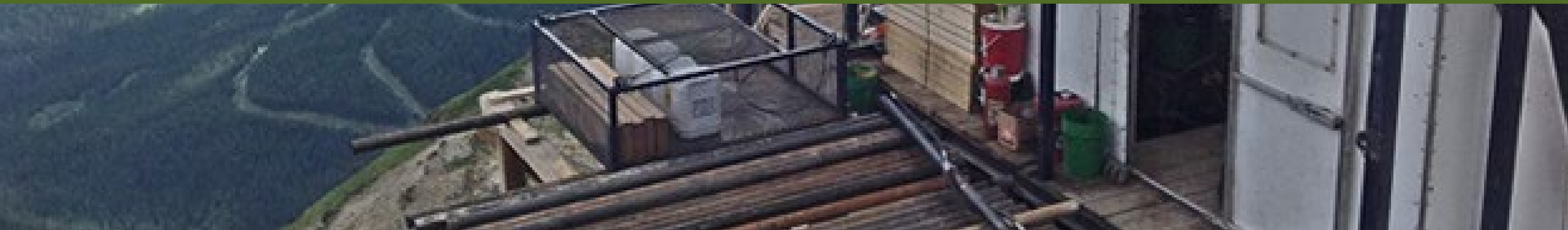
Surface Diamond Drilling Sector

Risk Assessment Report

A focused approach to improving workplace health and safety



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RA = risk assessment

SDD = Surface Diamond Drilling

Risk Assessment: Introduction

- **2013: MLITSD launched project to put in place an integrated risk assessment methodology to:**
  identify risks to worker health and safety & work with employers and workers on reducing those risks provide more information to employers, workers & their representatives about risks at the **SECTOR** level

With support of the Canadian Diamond Drilling Association, MLITSD and WSN planned and facilitated the **Surface Diamond Drilling Sector Risk Assessment**

- **Harness collective wisdom, across this sector nationally, in a tripartite process to focus the industry, health & safety associations (HSAs), and regulator on highest risks to health and safety**
- **Approach draws on industry, worker, HSA, & Ministry knowledge of risk and recognizes that one-size approach does not fit all**
- **The approach draws on empirical insights of risk management & operations research/decision science**

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Diamond Drilling is used in the mining industry to probe the contents of known ore deposits and potential sites. By withdrawing a small diameter core of rock from the orebody, Geologists can analyze the core by chemical assay and conduct petrologic, structural, and mineralogical studies of the rock

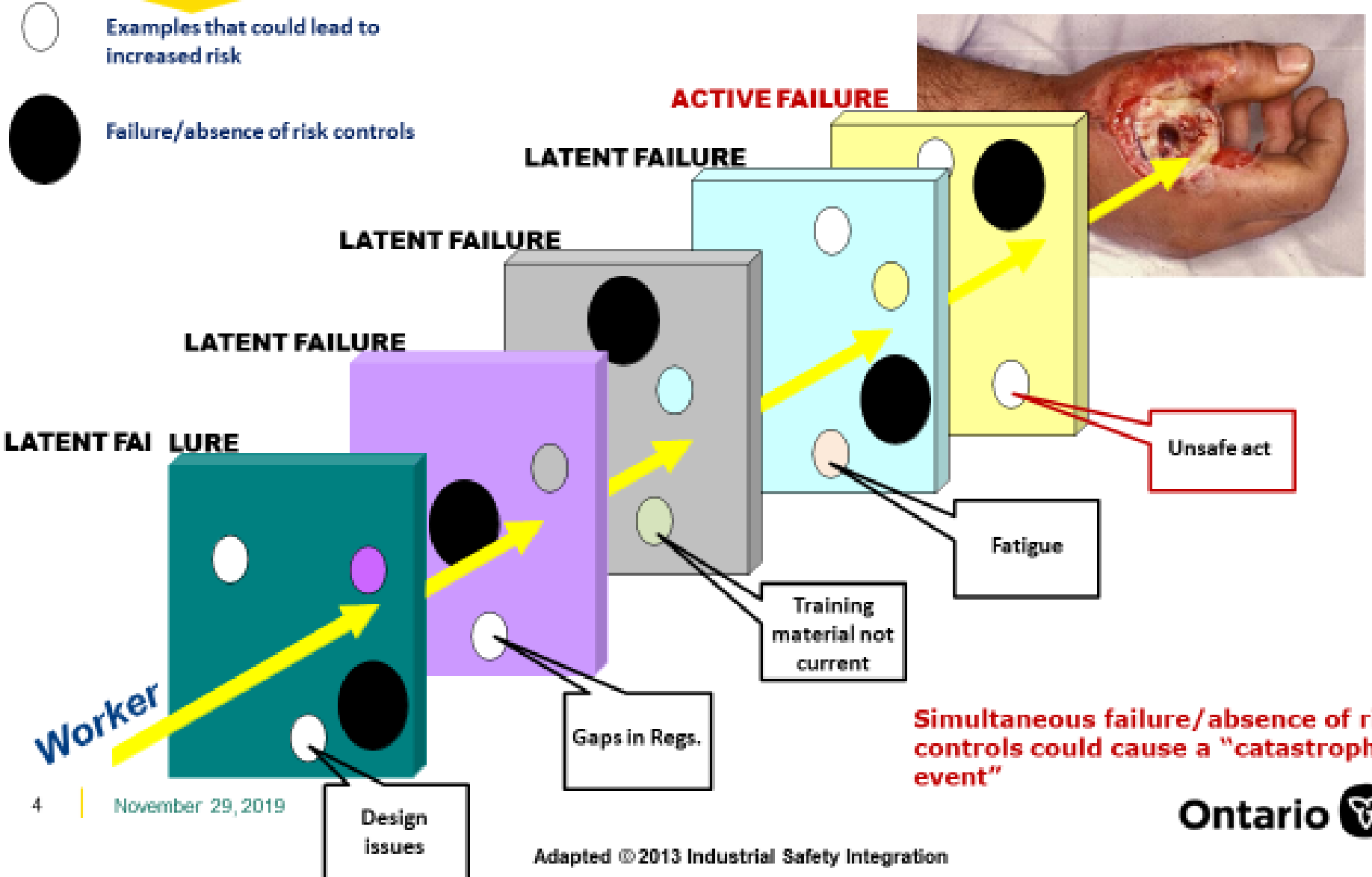
The focus of this risk assessment was surface diamond drilling

