underground mines in Ontario are using programmable logic controls (i.e. P.L.C.'s) to operate mine hoists. Such mines often rely on suppliers to commission hoists utilizing P.L.C.'s and do not have in-house subject matter experts who are familiar with this new technology. Moreover, Ministry of Labour Mining Health and Safety Inspectors lack knowledge in this area. Improper use of P.L.C.'s can result in unintended or uncontrolled movements of shaft conveyances. Such events have the potential to result in multiple fatalities.	**3.75**	1.20	**4.13**	1.05	**15.49**
71	Hoisting	Lack of proper hoist maintenance program.	**3.75**	0.66	**3.50**	0.87	**13.13**
107	Hoisting	Improper slinging of equipment in shaft improperly, rigging, load drops.	**3.50**	0.87	**3.50**	0.87	**12.25**
113	Hoisting	Damaged hoist ropes.	**3.75**	0.66	**3.25**	0.83	**12.19**
120	Hoisting	Inadvertent spilling of hoist rope outside of designated compartment	**3.50**	0.87	**3.38**	1.11	**11.83**
123	Hoisting	Incompetent hoist operators.	**3.25**	0.66	**3.63**	0.99	**11.80**
127	Hoisting	Shaft Conveyances being pulled through upper limits	**3.13**	0.78	**3.75**	1.09	**11.74**
213	Hoisting	Use of second-hand hoists	**3.63**	0.70	**2.63**	1.32	**9.55**

Underground Mining: Top Risks by Category

14. Training: Top 10 of 16 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
10	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	**4.38**	0.70	**4.13**	1.05	**18.09**
13	Training	Standards not being followed.	**4.50**	0.50	**3.88**	0.93	**17.46**
26	Training	Lack of communication of dangerous condition (i.e. not reported in logbook).	**4.13**	0.78	**3.63**	0.99	**14.99**
33	Training	Lack of competent personnel.	**4.13**	0.60	**3.50**	1.32	**14.46**
34	Training	Training not complete before supervisory duties commence	**4.25**	0.97	**3.38**	0.70	**14.37**
79	Training	Lack of procedures implemented communicated and enforced.	**4.00**	0.87	**3.25**	0.83	**13.00**
121	Training	Routine operating procedures are designed to protect the employer rather than be simple and effective to practice	**3.38**	0.70	**3.50**	0.87	**11.83**
124	Training	Inappropriate application of MTCU Signing Authority.	**3.63**	0.86	**3.25**	1.09	**11.80**
125	Training	Poor monitoring or communication during backfill placement operations.	**3.63**	1.11	**3.25**	0.83	**11.80**
170	Training	Driving a scoop into a drawpoint, beyond the brow, into a longhole stope.	**3.38**	0.99	**3.13**	1.27	**10.58**

Underground Mining: Top Risks by Category

15. Ergonomics: Top 2 of 2 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
30	Ergonomics	Inadequate design for equipment	**4.00**	0.71	**3.63**	0.48	**14.52**
45	Ergonomics	Inappropriate Manual Material handling.	**4.13**	0.78	**3.38**	0.70	**13.96**

16. Infrastructure: Top 2 of 2 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
60	Infrastructure	Infrastructure (i.e. processing plants, shafts, hoisting plants, head-frames, access ramps and ore passes) at some aging underground mines in Ontario has not been well maintained, or is still in use well beyond its designed life expectancy.	**4.13**	0.60	**3.25**	1.09	**13.42**
151	Infrastructure	Lack of inspection and verification of all ore and waste passes.	**3.88**	0.60	**2.88**	1.17	**11.17**

Underground Mining: Top Risks by Category

17. Fatigue: Top 1 of 1 identified event

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
8	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns.	**4.63**	0.48	**4.00**	0.87	**18.52**

18. Inquest: Top 2 of 2 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
35	Inquest	Coroner inquest recommendations are not binding	**4.38**	0.70	**3.25**	1.39	**14.24**
58	Inquest	Coroner's inquest recommendations not being tracked or followed province wide.	**4.00**	1.00	**3.38**	1.49	**13.52**
218	Inquest	Lack of mining sector expertise of the coroner and jury members	**3.63**	0.99	**2.50**	1.22	**9.08**

