Provincial Battery Electric Vehicle Root Cause Analysis Workshop Results and Next Steps

A focused approach to improving workplace health and safety

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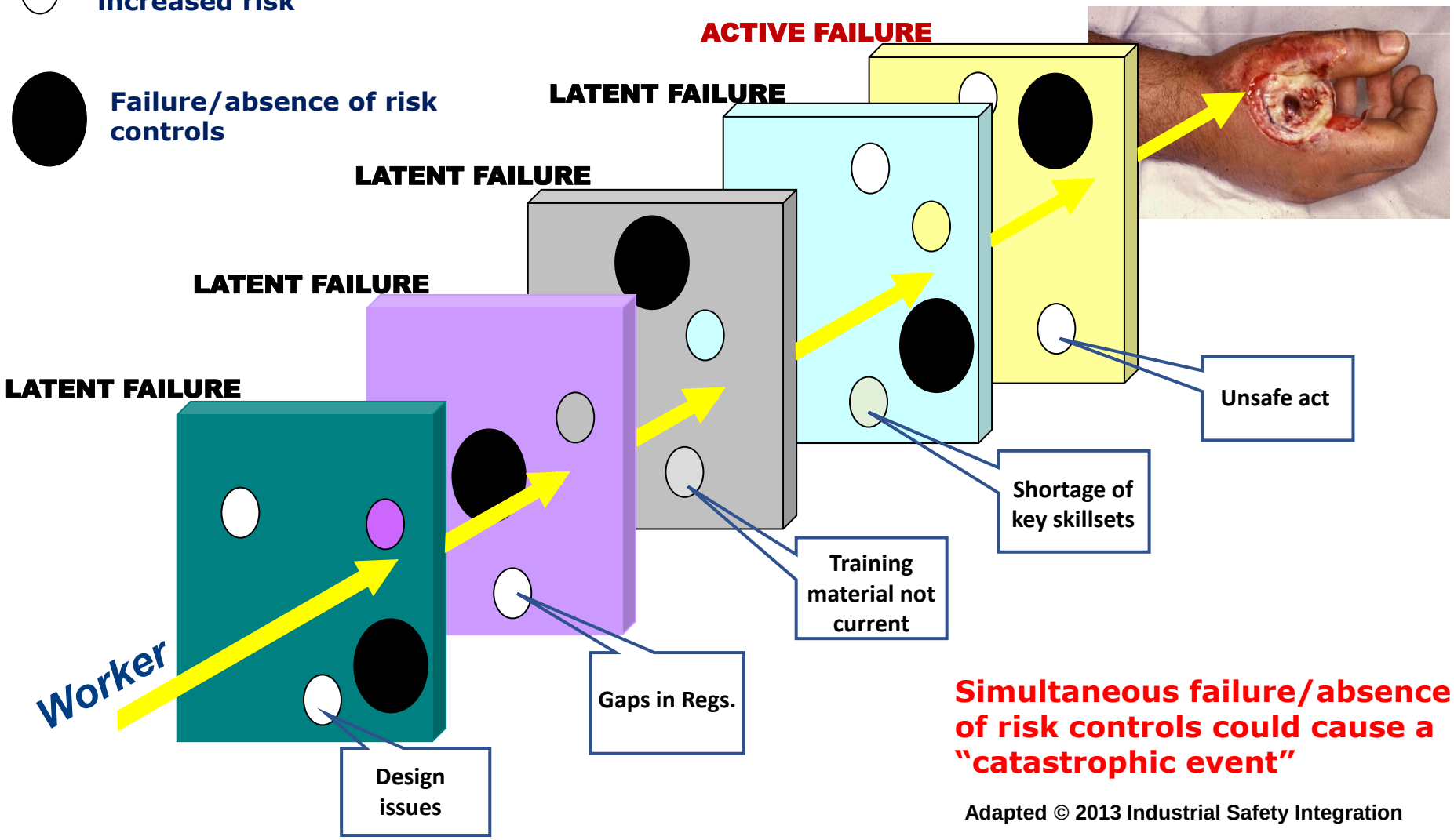
Risk Assessment Project