Prevention

The Swiss Cheese Model of Accident Causation

Examples that could lead to increased risk

Failure/absence of risk controls



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

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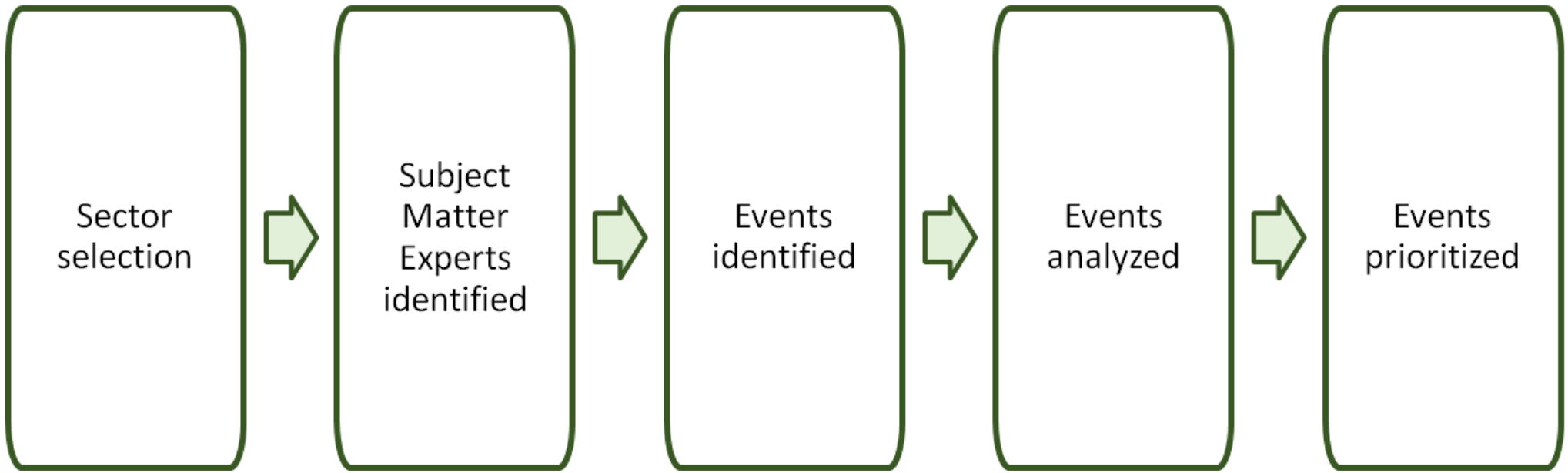
Ontario