Underground Mining: Top Risks by Category

19. IRS: Top 7 of 7 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
49	IRS	Effectiveness of behaviour based safety programs	**3.63**	0.99	**3.75**	1.30	**13.61**
50	IRS	Lack of workers ability to stop work without fear of reprisal. (i.e. Workers cannot stop unsafe work).	**3.75**	0.97	**3.63**	1.11	**13.61**
59	IRS	The Internal Responsibility System (i.e. the I.R.S.) is declining in the Ontario Mining Sector. The success of a health and safety system in any workplace is highly contingent on an effective I.R.S.	**4.00**	0.87	**3.38**	0.99	**13.52**
91	IRS	Lack of identification of all workplace hazards based on the activities of the operation.	**3.75**	0.66	**3.38**	0.70	**12.68**
97	IRS	In a global economy, changes in ownership of mining companies operating in Ontario are becoming more frequent. In some cases, new owners of mining companies bring health and safety cultures that are significantly different from those established by previous owners.	**3.88**	0.93	**3.25**	1.20	**12.61**
129	IRS	There exist variable and divergent opinions throughout the Ontario Mining Sector on what is meant by the I.R.S.	**3.88**	0.93	**3.00**	1.12	**11.64**
237	IRS	No formal health and safety management system in place.	**2.75**	1.20	**3.13**	1.05	**8.61**

Underground Mining: Top Risks by Category

20. JHSC: Top 4 of 4 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
43	JHSC	Lack of management response to outstanding issues identified by the JHSC.	**4.00**	0.71	**3.50**	1.32	**14.00**
108	JHSC	Joint health and safety committees in the Ontario Mining Sector are in some cases not permitted to fulfill the responsibilities afforded to them under the Occupational Health and Safety Act. Effective joint health and safety committees are an essential component of a workplace health and safety system.	**3.50**	1.00	**3.50**	1.32	**12.25**
173	JHSC	JHSC's lack the subject matter expertise to identify, assess, and control workplace hazards	**3.38**	0.48	**3.13**	1.05	**10.58**
226	JHSC	JHSC's are not permitted to conduct regular safety inspections.	**2.88**	0.93	**3.13**	1.17	**9.01**

21. Lighting: Top 2 of 2 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
39	Lighting	Inadequate lighting for identifying ground conditions and installing ground support	**3.88**	0.93	**3.63**	0.99	**14.08**
139	Lighting	Inadequate illumination from personal headlamps and insufficient luminance for equipment.	**3.50**	1.00	**3.25**	1.09	**11.38**

Underground Mining: Top Risks by Category

22. Management of Change/ New Technology: Top 3 of 3 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
22	Management of Change/ New technology	Legislation not keeping up with technology (i.e. collision avoidance systems, ventilation on-demand, anti-vibration technology.	**4.25**	0.66	**3.63**	1.32	**15.43**
51	Management of change/ New technology	Lack of common standard for safely introducing new technology	**3.75**	0.97	**3.63**	0.99	**13.61**
77	Management of Change/ New technology	Addition of new technology/equipment/processes in the absence of a health and safety review	**3.88**	0.60	**3.38**	0.86	**13.11**

23. MLRC: Top 1 of 1 identified event

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
101	MLRC	Dysfunctional (ineffective) MLRC	**3.63**	1.11	**3.38**	1.32	**12.27**

Underground Mining: Top Risks by Category

24. Mine Services: Top 5 of 5 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
16	Mine services	Working from a scoop-tramp bucket (i.e.. For fan installation and the provision of other services)	**4.38**	0.70	**3.63**	0.99	**15.90**
80	Mine services	Lack of identification of all services (i.e. air, water, electrical, and fuel).	**4.00**	0.87	**3.25**	0.83	**13.00**
92	Mine services	Hanging heavy fans and being struck by the fan.	**3.75**	0.83	**3.38**	0.70	**12.68**
114	Mine services	Failure to call before digging at sites where there is natural gas, propane, high-pressure air lines.	**3.75**	0.66	**3.25**	1.20	**12.19**
209	Mine services	Flammability of plastics mine piping and the resulting toxic materials that are admitted	**3.25**	1.20	**3.00**	1.12	**9.75**

Underground Mining: Top Risks by Category

25. MOL: Top 10 of 10 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
61	MOL	Out of date regs	**4.13**	0.60	**3.25**	0.97	**13.42**
78	MOL	Lack of MOL technical support (engineering and hygiene)	**3.88**	0.93	**3.38**	1.22	**13.11**
82	MOL	Ministry of Labour lacks strong presence in the workplace. Ministry inspectors understaffed and overworked.	**3.63**	1.22	**3.50**	1.32	**12.71**
109	MOL	Lack of ability to deal with new technology	**3.50**	0.71	**3.50**	1.12	**12.25**
140	MOL	Inconsistency in enforcement.	**3.25**	1.39	**3.50**	1.32	**11.38**
147	MOL	Lack of managerial competency and support	**3.63**	0.48	**3.13**	0.93	**11.36**
149	MOL	Out of date guidelines	**3.75**	0.66	**3.00**	1.22	**11.25**
165	MOL	No preoperational review by MOL to ensure program elements for hazards identified and H&S policy and program in place.	**3.63**	0.99	**3.00**	1.12	**10.89**
166	MOL	Blitz approach not effective	**3.63**	0.70	**3.00**	1.00	**10.89**
200	MOL	Inadequate inspector training	**3.50**	1.00	**2.88**	1.05	**10.08**