Examples that could lead to increased risk

Failure/absence of risk controls

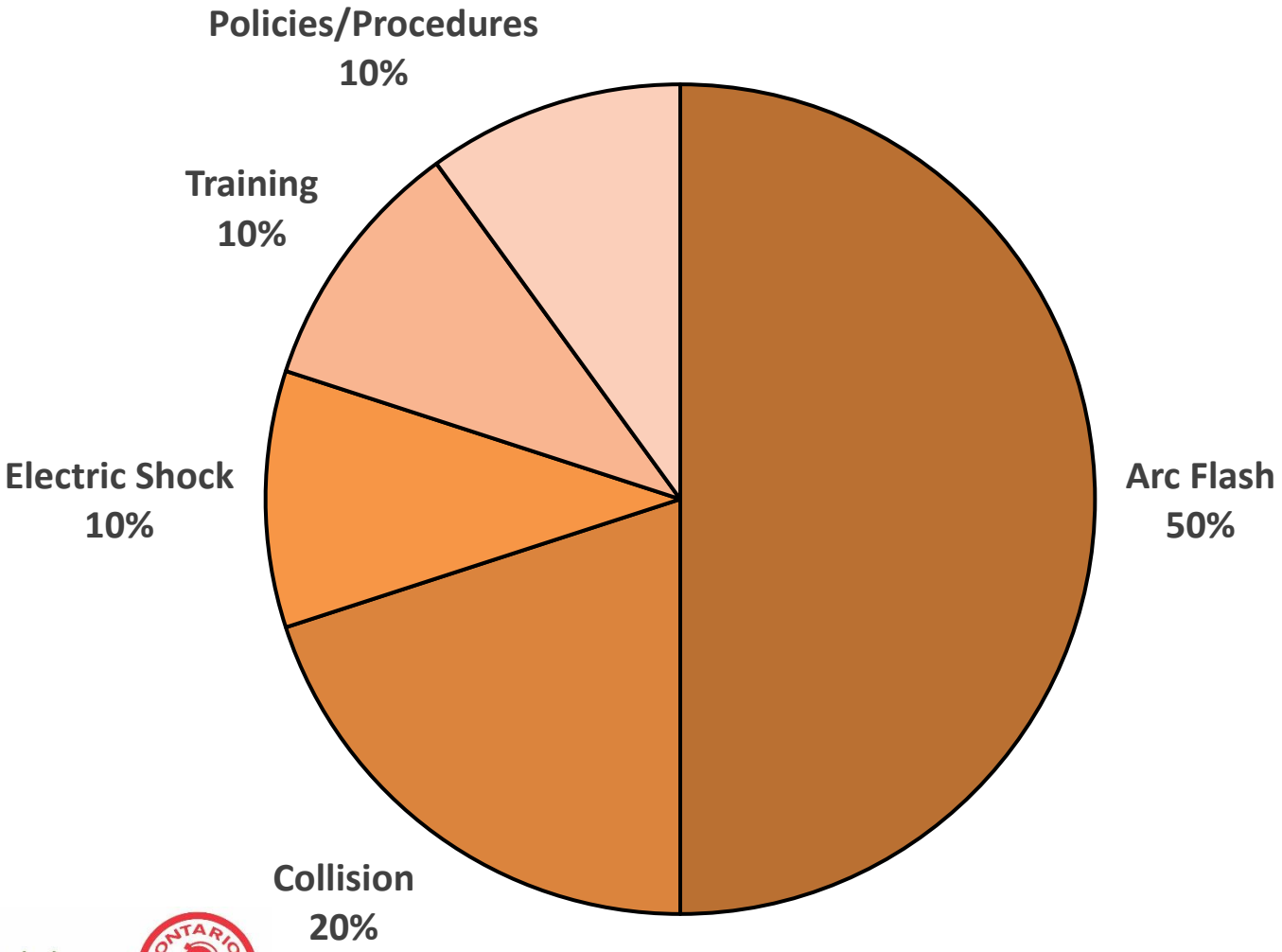


Simultaneous failure/absence of risk controls could cause a "catastrophic event"

BEV 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?
1	Collision	Personnel struck by battery electric equipment
2	Training	Lack of training for maintenance employees
3	Arc Flash	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Thermal runaway (fire), Arc Flash, Electric shock potentials (Improper live troubleshooting)
4	Arc Flash	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Thermal runaway (fire), Arc Flash, Electric shock potentials (Improper/unclear work delineation (worker assumes authorized to perform work on traditional work experience)
5	Policies/ procedures	There are no standardized industry regulations with regards to BEV charge stations and charge locations
6	Arc Flash	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Thermal runaway (fire), Arc Flash, Electric shock potentials (Inadequate specifications, standards, regulations - provincial)
7	Arc Flash	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Thermal runaway (fire), Arc Flash, Electric shock potentials (Inadequate management of change process)
8	Electric shock	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Electric shock
9	Arc Flash	Loss of control of a particular Li-Ion based battery chemical energy source; exposing personnel to: Thermal runaway (fire), Arc Flash, Electric shock potentials (Field repairs)
10	Collision	Inability to identify presence of an oncoming vehicle while traveling in a ramp system or around corners