Workshop: A Tripartite and Collective Process



Workshop: A Tripartite and Collective Process

Workshop process was open, transparent, and collaborative:

- Ensured any perspective or viewpoint was heard
- Each response received was respected and not freely edited
- Final list shared with workshop participants before the workshop
- Final workshop results reviewed/validated by industry participant
- Special recognition to participants from across Canada

Finding acceptable solutions that all members can support:

- Only industry experts ranked the risks, not government/HSA
- Process was NOT about consensus, although the results demonstrate a significant degree of convergence

Risk Assessment Committee

SUBJECT MATTER EXPERTS		
#	Name	Company/Representative
1	Shannon Bennett	JS Drilling, Ontario
2	Jim Butler	Hy-Tech Drilling, British Columbia
3	Gerry Cooke	Team Drilling, Saskatchewan
4	Clare Foladore	Vale – Exploration, Ontario
5	Wesley Keating	Hy-Tech Drilling, British Columbia
6	Kelly Lavis	Major Drilling, Saskatchewan
7	Barry Nabese	Hy-Tech Drilling, British Columbia
8	Mike Patenaude	Foraco, Ontario
9	Zach Purdy	Major Drilling, Manitoba
10	Ashton Van Gool	Team Drilling, Saskatchewan

WORKSHOP PARTICIPANTS		
#	Name	Company/Representative
11	Louise Lowe	Canadian Diamond Drilling Association
12	Scott Secord	Ministry of Labour, Immigration, Training & Skills Development
13	Harsim Kalsi	Ministry of Labour, Immigration, Training & Skills Development
14	Rick Schulist	Ministry of Labour, Immigration, Training & Skills Development
15	James Johnstone	Workplace Safety North: Facilitator
16	Tom Welton	Workplace Safety North: Director
17	Tiana Larocque	Workplace Safety North: Tech Support
18	Tricia Valentim	Workplace Safety North: Tech Support

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Risk Assessment Workshop: Event Categories

1. Planning
2. Environment
3. Drilling Process
4. Contact Hazards
5. Musculoskeletal Disorder Hazards
6. Vehicles and Driving

Risk Assessment: Prioritize risks

- The purpose of this stage is to assess the level of risk and establish risk priorities
- **Risk**, which is the **average Likelihood (L)** multiplied by the **average Consequence (C)** for each event, then is categorized with respective risk ratings using the **Risk Matrix (Heat Map)**

LIKELIHOOD	Low (1)	Minor (2)	Moderate (3)	Major (4)	Extreme (5)
Almost Certain (5)	5	10	15	20	25
Very Likely (4)	4	8	12	16	20
Likely (3)	3	6	9	12	15
Unlikely (2)	2	4	6	8	10
Rare (1)	1	2	3	4	5

CONSEQUENCE

Risk Matrix Result	Risk Rating
20 to 25	Critical
12 to 16	High
5 to 10	Moderate
1 to 4	Low