Underground Mining: Top Risks by Category

26. Raise Development: Top 5 of 5 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
83	Raise Development	Inadequate supervision for raise inspections	**3.63**	0.86	**3.50**	1.00	**12.71**
93	Raise Development	Ground instability in raises	**3.75**	0.66	**3.38**	0.99	**12.68**
102	Raise Development	Lack of face support in raises developed by raise climbers	**3.63**	0.86	**3.38**	1.22	**12.27**
234	Raise Development	Lack of Raise climbers' inspections.	**3.00**	0.87	**2.88**	1.05	**8.64**
243	Raise Development	Disposal of raise bore cuttings	**3.13**	1.17	**2.63**	1.11	**8.23**

Underground Mining: Top Risks by Category

27. Reporting: Top 2 of 2 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
130	Reporting	Not all unusual occurrences occurring in the Ontario Mining Sector that are required to be reported to the Ministry of Labour under Regulation 854, are actually reported.	**3.88**	0.60	**3.00**	1.00	**11.64**
163	Reporting	Discontinued compilation and distribution of unusual occurrence information by MOL	**3.50**	1.32	**3.13**	1.05	**10.96**

28. Research: Top 1 of 1 identified event

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
199	Research	There is not enough legitimate research being done into mining health and safety in Ontario.	**3.38**	1.22	**3.00**	1.12	**10.14**

Underground Mining: Top Risks by Category

29. Stockpiles: Top 4 of 4 identified events

Overall Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	L		C		Risk
			L	sd-L	C	sd-C	
64	Stockpiles	Lack of controls when working around stockpiles or surge piles (winter freeze up)	**3.63**	0.70	**3.63**	0.70	**13.18**
84	Stockpiles	Inadvertent movement of bulk materials as a result of withdrawal, collapse or shifting of material.	**3.63**	0.70	**3.50**	0.71	**12.71**
103	Stockpiles	Inappropriate management of stockpiles (i.e. natural angle of repose, sampling methods, height, inspection, berms)	**3.63**	0.70	**3.38**	0.70	**12.27**
158	Stockpiles	Insufficient High Stockpile safety	**3.25**	0.66	**3.38**	0.70	**10.99**

Appendix A: Labour vs. Employer - Top 10

Labour

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Mobile equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	23.75
2	Emergency Preparedness	Serious U/G fire resulting in fatalities.	23.75
3	Hoisting	More underground mines in Ontario are using programmable logic controls (i.e. P.L.C.'s) to operate mine hoists. Such mines often rely on suppliers to commission hoists utilizing P.L.C.'s and do not have in-house subject matter experts who are familiar with this new technology. Moreover, Ministry of Labour Mining Health and Safety Inspectors lack knowledge in this area. Improper use of P.L.C.'s can result in unintended or uncontrolled movements of shaft conveyances. Such events have the potential to result in multiple fatalities.	23.75
4	Ground control	Loose rock at the face continues to kill and injure workers UG	22.56
5	Ground control	High faces not scaled and secured to protect workers.	22.56
6	Ground control	Rock bursts underground.	22.50
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	21.38
8	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	21.38
9	Management of Change/ New technology	Legislation not keeping up with technology (i.e. collision avoidance systems, ventilation on-demand, anti-vibration technology.	21.38
10	Ventilation	Little in the way of controls on diesel equipment operating in certain areas. No way for workers to know how much equipment is working in any given area. Diesel emissions now a recognized cause of cancer.	21.25

Employer

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Ground control	Rock bursts underground.	20.25
2	Ground Control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability.	18.06
3	Mobile equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	18.00
4	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns.	17.81
5	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	17.00
6	Ground control	Loose rock at the face continues to kill and injure workers UG	16.88
7	Falls	Slipping hazards in parking lots during winter months.	16.25
8	Ground control	High faces not supported for ground falls.	15.94
9	Ground control	High faces not scaled and secured to protect workers.	15.94
10	Ground control	Fall of ground while installing ground support.	15.94