Top 10 BEV Risks



Analysis of Top 10 Risks

Risks and undesired outcomes identified in the following overall ranking/categories

Risk Rank	Risk Category	Contributing Factor	Result
1	**Arc Flash**	• Improper live troubleshooting • Improper/unclear work delineation; worker assumes authorized to perform work on traditional work experience • Inadequate specifications, standards, regulations – provincial • Inadequate management of change process In field repairs	**Thermal runaway**
2	**Collision**	• Lower sound or awareness of nearby operation	**Collision with people or other equipment**
3	**Training**	• Lack of training for maintenance and operators	**Injury to worker** **Damage to equipment** **Loss of process**
4	**Policies and Procedures**	• No standardized industry regulations with regard to BEV charge stations and charge locations	**Inadequate management of change process**
5	**Electric Shock**	• Loss of control of a particular Li-Ion based battery chemical energy source	**Exposure to electric shock**

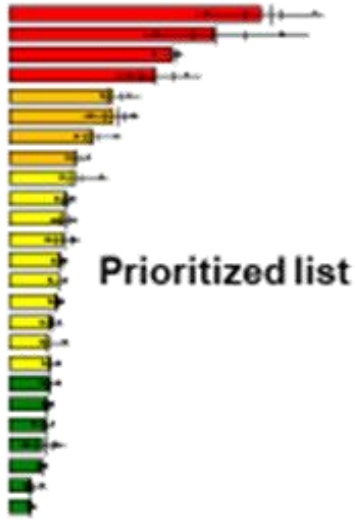
Root Cause Analysis: Risk Statement

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 Arc Flash or Thermal Runaway:

"Thermal Runaway event can result in unintended adverse effects on the wellbeing of workers."

Workshop: A Tripartite and Collective Process

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



Root Cause Analysis Workshop: Participants

SUBJECT MATTER EXPERTS		
#	Name	Company/Representative
1	Craig Allair	Vale (U.S.W., Local 6500)
2	Richard Genesse	Impala - Lac Des Iles (U.S.W. Local 9422)
3	Daniel Gareau	Glencore (UNIFOR Local 598)
4	Matthew Curtis	Newmont
5	Raphael Tiangco	Vale
6	Steven Holmik	Glencore

Worker Representation

Employer Representation

WORKSHOP PARTICIPANTS		
#	Name	Company/Representative
7	Derek Budge	Mining Legislative Review Committee
8	Malcolm Mills	Mining Legislative Review Committee
9	Bob Barclay	MLITSD: Senior Manager, Mining (observer)
10	Scott Secord	MLITSD: Inspector (observer)
11	Tom Welton	WSN: Facilitator
12	Tiana Larocque	WSN: Tech Support
13	Tricia Valentim	WSN: Tech Support

WSN: *Workplace Safety North*
MLITSD*: Ministry of Labour, Immigration, Training, and Skills Development*

