Participants discussed the project purpose, scope, and relevant standards.

## 1.0 Project Purpose

Participants discussed key requirements, considerations, and common challenges around asset management for electrification. The topics included:

- Workforce and training
- Reliability and unknowns
- Data requirements in cybersecurity
- Battery fire management
- Battery management
- Asset lifecycle and production management
- Infrastructure
- Budgeting and commitment

### Workforce and training

- What does a battery electric maintainer look like?
- Are different skill sets needed?
- Be mindful not to pull skills from other industries and focus more on training in mining.
- Training is not fully complete with the new technology because the battery side is new, so resources need to go there to facilitate these trainings.
- Training may not be accompanied by actual experience which means it will take longer.

### Reliability and unknowns

- A set of questions that should be asked even if the answers aren’t currently available, at least there will be something for consideration to determine how ready they might be.
## Asset Management for Electrification Workshop

### June 29, 2023

| Data requirements in cybersecurity | ▪ Manufacturing needs to provide standardized data so it will be easier to get true data (common language).  
▪ Data exchange and standards that are in place to adapt to them. In other industries some equipment already has data standardized that needs to be monitored for operations.  
▪ What kind of data is exchanged by manufacturer (interoperability)?  
▪ Cybersecurity and access to businesses to monitor for issues leading to infrastructure costs. |
| --- | --- |
| Battery fire and hazardous compound management | ▪ Machine fires because of lithium batteries and how guidance on how to respond to them and make sure management teams are prepared correctly.  
▪ Hydrogen fluoride gas from battery fires and how ventilation plays a factor.  
▪ From an asset management perspective there needs to be fire management systems.  
▪ Stopping fire on the vehicle so it doesn't get to the battery.  
▪ In the underground, there is usually only one way out, so if there are chemical issues or thermal reactions the personnel need to pass the hazard. Some use cranes to lift and move it across - many safety risks for the charging of vehicles. |
| Battery management | ▪ Batteries are large - what happens when it needs to be changed, how do we manage it safely?  
▪ Transportation: many of these sites are in remote locations, so the battery must get shipped, and they're dangerous goods, so this poses challenges (money, effort, safety, more considerations that aren't fully ironed out yet).  
▪ How to handle a damaged cell, what kind of containment, distances between batteries (can't stack them).  
▪ Benefit is that a lot of bigger vehicles have a swap system. |
| Asset lifecycle and production impact | ▪ Batteries have a finite lifespan, and a large portion of the production shift is taken up by battery changes. How does it impact production? |
| Consideration and simulation work is being done for further understanding. |
| Electrical grid and charging infrastructure and how to support them and charging at various times. |
| Automation and battery swapping process in block caving (e.g., airlock). |
| Logistics and transporting large batteries on road trucks and storage in warehouses etc. (what kind of processes do we need there in case of fires). |
| Environment and batteries (circularity and understanding where batteries can be leveraged if they are under 80% capacity i.e., solar). |
| Some batteries are not worth recycling, but some have a lot of valuable components that are easier to recycle. |
| Multiple different applications, lifecycles, and trying to fit them into the operation. |
| Need to define how we change and repair the equipment over time. When one is out of service, it affects productivity, this needs to be taken into consideration. |

| Infrastructure |
| Ventilation: opportunity to change mine design (30% cost reduction in ventilation infrastructure) still needed to clear blast fumes. |
| Making sure there is an adequate power supply for brownfields. |
| Tethered based equipment doesn't have a battery but has its own issues i.e., cords. |
| Charging stations need a large cut-out. Mining vehicles can have poor maneuverability and can risk running into a battery or other user and they also need to get charging to the equipment. |
| Getting BEVs into an existing mine – there usually isn’t a lot of power available and where they do, these are long-distances, so the charging system contributes to a fault due to grid attachment. |

| Budgeting and commitment |
| Budget: committing to deliver can impact safety in order to meet goals. |
| Considerations around budgeting and commitment: warehouse and workshop temperatures, etc. |
| Cycle of equipment = capacity of the network to support the movement to different fuel that can support the growth and future needs. Issues of capacity from utilities. Need to understand this for each individual company before planning. |
| Risk with potential issues - longer downtime for repair with electric, so is there really a gain? |
### Environmental impact

- Will it really reduce emissions? If we're going to electrify, are we going to achieve that or will it be more displacement to another problem of managing batteries and lifecycles and disposal and recycling of them.
- How clean the grid is - if you replace diesel with electric, how far does it go until it levels out? Is the "green" as "green" as we hope it is?
- Batteries are not easily recycled, and some don't have swap systems, so you'll be down for time it takes to swap the battery or swap the vehicle.
- Power quality needs to be monitored and managed.

