

# Macassa Mine Battery Fires Summary

February 15, 2024

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**AGNICO EAGLE**

## Summary

The following presentation will detail a summary of battery fires experienced at our Macassa operation.

The data collected includes fires – between 2022 and 2023.

During this time period – we have experienced (6) fires involving batteries.  
(1) in 2022  
(5) in 2023

Please note that we are working with our Equipment Manufacturer for guidance and support in investigating all these fires, so we can understand why these fires are occurring, what can be done about them, how we can move forward to reduce and/or eliminate fires from occurring the first place and how to respond to fires if and when they occur.

This report will provide insight into the fires and the measures taken to prevent future events

# BATTERY FIRE EVENTS

## Definitions:

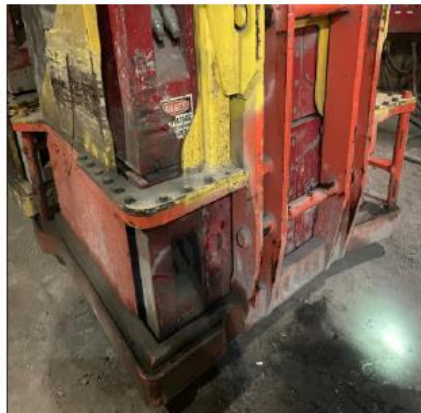
**Battery Pack Set:** 2 batteries stacked together in a “cage” that comprise the electrical power for the Z40/50 haul trucks

**Battery:** Comprised of varying number of “modules” depending on the equipment it is intended for. A Z40/50 battery is comprised of 16 modules, ST7 LHD or the decommissioned Copco 2010 haulage trucks are also comprised of 16 modules whereas the RDH Muckmaster LHD’s are comprised of 12 modules.

**Module:** Are comprised of varying number of “cells” depending on the equipment they are used for. Z40/50 modules are comprised of 48 “blue” cells whereas the ST7/RDH modules are comprised of 12 “yellow” cells. Modules have a nominal voltage of ~48 volts DC and have the cells arranged in a series/parallel circuit for the Z40/50 model.

**Cells:** Cells come in 2 different forms. “blue” cells which are used for the Z40/50 “modules” have a nominal voltage of 3.6 volts and an AH (amp hour) rating 72 whereas the “yellow” cells are used for the RDH Muckmaster and ST7 modules and have a nominal voltage of 3.6 volts and an AH rating of 260.

Pack Set



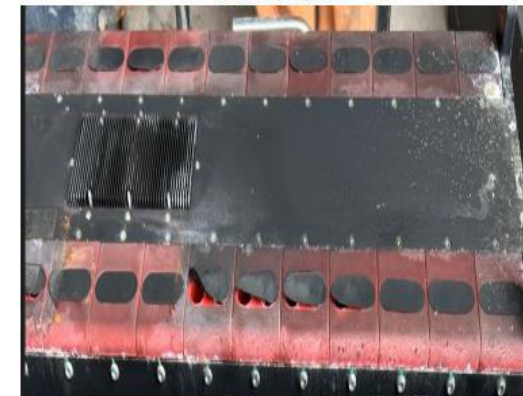
Battery



Cells



Module



<b>DATE:</b>	<b>BATTERY UNIT / EVENT LOCATION</b>
<b>August 14th</b>	<b>BI-0013 - On-Site - U/G</b>
<b>June 30th</b>	<b>BZ0007 - On-Site - Surface</b>
<b>July 10th</b>	<b>Trailer Fire - Off-Site - Surface</b>
<b>July 15th</b>	<b>BZ0055 - On-Site - Surface</b>
<b>July 17th</b>	<b>BZ0055 - On-Site - Surface</b>
<b>August 11th</b>	<b>BZ0082 - On-Site - Surface</b>

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## August 14<sup>th</sup> – BI-0013 – On-Site – U/G

### **Brief Description of the Event:**

The scoop operator called the battery team due to scoop #208 (battery BI-0013) stalling issues. The scoop was reset, moved 50 feet, and then stalled again. It was then, that smoldering, and sparks were noticed in battery BI -0013. The scoop operator used a handheld fire extinguisher to ensure that no further thermal activity occurred. He then called the Supervisor and the Maintenance department to come and check the scooptram out. The scoop was towed to the 5656 shop where the battery was removed and changed-out.

### **Immediate Cause:**

Damaged battery connection.

Handheld fire extinguisher used to extinguish fire.

No thermal runaway occurred.

# BATTERY FIRE EVENTS

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**June 30<sup>th</sup> – BZ0007**

## **Brief Description of Event:**

At 11:35 am on 30 June 2023, a Mechanic was passing past the surface battery storage area and noticed smoke emanating from a decommissioned Artisan battery pack BZ007 (used in Z40/50 underground haulage trucks). Shortly after, the flame could also be seen. They immediately notified his supervisor, who notified Site Security. The mechanic, along with another, attempted to extinguish the flame using handheld ABC extinguishers (5 in total), this was initially successful. The local fire department was called. The mechanics began to separate the batteries using a front-end loader to give the fire department room to work and prevent other batteries from being affected, while doing so, the affected battery reignited. The fire department arrived on site and doused the battery with water and then foam, extinguishing the fire.