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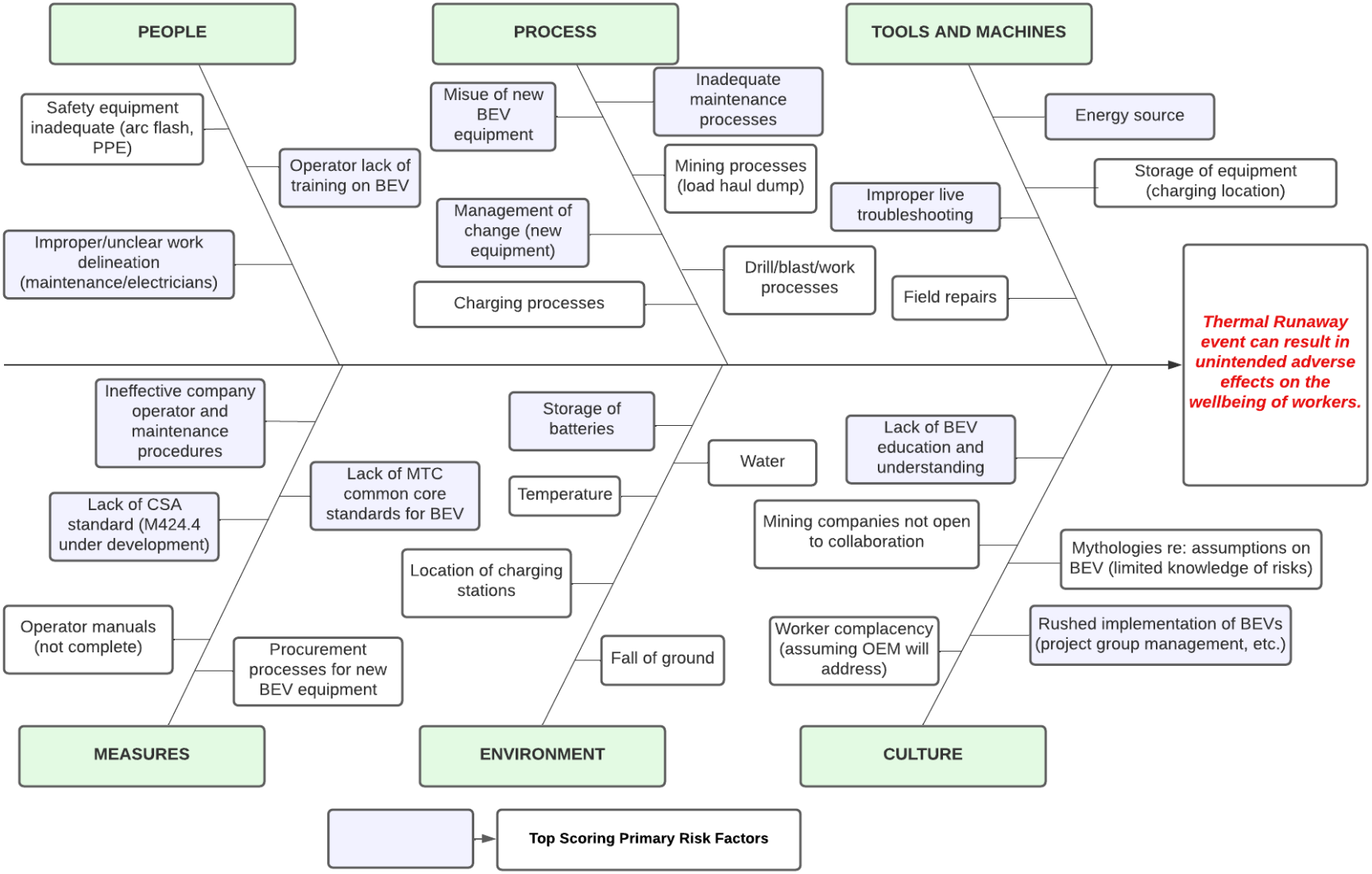
Workshop: A Tripartite and Collective Process

Workshop process was open, transparent, and collaborative:

- Ensured perspectives/viewpoints were heard
- Responses were respected, not freely edited
- Final list shared with participants before workshop
- Workshop results reviewed/validated by participants

Finding acceptable solutions that all members can support:

- Only industry experts ranked the risks
- Process was NOT about consensus (although results demonstrate a significant degree of convergence)


PEOPLE
PROCESS
TOOLS AND MACHINES
Safety equipment inadequate (arc flash, PPE)
Operator lack of training on BEV
Improper/unclear work delineation (maintenance/electricians)
Misue of new BEV equipment
Inadequate maintenance processes
Mining processes (load haul dump)
Management of change (new equipment)
Drill/blast/work processes
Charging processes
Energy source
Storage of equipment (charging location)
Improper live troubleshooting
Field repairs
Thermal Runaway event can result in unintended adverse effects on the wellbeing of workers.
Ineffective company operator and maintenance procedures
Lack of MTC common core standards for BEV
Lack of CSA standard (M424.4 under development)
Operator manuals (not complete)
Procurement processes for new BEV equipment
Storage of batteries
Water
Temperature
Location of charging stations
Fall of ground
Lack of BEV education and understanding
Mining companies not open to collaboration
Mythologies re: assumptions on BEV (limited knowledge of risks)
Worker complacency (assuming OEM will address)
Rushed implementation of BEVs (project group management, etc.)
MEASURES
ENVIRONMENT
CULTURE
Top Scoring Primary Risk Factors