### 2.0 Scope

During the workshops participants discussed potential in scope and out of scope topics. However, there was some uncertainty about some topics and will require more discussion.

#### 2.1 In Scope

- Guidance on notes for asset management.
- White paper document that focuses on what questions to ask.
- Operational considerations.
- What are the new assets that electrification brings into mining?
- Define how many and what type of electric assets are being introduced into the mine before making further decisions (e.g., robotics, autonomous connectors, connector interfaces, trolley, poles, wires, dynamic charging).
- Supply chain management
- Storage length
- Vehicles are considered an asset (the physical asset). E.g., the shovel, all maintenance required, environment such as road.
- Different organizations are at different points of the journey and different maturity. How do we incorporate that?
- Terminology is critical in early stages to ensure everyone is thinking about the same thing.
- Lifecycle and understand the impact on different environments (e.g., quality of roads, loads of machines and putting excess pressure on batteries, temperatures)
2.1 In Scope

- Functional safety and where does it fit in the strategy.
- Data exchange with similar standards because all assets have similar information that is being shared and tracked.
- Skills and skilled trades available and the right understanding of the equipment
- Safety to install and protect against fires, station locations, size, number of chargers to limit to and safety associated to fire.
- Preparing for the environmental impact and determining if it is better with ventilation, heat generation, hydrocarbons, battery challenges, etc.
- Vendor management with non-interchangeable equipment
- Number and location of charging stations and how to manage the influx of top-ups vs big charge vs breaks.
- Lead time (a year out?).
- Battery lifecycle
- Logistics about getting batteries, BEVs, and related parts to site.
- Batter management: battery weight and the need for heavy equipment, PPE to manage emergencies with batteries.
- How to get, maintain, and manage spare parts and batteries.

2.2 Out of Scope

- Training and making sure everyone has proper PPE regardless if they are operator or maintenance personnel.
- Budgeting and planning.

2.3 Scope Topics to Consider

More discussion is needed to determine if the following topics are in or out of scope given the depth of the topic:

- Does it cover all technology?
- Surface and underground?
- Hybrid and fuel cell
- Diesel engine but connects to trolley system.
- What dangers each asset can pose?
- Safety

3.0 Parking Lot

- Creating a maturity lifecycle for electrification that includes performance metrics (similar to autonomous mine maturity lifecycle diagram)
Interoperability

Will it really reduce emissions? If we're going to electrify, are we going to achieve that or will it be more displacement to another problem of managing batteries and lifecycles and disposal and recycling of them.

How clean the grid is - if you replace diesel with electric, how far does it go until it levels out? Is the "green" as "green" as we hope it is?

Mines do not have enough capacity with current grid connection – different site capacity needs to be addressed.

Is the grid ready? Does the mine power grid have capacity? Is the energy of the proper quality to connect these power sources? How to avoid instability? Is the mine prepared to have the equipment installed?

Power studies

Arc-flash considerations

How does the battery contribute to short circuit events?

4.0 Related Standards

IEC TC 123 Management of network assets in power systems - relevant to independent networks

Electrification of the logistic / supply chain - i.e., rail (IEC TC 9)

Siemag Tecberg's Mining Truck Hoisting System

Leverage the established practices with electric networks required for electric shovels and draglines.

Automotive industry

Fire departments looking at specific methods to manage battery fires (e.g., F500 fire extinguishers are readily available).

Standard that governs protection of electric equipment that's internationally recognized (M.A.): IEC-61 850 - used across the board for protection for electric vehicles and others.

Standards for charging connectors associated with equipment.

CSA has a series of standards related to on-road vehicles, not for heavy industry.
5.0 Next Steps

The project needs a steering committee. There will also be a need to work with the steering committee on the Implementing the Transition from Diesel Mobile Equipment in Surface Mining project because the topics discussed by both working groups align. To ensure there is no repetition across projects, there will be a discussion to determine what topic belongs under which project.