



Provincial Battery Electric Vehicle Root Cause Analysis Workshop Results

A focused approach to improving workplace health & safety

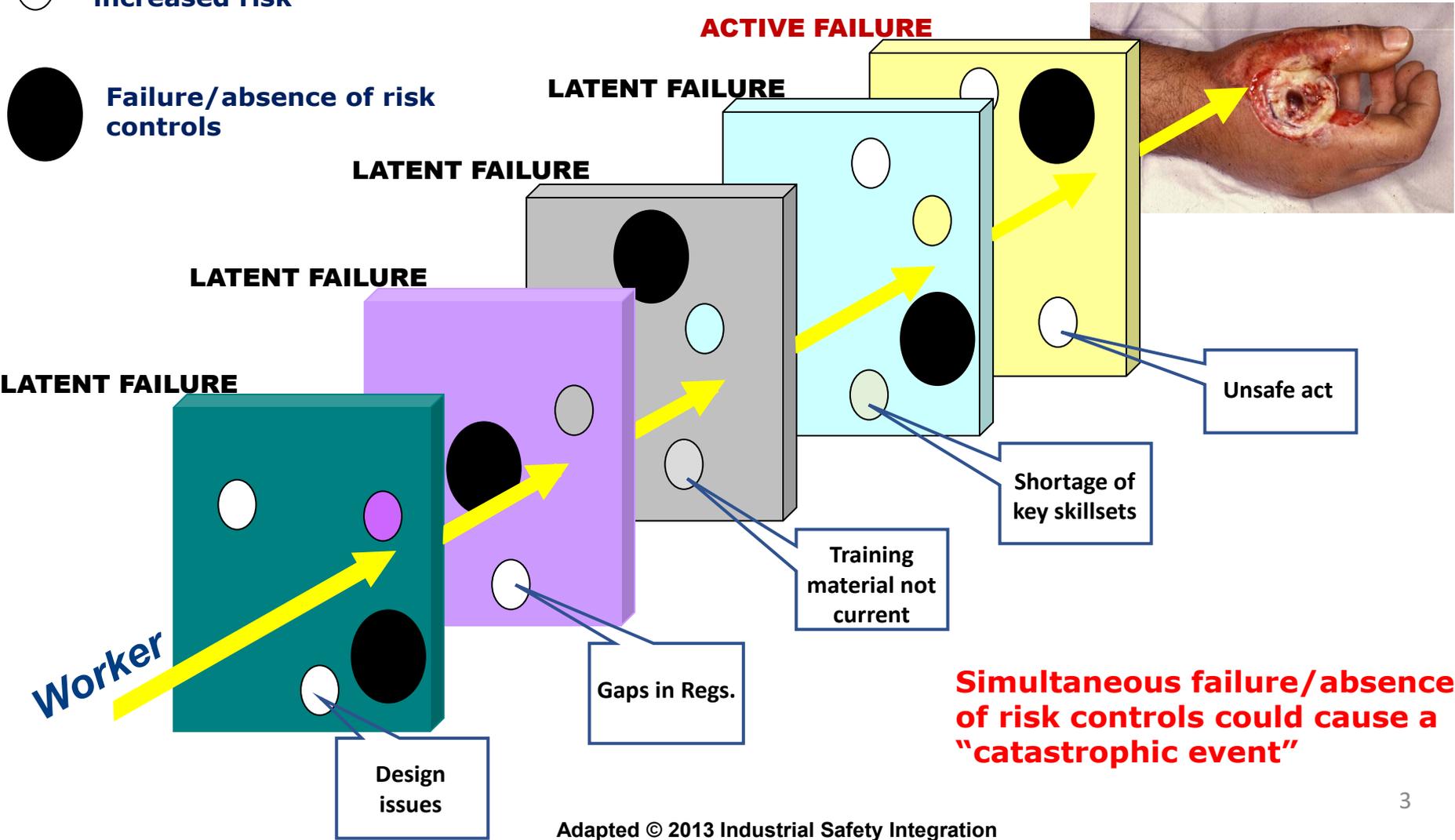
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Risk Assessment Project