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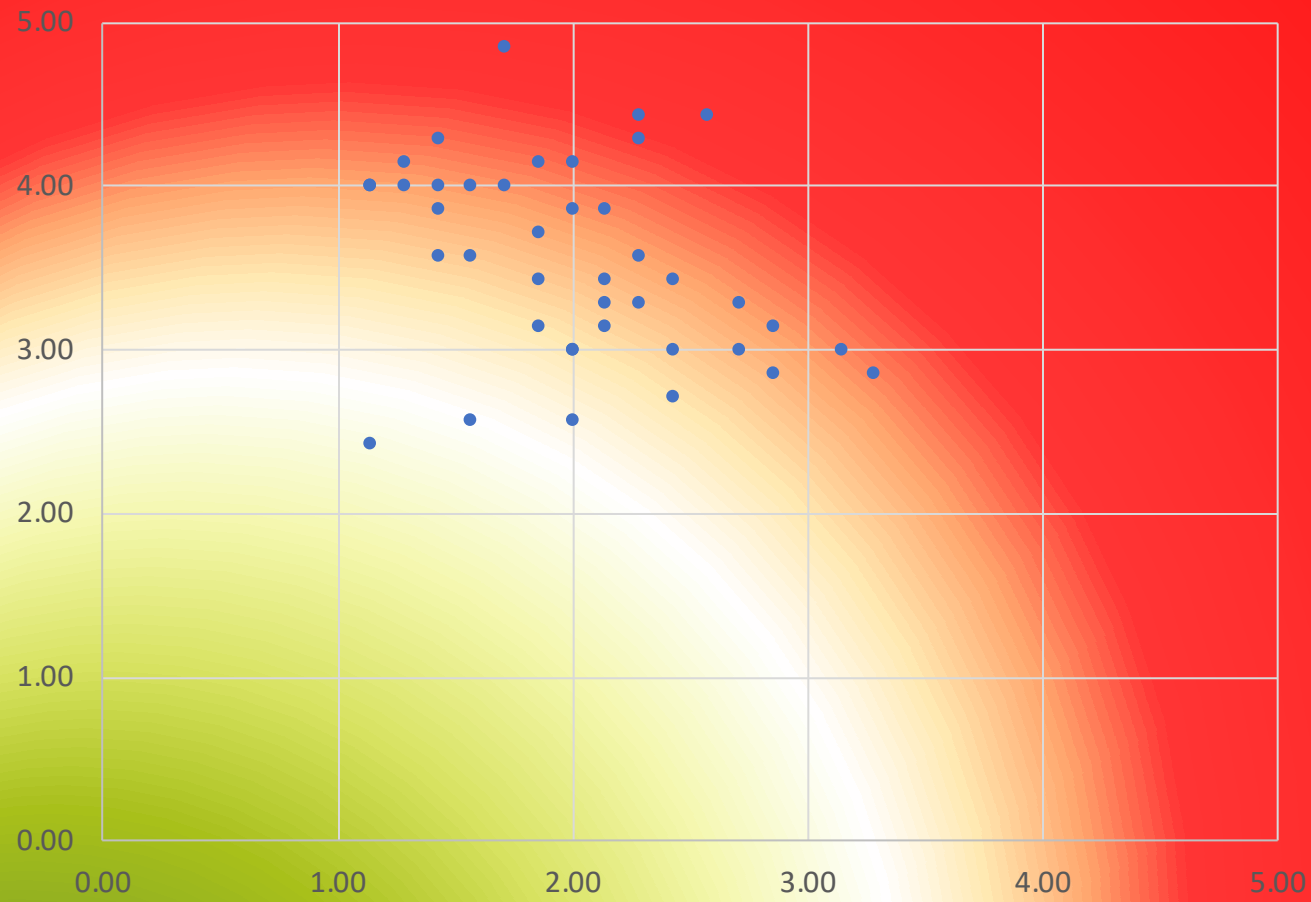
SDD Risk Assessment:

CONSEQUENCE	DESCRIPTION
Extreme [5]	**Fatality or Permanent Disability** [or extreme impact/importance]
Major [4]	**Serious Event/ Critical Injury or Critical Illness** [or major impact/importance]
Moderate [3]	**Temporary Disability (Lost Time): Injury/Illness** [or moderate impact/importance]
Minor [2]	**First Aid Treatment (No Lost Time)** [or minor impact/importance]
Low [1]	**No injury or Illness** [or negligible impact/importance]

LIKELIHOOD	DESCRIPTION
Almost Certain [5]	**Unwanted event is almost certain to happen in the next year** [or 90% or greater chance of occurrence]
Very Likely [4]	**High probability for unwanted event to occur in the next year** [or between 50%-90% chance of occurrence]
Likely [3]	**It is possible for unwanted event to occur in the next year** [or between 20%-50% chance of occurrence]
Unlikely [2]	**Low probability for unwanted event to occur in the next year** [or between 5%-20% chance of occurrence]
Rare [1]	**Very low probability for unwanted event to occur in the next year** [or less than 5% chance of occurrence]

Heat Map



SDD Risk Assessment: Top 10 of 41 identified events

Rank	Category	Event (Situation/Condition) that could result in Injury or Illness OR What could keep you up at night?
1	**Planning**	No timely emergency response to injured
2	**Environment**	Struck by Chicot (dead trees)
3	**Drilling Process**	Drilling on ice cover
4	**Contact Hazards**	Pinch Points
5	**Environment**	Exposure to extreme weather event, Contact or exposure to lightning event, over exposure to sun, contact with plant life or insects, contact with wildlife, contact by falling tree
6	**Musculoskeletal Disorder Hazards**	Repetitive work resulting in injury
7	**Vehicle & Driving**	Travel to and from drills by UTV and Snowmobiles
8	**Vehicle & Driving**	Travel (to, from and on drill sites) Drowsy driving
9	**Vehicle & Driving**	Helicopter material transport. Fly Program/Crew change, Crash and contact with rotating blades
10	**Vehicle & Driving**	Heavy duty mobile equipment

SDD Risk Assessment:

Top 10 risk categories based on highest risk within that category

Rank	Category	Event (Situation/Condition) that could result in Injury or Illness OR What could keep you up at night?	Likelihood	Consequence	Risk (LxC)
1	**Planning**	No timely emergency response to injured	2.57	4.43	**11.39**
2	**Environment**	Struck by Chicot (dead trees)	2.29	4.43	**10.12**
3	**Drilling Process**	Drilling on ice cover	2.29	4.29	**9.80**
4	**Contact Hazards**	Pinch Points	3.14	3.00	**9.43**
5	**Environment**	Exposure to extreme weather event, Contact or exposure to lightning event, over exposure to sun, contact with plant life or insects, contact with wildlife, contact by falling tree	3.29	2.86	**9.39**
6	**Musculoskeletal Disorder Hazards**	Repetitive work resulting in injury	2.86	3.14	**8.98**
7	**Vehicle & Driving**	Travel to and from drills by UTV and Snowmobiles	2.71	3.29	**8.92**
8	**Vehicle & Driving**	Travel (to, from and on drill sites) Drowsy driving	2.43	3.43	**8.33**
9	**Vehicle & Driving**	Helicopter material transport. Fly Program/Crew change, Crash and contact with rotating blades	1.71	4.86	**8.33**
10	**Vehicle & Driving**	Heavy duty mobile equipment	2.00	4.14	**8.29**

Appendix A: Workshop Process Details

1. A sector is identified and defined for risk assessment
2. Subject matter experts (SMEs) from the selected sector are identified
3. Each of the selected SME's list (identify) the situations or conditions (events) that could lead to injury or illness with appropriate evidence for each event (pre-workshop)
4. The lists are collected and amalgamated into one list (pre-workshop)
5. The amalgamated list is sent to each SME for review (pre-workshop)
6. A workshop is scheduled for the analysis and prioritization of each identified event on the amalgamated (final) list
7. Workshop conducted in blended face-to-face and videoconferencing format due to the sheer distances between participants nationally
8. For each identified event on the list, SMEs contribute toward a robust discussion, generating deeper objective understanding and allowing for all perspectives to be heard (comments are NOT attributed)
9. After each discussion for each identified event, each SME "votes" (based on identified criteria/scale) to lock in a value judgement on **likelihood of the event occurring** and **severity of the consequence if the event was to occur**
10. Electronic voting tools are used to make voting easy and anonymous; results on each event are instantaneous
11. Project manager takes results to create a risk profile/heat map for the sector
12. Results validation includes "smell test" by industry SMEs before releasing final results

Appendix B: Risk Assessment Processes/Standards

1. Bayesian Analysis
2. Bow-tie analysis
3. Brainstorming (e.g. what-if)
4. Business impact analysis
5. Cause and effect analysis
6. Checklists
7. Computer Hazard and Operability Studies (CHAZOP)
8. Consequence Analysis (also called Cause-Consequence Analysis)
9. Likelihood/Consequence matrix
10. Construction Hazard Assessment and Implication Review (CHAIR)
11. Decision tree
12. Delphi technique
13. Energy Barrier Analysis (or Energy Trace Barrier Analysis)
14. Environmental risk assessment
15. Event tree analysis
16. Failure Mode and Effect Analysis (FMEA)
17. Failure mode, effect and criticality analysis
18. Fault Tree Analysis
19. Fishbone (Ishikawa) Analysis
20. Hazard analysis and critical control points
21. Hazard and Operability studies (HAZOP)
22. Human reliability analysis
23. Job Safety Analysis (JSA)
24. Level of Protection Analysis (LOPA)
25. Markov analysis
26. Monte Carlo
27. Preliminary Hazard Analysis (PHA)
28. Reliability centered maintenance
29. Scenario analysis
30. Sneak circuit analysis
31. Structured/semi-structured interviews
32. SWIFT (i.e. structured what-if)
33. Systemic Cause Analysis Technique (SCAT)
34. Human Error Analysis (HEA)
35. Workplace Risk Assessment and Control (WRAC)

Risk Management Standards:

1. Risk Management Principles and Guidelines (ISO 31000:2009)
2. Risk Assessment Techniques (ISO/IEC 31010:2009)
3. OH&S Hazard Identification and Elimination and Risk Assessment and Control (CSA Z1002)
4. Process Safety Management (CSA Z767-17)
5. Enterprise Risk Management (COSO 2004)
6. Global Minerals Industry Risk Management (GMIRM)
7. International Council on Mining & Metals (ICMM)

*** Not an exhaustive list**

Appendix C: Contacts

For additional information or questions, please contact:

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