Common events in the Top 10

Appendix B: Labour vs. (Labour+Employer) - Top 10

Labour

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Mobile equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	23.75
2	Emergency Preparedness	Serious U/G fire resulting in fatalities.	23.75
3	Hoisting	More underground mines in Ontario are using programmable logic controls (i.e. P.L.C.'s) to operate mine hoists. Such mines often rely on suppliers to commission hoists utilizing P.L.C.'s and do not have in-house subject matter experts who are familiar with this new technology. Moreover, Ministry of Labour Mining Health and Safety Inspectors lack knowledge in this area. Improper use of P.L.C.'s can result in unintended or uncontrolled movements of shaft conveyances. Such events have the potential to result in multiple fatalities.	23.75
4	Ground control	Loose rock at the face continues to kill and injure workers UG	22.56
5	Ground control	High faces not scaled and secured to protect workers.	22.56
6	Ground control	Rock bursts underground.	22.50
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	21.38
8	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	21.38
9	Management of Change/ New technology	Legislation not keeping up with technology (i.e. collision avoidance systems, ventilation on-demand, anti-vibration technology.	21.38
10	Ventilation	Little in the way of controls on diesel equipment operating in certain areas. No way for workers to know how much equipment is working in any given area. Diesel emissions now a recognized cause of cancer.	21.25

Labour + Employer

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Ground control	Rock bursts underground.	21.38
2	Mobile Equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	20.81
3	Ground control	Loose rock at the face continues to kill and injure workers UG	19.68
4	Ground control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability.	19.13
5	Ground control	High faces not scaled and secured to protect workers.	19.13
6	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	18.62
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	18.52
8	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns.	18.52
9	Ground control	Fall of ground while installing ground support.	18.09
10	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	18.09

Common events in the Top 10

Appendix C: Employer vs. (Labour+Employer) - Top 10

Employer

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Ground control	Rock bursts underground.	20.25
2	Ground Control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability.	18.06
3	Mobile equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	18.00
4	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns.	17.81
5	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	17.00
6	Ground control	Loose rock at the face continues to kill and injure workers UG	16.88
7	Falls	Slipping hazards in parking lots during winter months.	16.25
8	Ground control	High faces not supported for ground falls.	15.94
9	Ground control	High faces not scaled and secured to protect workers.	15.94
10	Ground control	Fall of ground while installing ground support.	15.94

Labour + Employer

Risk Rank	Category	Situation or Condition or Factor that could result in Injury or Illness OR What could keep you up at night?	Risk
1	Ground control	Rock bursts underground.	21.38
2	Mobile Equipment	Large vehicle and pedestrian or small vehicle interaction is common and lethal	20.81
3	Ground control	Loose rock at the face continues to kill and injure workers UG	19.68
4	Ground Control	Existing underground mines in Ontario are becoming deeper and incurring higher extraction ratios. These situations can result in various forms of ground instability.	19.13
5	Ground control	High faces not scaled and secured to protect workers.	19.13
6	Mobile Equipment	The mobile equipment employed in many underground mines is getting bigger. Bigger equipment can often result in poorer operator visibility (i.e. more and larger blind spots). This can result in collisions with other vehicles or contact with pedestrians.	18.62
7	Occ. Disease	Exposure to hazardous substances(dusts, materials, metals), gases/ fumes, biological materials or forms, Physical Hazards (vibration, noise, heat/cold stress, light.)	18.52
8	Fatigue	Working Shiftwork resulting in disrupted sleeping patterns.	18.52
9	Ground control	Fall of ground while installing ground support.	18.09
10	Training	Supervisors in some mines in Ontario lack the proper experience and Training. Inexperienced and improperly trained supervisors pose a threat to themselves and their direct-report workers.	18.09

Common events in the Top 10

Appendix D: Risk Assessment Approaches

1. Fault Tree Analysis (FTA)
2. Failure Mode and Effect Analysis (FMEA)
3. International Organization for Standardization (ISO 31000:2009)
4. Committee of Sponsoring Organizations of the Treadway Commission (COSO)
5. Global Minerals Industry Risk Management (GMIRM)
6. Canadian Standards Association Risk Assessment (CSA Z1002)
7. Hazard and Operability (HAZOP)
8. Computer Hazard and Operability Studies (CHAZOP)
9. Preliminary Hazard Assessment or Preliminary Hazard Analysis (PHA)
10. Job Safety Analysis (JSA)
11. Construction Hazard Assessment and Implication Review (CHAIR)
12. Energy Barrier Analysis (also called Energy Trace Barrier Analysis)
13. Consequence Analysis (also called Cause-Consequence Analysis)
14. Human Error Analysis (HEA)
15. Workplace Risk Assessment and Control (WRAC)
16. Level of Protection Analysis (LOPA)