○ Examples that could lead to increased risk

● Failure/absence of risk controls



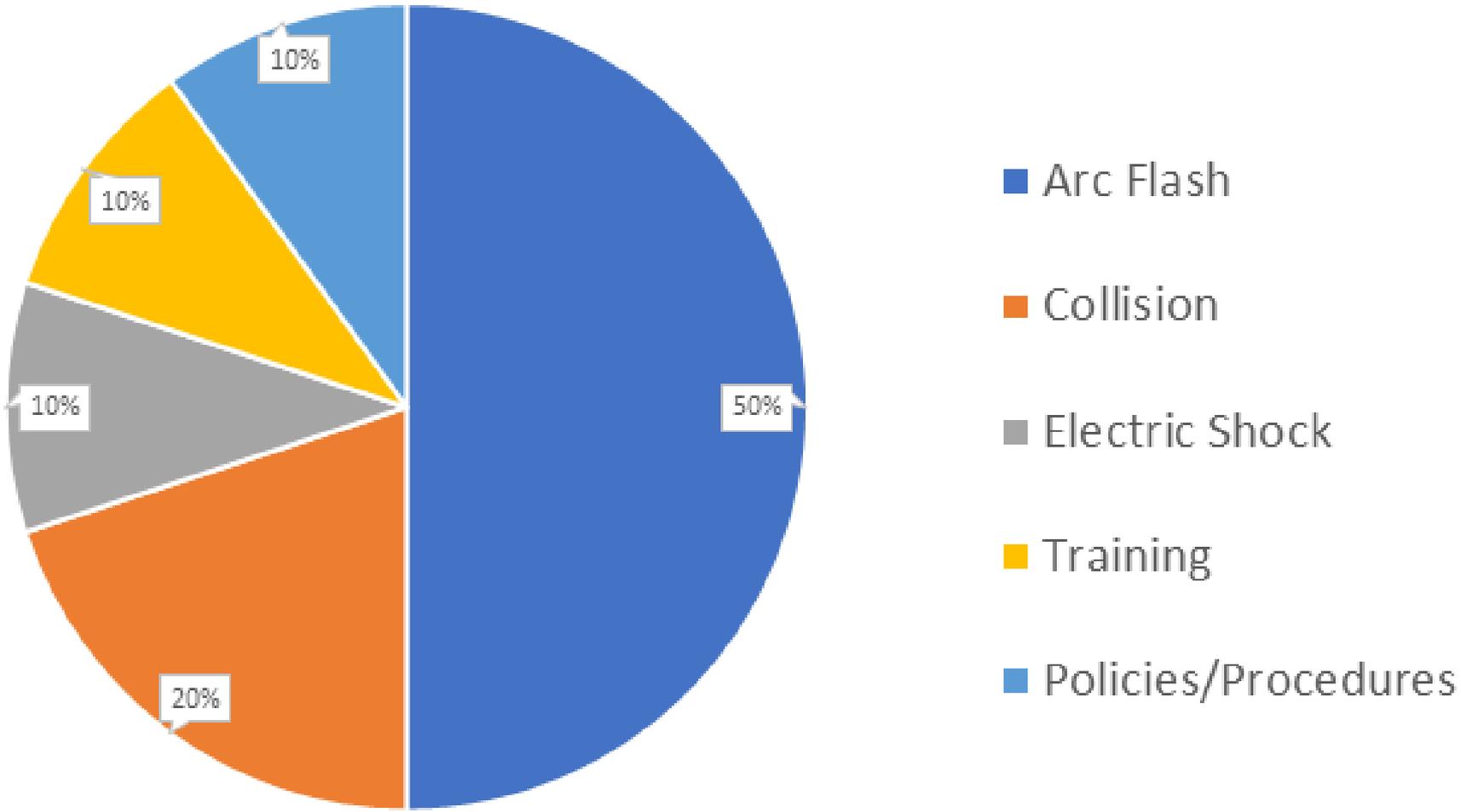
Simultaneous failure/absence of risk controls could cause a "catastrophic event"

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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

BEV Risk Assessment: Top 10 risk categories based on highest risk within that category

Top 10 BEV Risks



Analyses of the top 10 risks and their undesired outcomes have identified the following overall risk ranking based on the following risk categories:

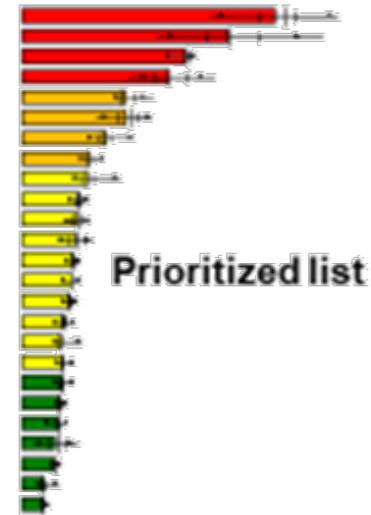
Risk Rank	Risk Category	Contributing Factor	Result
1	Arc Flash	Improper live troubleshooting Improper/unclear work delineation; worker assumes authorized to perform work on traditional work experience Inadequate specifications, standards, regulations – provincial Inadequate management of change process In field Repairs	Thermal Runaway
2	Collision	Lower sound or operational presences	Collision with people or other equipment
3	Training	Lack of training for maintenance and operational workers	Injury to worker Damage to Equipment Loss of process
4	Policies and Procedures	No standardized industry regulations with regards 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 the results of the Battery Electric Vehicle Risk Assessment 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



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 participants before the workshop
- Final workshop results reviewed/validated by industry participants

Finding acceptable solutions that all members can support:

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

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

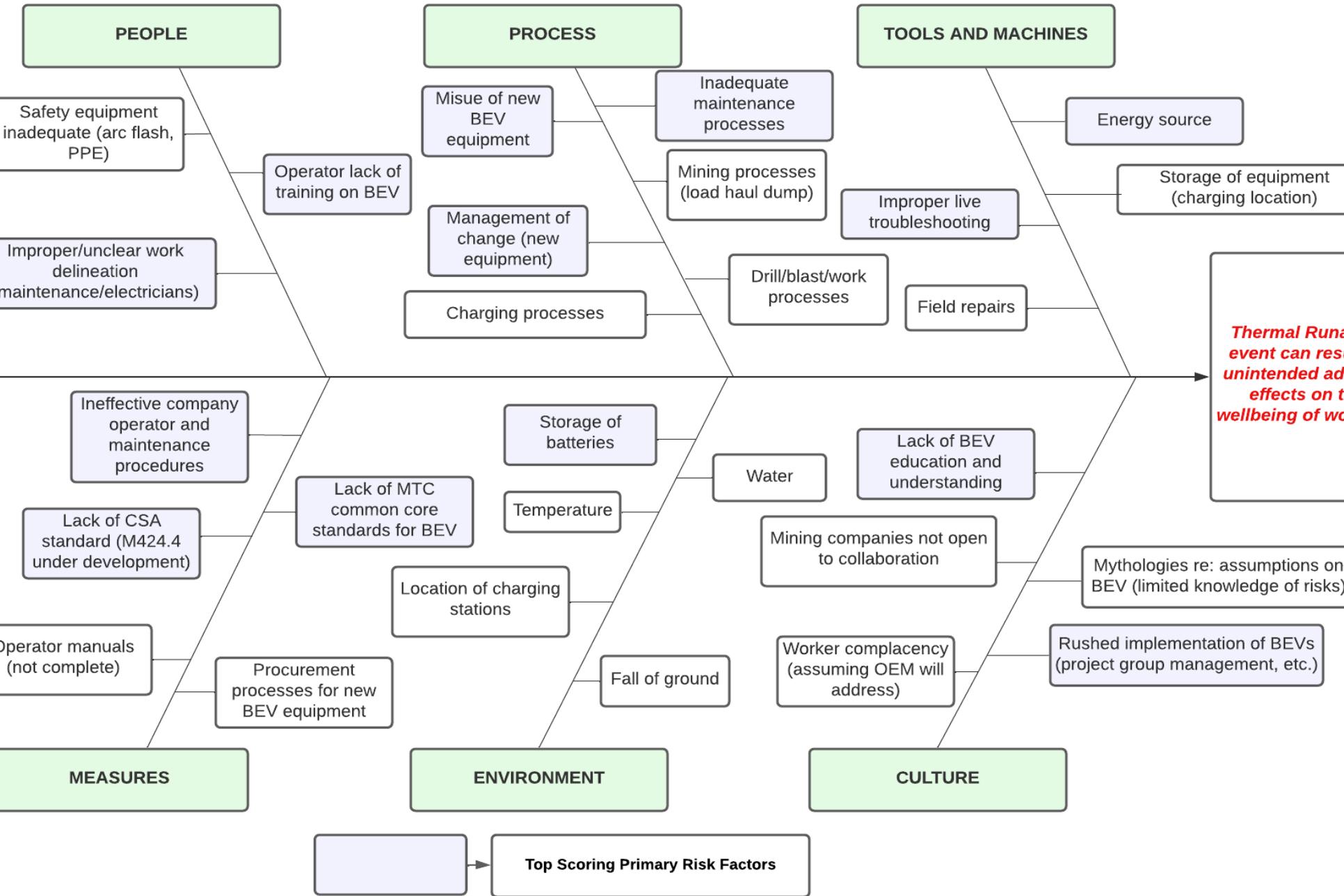
Employer Representation

WORKSHOP PARTICIPANTS

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

WSN: Workplace Safety North

MLTSD: Ministry of Labour, Training, and Skills Development



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/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**