## **Immediate Cause:**

The investigation revealed that there were isolation faults between the modules within the battery pack that shorted through the frame igniting the internal flammable components of the battery pack.



June 30<sup>th</sup> – BZ0007

## Key Findings

- Batteries stored on the surface exposed to the elements increase the degradation and deterioration of components within the battery pack, increasing the likelihood of shorting.
- Moving decommissioned batteries that have been in prolonged storage and may have degraded in the elements greatly increases the potential for shorting/isolation faults to occur.
- Due to the inability to fully discharge the battery packs because of isolation faults, all modules or cells within may still have an electrical potential within the battery pack, if a short occurs, there is a higher likelihood or potential of fire.
- Prolonged storage in adverse conditions allowed water to enter the battery pack and add to the rate and extent of deterioration of the battery components within.
- Storing decommissioned batteries outside for an extended period due to the lack of storage facilities on site and lack of disposal/recycling ability in the industry.



## BATTERY FIRE EVENTS

June 30<sup>th</sup> – BZ0007

### Recommendations:

	Recommendation	By When
1.	All batteries stored on the surface will have all modules removed and stored on pallets to minimize fault severity and occurrence and maintained on a regular basis moving forward.	26 Jul 2023 Complete
2.	Develop a formal SOP to deal with batteries deemed unserviceable, to include testing, dissipating any potential charge, safe storage, dismantling (removing modules and cells), and packaging for disposal and recycling.	31 Aug 2023 SOP developed
3.	Live parts on modules are to be covered to prevent moisture from entering modules.	15 Sep 2023 Complete
4.	All retired batteries underground will be sent to the surface to have modules isolated on the surface and stored separately.	26 Jul 2023 Complete
5.	Test all Atlas Copco truck batteries for isolation faults before transportation to the surface.	13 Jul 2023 Complete
6.	Look into finding proper disposal or removal from the site of lithium-ion battery cells stored on the surface to a suitable disposal/recycling facility.	10 Aug 2023 Ongoing



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# BATTERY FIRE EVENTS

## Battery Fire Events

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### July 10<sup>th</sup> – Trailer Fire

#### **Brief Description of Event:**

On July 10<sup>th</sup> a trailer laden with battery cells from Macassa, left a logistics yard in Amos QC after having been re-packaged and reloaded onto a third party tractor trailer. Shortly after the CMV departed, the driver of the truck was flagged down to advise there was smoke coming from the trailer. The CMV came to a stop at a location off the highway where the Amos municipal fire department responded to extinguish the fire. It was determined, post incident that a number of the isolated cells had come into contact with metal components of either the tote bins they were stacked in or structural components of the trailer, resulting in the battery terminals shorting out, causing a fire which then propagated to adjacent battery cells.

#### **Shipping Recommendations:**

Modules on the pallets are fine but should be shipped at 50% charge capacity or less. The + and –terminals should be removed or insulated to protect against shorting. Modules sent by Macassa were deemed less than 50%.

Cells are to be shipped in a wooded crate single stacked with the + and –terminals upwards with an insulating medium to protect against un-intentional shorts on top of the cells.



# BATTERY FIRE EVENTS



Packaged in trailer prior to fire



Contents removed from trailer

Cells had been re-packaged off-site.

- Cell configuration has changed in the plastic tote
- Cells were re-palletized and not as they were shipped off-site.

# BATTERY FIRE EVENTS



What we see in this picture are weld marks on the outside of the tote in the same general spacing of the + and - terminals from one of the cells that was re-palletted on the wooden skid from the previous picture. I believe a cell had made contact with the aluminum frame and started to arc (weld) itself causing high heat which in turn ignited the plastic of the tote. I believe this served as a catalyst for the fire in the trailer

Photo from the re-palletted cells in conjunction with the picture of the weld marks suggests this is the pallet that had made contact with the frame of the tote.



# BATTERY FIRE EVENTS

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**July 15<sup>th</sup> and 17<sup>th</sup> – BZ0055**

## Description:

After investigation into the June 30<sup>th</sup> fire, it was decided to remove all of the modules underground and on surface from batteries that were identified to have isolation faults.

The rationale behind this decision was that instead of having the potential of close to full pack voltage ~700volts DC and large capacity rating up to 288AH to break this down into a lower potential where maximum voltage would be ~48 volts DC

Electrical Crew were assigned to work on surface on July 15 to expedite this process. In total 11 Z40/50 batteries were further isolated during the shift and brought down to the module form seen in the picture.



## July 15<sup>th</sup> and 17<sup>th</sup> – BZ0055

### Description Continued:



Upon tear down on BZ55 on July 15<sup>th</sup> it was noted that a thermal event had occurred at an unknown time and date inside this battery. It was observed that 3 modules had roughly a loonie sized hole blown through the side of the modules in basically the same area as the CM board location.