Top Primary Causal Factors

- Inadequate maintenance processes
- Current lack of CSA standard for BEVs
- Ineffective management of change on new equipment
- Energy sources creating potential for electric shock
- Ineffective company operator and maintenance procedures
- Improper live troubleshooting on issues with BEV machines
- Operator lack of training on BEVs
- Lack of education and understanding of BEV safe use
- Misuse of new BEV equipment
- Rushed implementation of BEV use
- Lack of common core training standards for BEV use
- Improper or unclear work delineation for electricians and maintenance personnel
- Inadequate battery storage

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 **specified**, **observable**, **measurable** and **auditable.**

Next Steps: What should we focus on immediately?

Based on controls identified for the Top Primary Causal Factors, it would be beneficial, as a start, to focus right away on the following common systemic weaknesses:

- Current lack of a CSA standard for BEVs (CSA M424.4:22 Self-propelled, electrically driven, non-rail-bound mobile machines for use in non-gassy underground mines under development)
- Lack of modular training program Common Core standard for BEVs

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

Following a results presentation to the MLRC, a committee-specific BEV Subcommittee was established to 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
- Available legislation & standards

Thank you for attending today's webinar and helping make workplaces safer.

Questions?

Workshop Contact

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Workplace Safety North
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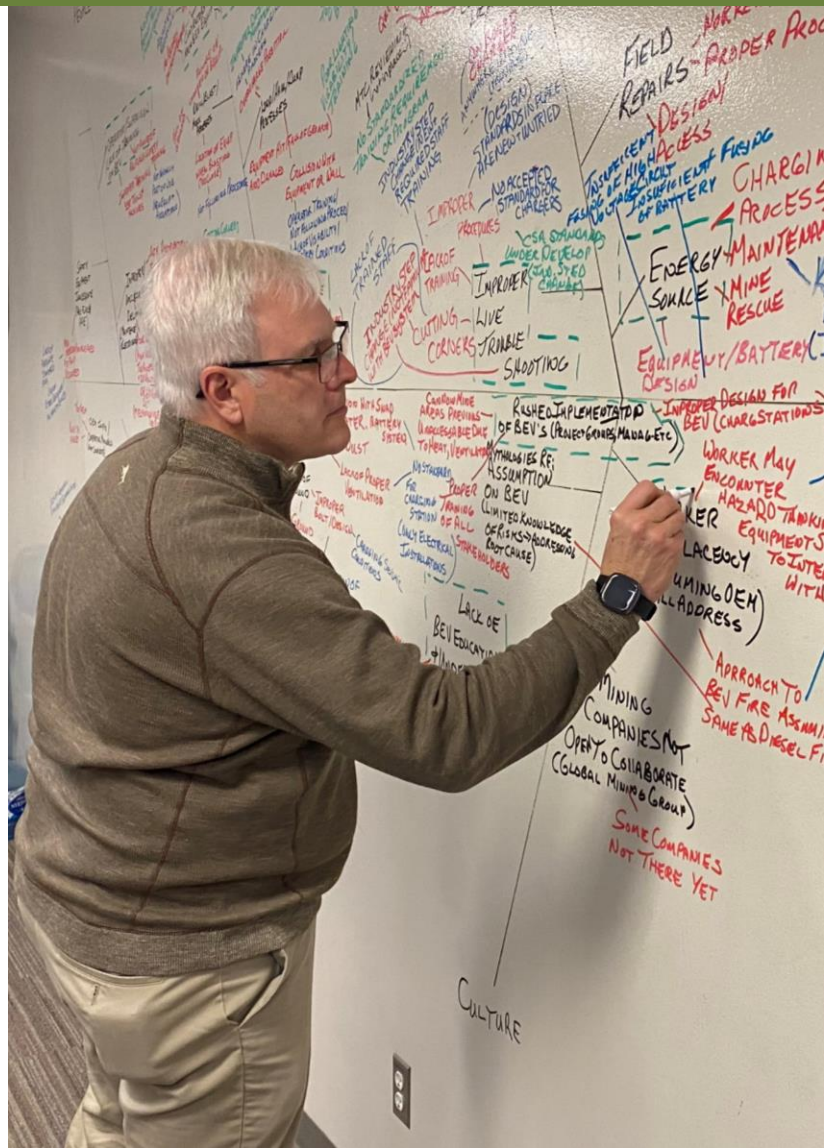

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