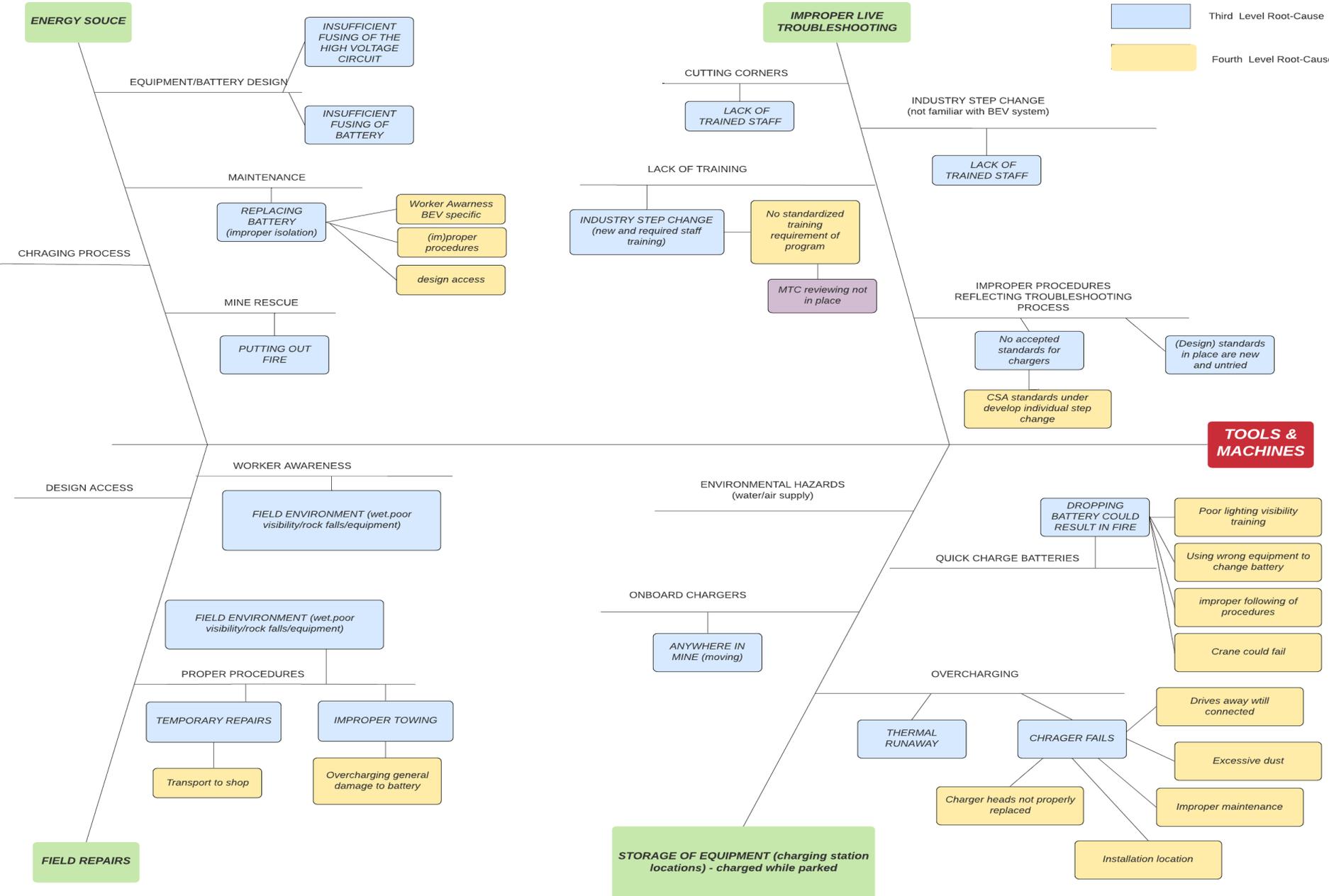
Next Steps

What should we focus on immediately?

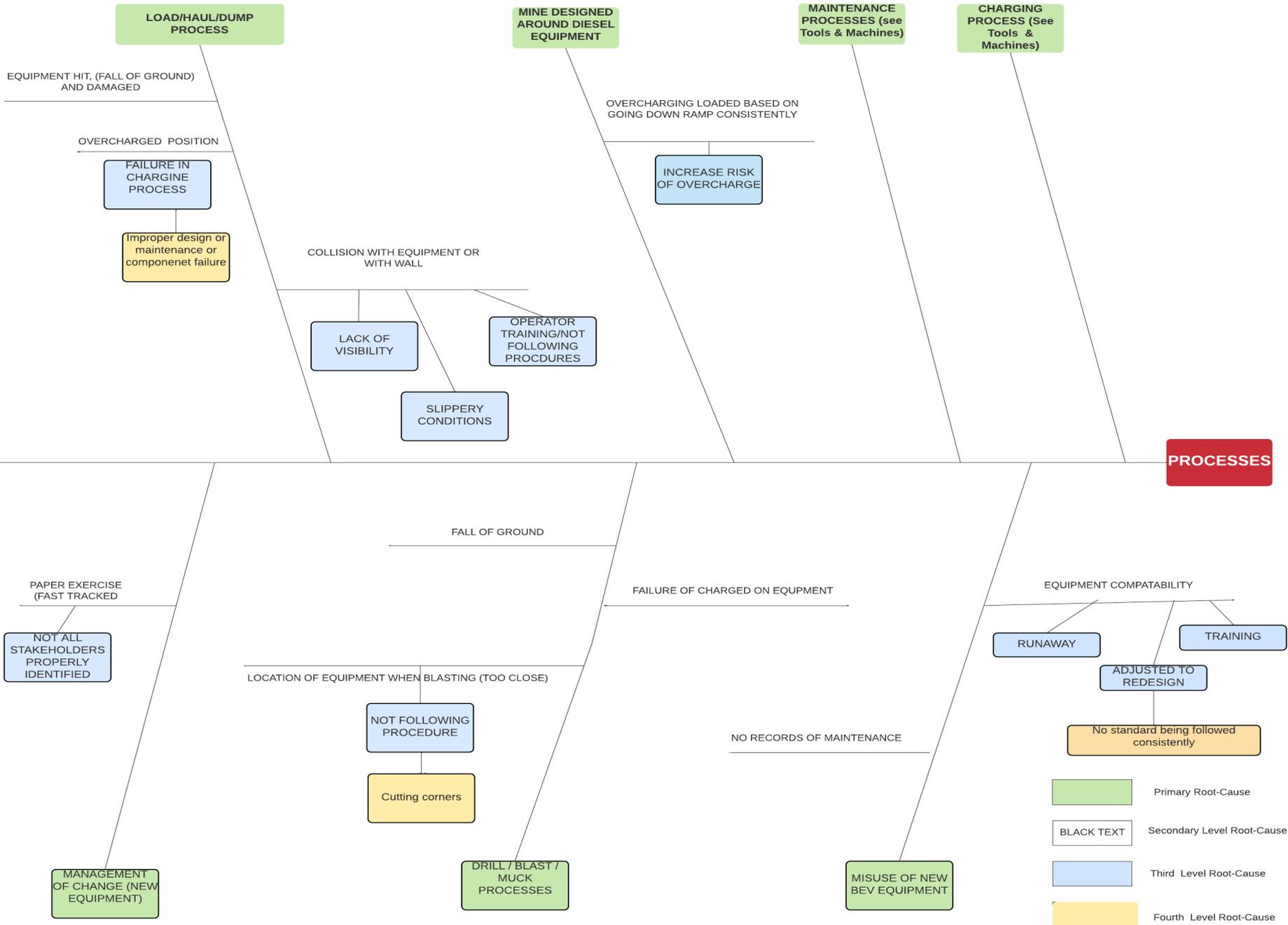
- Based on a scan of controls identified for the Top Primary Causal Factors, it would be beneficial, as a start, to focus right away on the following common systemic weaknesses
 - Current lack of a CSA standard for BEVs (M424.4 under development)
 - Lack of modular training program Common Core standard for BEVs