BZ0055 history: New pack in April of 2021 and put into service. Was sent to Sandvik for refurbishment approximately 6 months later. Flex circuit upgrades and module replacement. Battery pack was pulled out of service due to poor AH rating in August of 2022 and was sent to surface

## July 15<sup>th</sup> and 17<sup>th</sup> – BZ0055

### Description Continued:

The morning of July 17<sup>th</sup> at approx. 7:00 a.m., a call was received about a Z40/50 module that was observed emitting smoke. This module was part of the work that was completed on July 15<sup>th</sup>.

Upon arrival to investigate, heavy smoke was noticed coming from the module. The module top was observed to be heavily melted around the CM board area of the module. The surface loader operator was instructed to bring over a large tote of water so the module could be submerged to stop the thermal process. While waiting for the tote, a small flame was noticed in the CM board location of the module.



Module was then fully submerged in the tote. At this time, a second module was noticed to have started emitting smoke. No open flame was observed, but damage due to heat was also noticed in the same location as the first module. Around the CM board location. This module was also submerged to stop the thermal process.

# BATTERY FIRE EVENTS

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July 15<sup>th</sup> and 17<sup>th</sup> – BZ0055

## Immediate Actions:

An investigation was completed the afternoon of the 17<sup>th</sup> on the two modules and the cause was found to be tracking under the CM board due to moisture. This led to the module itself shorting out.

Actions taken were to remove the module tops that house the CM board and Flex tape circuit which also would remove the buss bars from the individual cells further isolating them down to individual cell voltages of ~3.6 volts. The modules with the “module tops” removed have been wrapped in plastic to keep water from entering.

The Z40/50 modules were prioritized to be completed first as they were identified to have the highest risk due to design and all modules have been completed on this style.



## August 11<sup>th</sup> – BZ0082 – onsite – Surface

### Brief Description of Event:

Z40 / Z50 Battery, located on surface in the One-Haul lay-down yard, began to off-gas. The battery ignited causing a thermal event. The battery compartment pressurised. An internal arc created an ignition which blew the side compartment doors off. Surface crew began to apply water to the battery in order to cool the unit down. Additional arcing and short circuiting caused the venting gasses to combust resulting in a fire. The KLFD was called to the scene to apply additional water and foam. The fire was fully extinguished, and the battery modules were isolated to prevent a further thermal event. The battery was transported to the Thickener building under security camera 24hr surveillance as fire-watch.

### Immediate causes:

- We believe it was caused by water ingress into the battery pack and subsequently into a module
- The battery was left outside, uncovered and allowed to get wet
- The short circuiting caused the cells to overheat and then vent
- The arcing ignited the vented gas and initiated combustion



## August 11<sup>th</sup> – BZ0082 – onsite – Surface

### Key Learnings:

- There is a susceptibility for water ingress into the pack (when the battery pack is removed from the vehicle cage assembly). If water gets into the individual battery module cover it could lead to isolation breakdown and subsequent short circuiting.
- It was discovered on the day of the event that the top cover gasket was on the wrong side of the bolt holes; this could have allowed water to enter the cover and drip on the top of the battery module.
- Loose battery packs must be protected from getting wet. They need to be kept indoors or covered.
- The battery sat on surface in the elements longer than we had intended.
- The arcing on the top of the batteries is consistent with water pooling on the module tops as was the case with the isolated modules that previously burnt on surface.
- At this point we are not certain as to what caused the initial over pressurisation of the battery pack that lead to the initial explosion.
- Working with battery manufacturer on possible reasons and solutions for battery fires / explosions and safe storage.

## Ongoing On-Site Battery Management:

- Batteries that are sent to surface, have their bus-bars removed to prevent any potential short-circuiting propagation from one module to another. Cells are also isolated with each module. The modules are then packaged in plywood boxes with weather resistant tops to reduce the potential of water from getting into/onto the isolated cells/modules.
- Standard Operating Procedure developed for battery management.
  - MAC-R112: Battery Isolation Fault Handling
  - MAC-U255: Assessing Batteries



## Ongoing On-Site Battery Management



Before – Surface Storage



Current – Surface Storage Area

## Response to Battery Fires:



BZ007 Battery pack in surface battery storage area in close proximity to other decommissioned batteries.



Battery pack after being extinguished and moved to a safe location. The top panel was opened by the fire department to aid in firefighting efforts (water and AFFF).

August 11<sup>th</sup> – BZ0082 – onsite – Surface

Extinguishment of Fire:



Initial deployment of water/foam



6-seconds after initial application of water/foam

## Conclusion or Final Comments:

- As an industry – we need to work together to resolve the issues regarding Battery Fires that occur or can occur on our equipment.
- We need to work with Manufacturer's / Suppliers – to ensure that best management practices are followed and adhered to regarding battery fabrication and safety
- We need to work with Fire Extinguishment Professionals – e.g.: Leavitt Safety, ANSUL, etc. for leading edge fire extinguishment capabilities for battery type fires
- We need to “share” incidents / near misses that occur on our sites. Together – we are stronger
- We need to train our Emergency Response teams for dealing with battery type fires
- We need to share best management practices for using, maintaining, storing, disposal and transporting of batteries on/off our sites
- Together (we) – Industry – Manufacturers – Fire Specialists – Regulators – Emergency Response can make a difference and provide a solution!

**Our Industry Depends on it!**



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## Thank you

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