BEV RCA - TOOLS AND MACHINES

- Primary Root-Cause
- BLACK TEXT Secondary Level Root-Cause
- Third Level Root-Cause
- Fourth Level Root-Cause

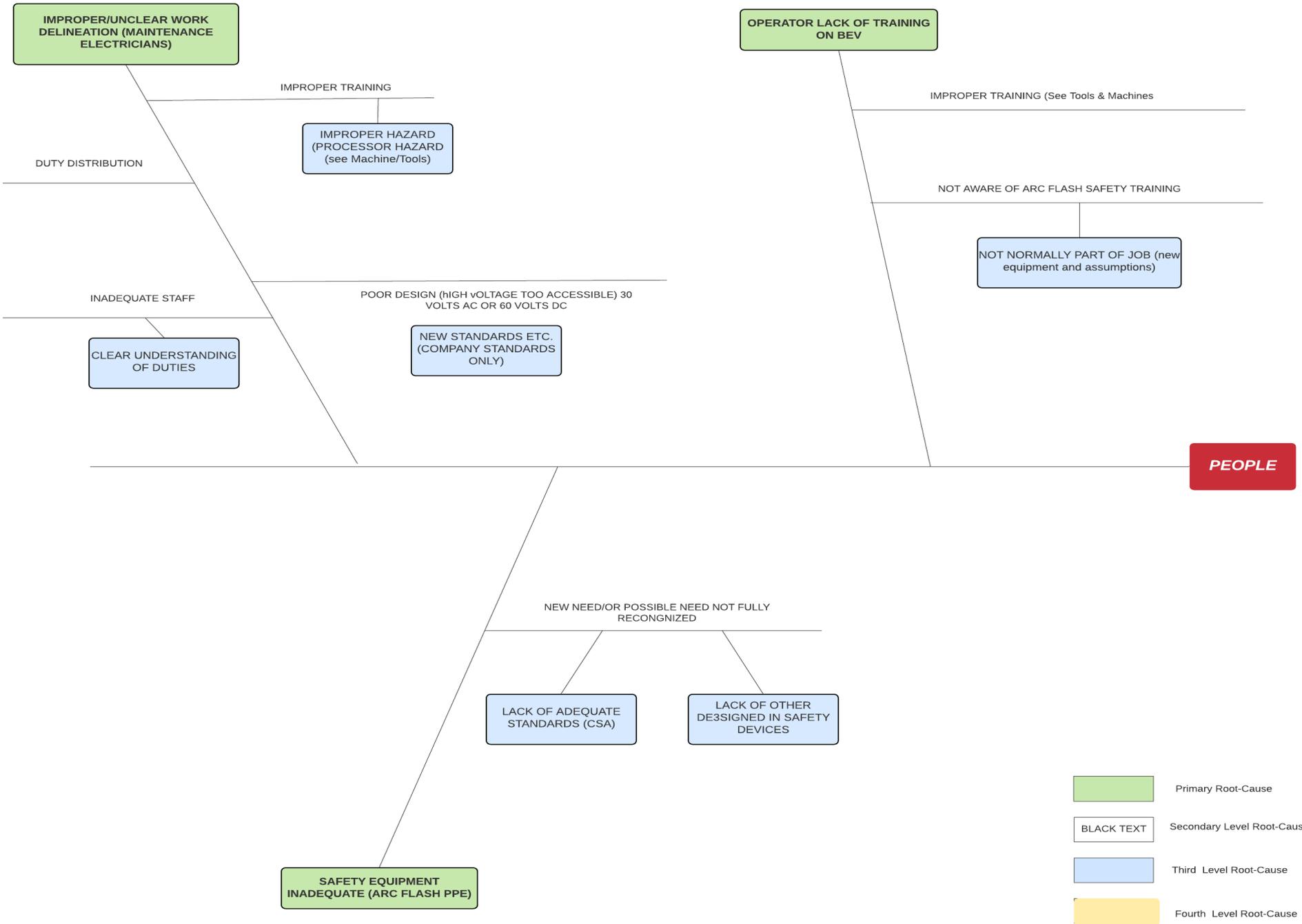


BEV RCA - PROCESSES



- Primary Root-Cause
- BLACK TEXT Secondary Level Root-Cause
- Third Level Root-Cause
- Fourth Level Root-Cause

BEV RCA - PEOPLE



BEV RCA CULTURE

WORKER COMPLACENCY (ASSUMING OEM WILL ADDRESS)

WORKER MAY ENCOUNTER HAZARD
THINKING EQUIPMENT IS SAE TO INTERACT WITH

RISK ASSESSMENT DONE WITH LIMITED KNOWLEDGE OF RISK

APPROACH TO BEV FIRE ASSUMING ASME AS DIESEL FIRE

EXPERIENCE RE: RISK - DON'T KNOW WHAT YOU DON'T KNOW

ADDITIONAL TRAINING OF WORKERS (UPDATED TRAINING)

MYTHOLOGIES RE: ASSUMPTIONS ON BEV (LIMITED KNOWLEDGE OF RISKS - ADDRESSING ROOT CAUSE)

APPROACH TO BEV FIRE ASSUMING SAME AS DIESEL FIRE

RISK ASSESSMENT DONE WITH LIMITED KNOWLEDGE OF RISK

EXPERIENCE RE: RISK - DON'T KNOW WHAT YOU DON'T KNOW

ADDITIONAL TRAINING OF WORKERS (UPDATED TRAINING)

MINING COMPANIES NOT OPEN TO COLLABORATE (GLOBAL MINING GROUP)

SOME COMPANIES NOT THERE YET

CULTURE

PARADIGM SHIFT (COMFORT ZONE)
HUMAN FACTORS - FIRST ADOPTERS

PROP TRAINING OF ALL STAKEHOLDERS

CAN NOW MINE AREAS PREVIOUS INACCESSIBLE DUE TO HEAT, VENTILATION

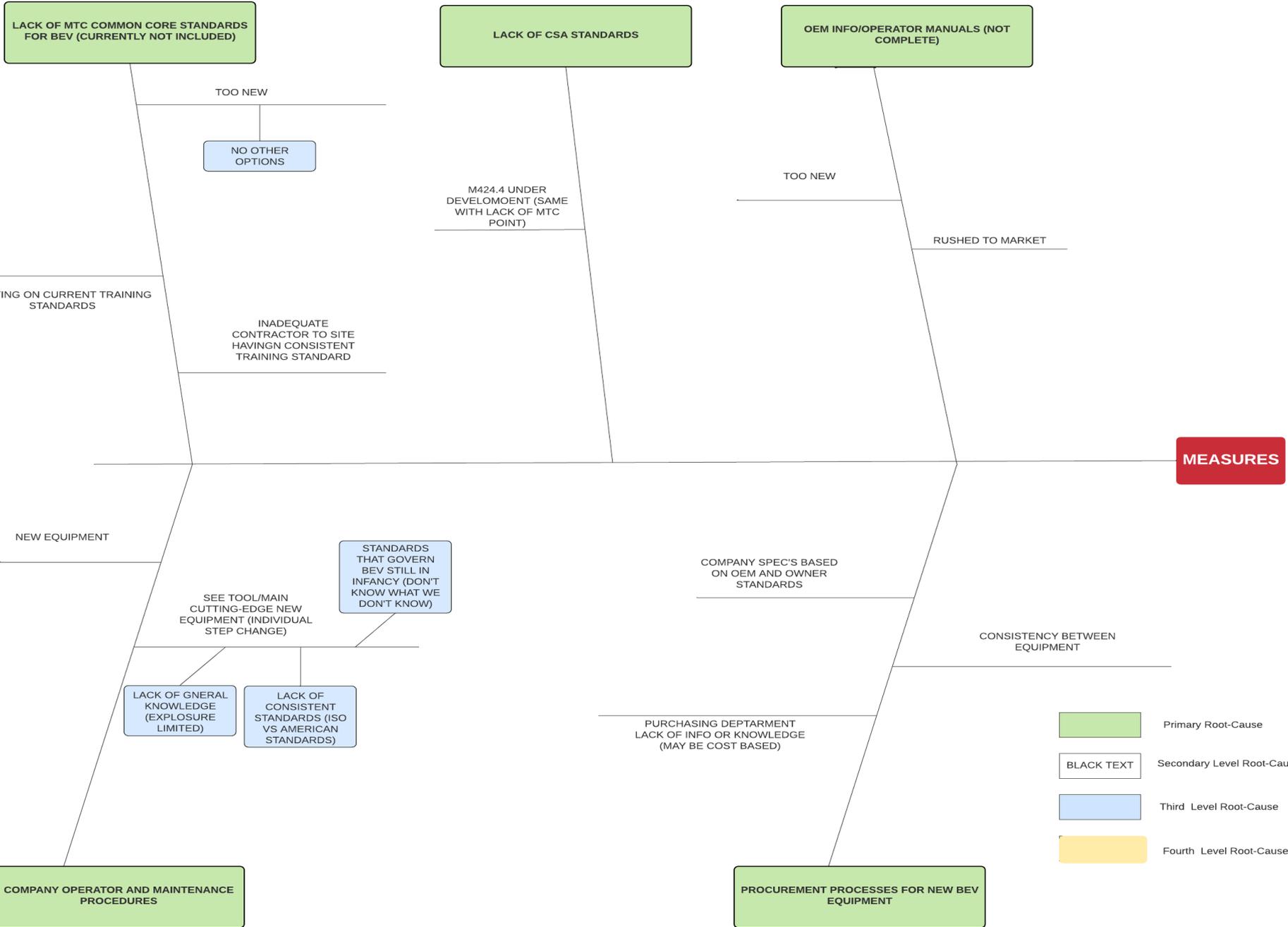
IMPROPER DESIGN FOR BEV (CHARGE STATIONS)

LACK OF BEV EDUCATION AND UNDERSTANDING

RUSHED IMPLEMENTATION OF BEV'S (PROJECT GROUPS, MANAGEMENT ETC)

- Primary Root-Cause
- BLACK TEXT Secondary Level Root-Cause
- Third Level Root-Cause
- Fourth Level Root-Cause

BEV RCA - MEASURES



LACK OF MTC COMMON CORE STANDARDS FOR BEV (CURRENTLY NOT INCLUDED)

LACK OF CSA STANDARDS

OEM INFO/OPERATOR MANUALS (NOT COMPLETE)

MEASURES

COMPANY OPERATOR AND MAINTENANCE PROCEDURES

PROCUREMENT PROCESSES FOR NEW BEV EQUIPMENT

TOO NEW

NO OTHER OPTIONS

M424.4 UNDER DEVELOPMENT (SAME WITH LACK OF MTC POINT)

TOO NEW

RUSHED TO MARKET

RELYING ON CURRENT TRAINING STANDARDS

INADEQUATE CONTRACTOR TO SITE HAVINGN CONSISTENT TRAINING STANDARD

NEW EQUIPMENT

SEE TOOL/MAIN CUTTING-EDGE NEW EQUIPMENT (INDIVIDUAL STEP CHANGE)

STANDARDS THAT GOVERN BEV STILL IN INFANCY (DON'T KNOW WHAT WE DON'T KNOW)

LACK OF GNERAL KNOWLEDGE (EXPLOSURE LIMITED)

LACK OF CONSISTENT STANDARDS (ISO VS AMERICAN STANDARDS)

COMPANY SPEC'S BASED ON OEM AND OWNER STANDARDS

PURCHASING DEPTARMENT LACK OF INFO OR KNOWLEDGE (MAY BE COST BASED)

CONSISTENCY BETWEEN EQUIPMENT

- Primary Root-Cause
- BLACK TEXT Secondary Level Root-Cause
- Third Level Root-Cause
- Fourth Level Root-Cause

Appendix A

Workshop Contacts

- For additional information or questions, please contact:

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Ministry of Labour, Training and Skills Development
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