REDUCING FIRE AND EXPLOSION HAZARDS OF LITHIUM-ION BATTERIES WITH NFPA 855 COMPLIANCE

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Does your utility, commercial, or industrial operation include lithium-ion batteries? Do you know if you're compliant with the new, mandatory NFPA 855 regulations?

Find out what kind of precautions you need in place to be compliant and why they're important to your operations.

If you need help managing battery safety, Microwatt can help.

Contact us

Growing Demand for BESS

The global demand for stationary battery energy storage systems (BESS) or energy storage systems (ESS) has grown strongly over the past several years due to an increased demand to supplement current energy needs with a renewable and sustainable energy source.

> As per the latest Wood Mackenzie report, the world's energy storage capacity is set to grow at a compound annual growth rate (CAGR) of 31% by 2030.

For the different battery chemistries available, lithium-ion batteries are one of the most promising technologies that have been applied in different market sectors including home storage systems (i.e., for solar consumption), industrial storage systems, and large-scale industrial storage systems.

As growth rates surge for this emerging technology, careful consideration is required to manage the risk of installation and implementation of ESS.

How Fire and Explosive Hazards Occur

For most battery technologies including lead-acid, nickel (Ni-Cad, Ni-MH, Ni-Zn), lithium-ion, and sodium nickel chloride, under normal operation fire and explosive hazards can occur due to

available heat sources such as live parts being in contact with combustible materials during service or maintenance.

Due to the electrochemistry of certain batteries, ignition of combustible concentrations can occur as part of the normal operations of ESS such as the occurrence of hydrogen off-gassing from batteries with aqueous electrolytes that are open to the atmosphere.

Lithium-ion batteries, in particular, have been valued for their high energy density properties, however, this attribute along with containing a flammable electrolyte allows for very energetic thermal runaway reactions.

The Risks of a Battery Fire

Damaged cells can lead to thermal runaway reactions affecting adjacent cells resulting in fire, asset damage and potential injury to personnel if not more catastrophic consequences.

For larger-scale systems with multiple ESS, this deflagration event in the presence of combustible off-gassing with nearby ignition sources could result in an explosion leading to critical injuries and fatalities.

> While the failure rate of a lithium-ion battery cell is extremely low at approximately 1 in 12 million per year, with worldwide production rates exceeding hundreds of millions per year, the frequency of an unmitigated battery fire incident increases significantly.

The New Standards

The NFPA recently published the first fire protection standard for ESS in 2019 – NPFA 855, Standard for the Installation of Stationary Energy Storage Systems.

This newly created standard specifies mandatory requirements for the overall management of ESS, for hazard mitigation analysis and additional measures for authority having jurisdiction (AHJ)

approval.

How to Be Compliant

With respect to a thermal runaway reaction, the NPFA 855 Electrochemical Energy Storage Systems Section 9.3 Thermal Runaway Protection states:

"Where required by Table 9.2, a listed device or other approved method ***shall*** be provided to preclude, ***detect***, and minimize the impact of thermal runaway." Table 9.2 lists the specific compliance requirements for each ESS technology.

In the case of Lithium-ion cells, thermal runaway protection is a mandatory requirement.

Not sure if you're compliant?

Contact us to find out.

Protection Mechanisms

Traditional protection mechanisms against fire hazards include sprinklers, fire suppression systems, and an overall emergency response plan.

While these protection systems play an important role in minimizing the impact of a fire hazard, they all share a common theme as mitigative protection layers.

These mechanisms act *after* the fire has occurred when essential asset damage and potential harm to personnel have already initiated.

Of the highest concern is an ESS-based thermal runaway event generating a mega-fire and explosion which now has the greater potential for personnel injury and fatality.

A Real-World Example

As seen from the 2019 lithium-ion battery explosion that critically injured four firefighters in Surprise, Arizona (with 8 firefighters injured in total), the potential for catastrophic consequences has been freshly evidenced.

The UL Firefighter Safety Research Institute released a pioneering investigation based on the experience of the surviving firefighters.

In this UL FSRI report, several key recommendations were developed and the following highlights specific recommendations regarding monitoring:

- Lithium-ion battery ESSs should incorporate gas monitoring that can be monitored remotely.
- Research that includes multi-scale testing should be conducted to evaluate the effectiveness and limitations of stationary gas monitoring systems for lithium-ion battery ESSs.
- Lithium-ion battery ESSs should incorporate robust communications systems to ensure remote access to data from the Battery Management System, sensors throughout the ESS, and the fire alarm control panel remains uninterrupted.
- Lithium-ion battery ESSs should incorporate adequate explosion prevention protection (i.e. detection and mitigative action) as required in NFPA 855 or International Fire Code Chapter 12, where applicable, in coordination with the emergency operations plan.
- Research that includes full-scale testing should be conducted to determine the most effective fire suppression and explosion prevention systems for lithium-ion battery ESSs.

The first-of-its-kind UL FSRI report regarding the Arizona ESS facility incident recommends gas monitoring and the NPFA 855 clearly states that detection of the thermal runaway is required.

So how do we achieve this?

Detecting the Thermal Runaway

Lithium-ion battery failure is characterized by four stages: initial abuse, off-gas generation, smoke generation, and fire propagation.

Stage 1 – Initial abuse – can be thermal, electrical, or mechanical abuse such as physical battery damage, overcharging, overheating, and manufacturing defects

Stage 2 – Off-gas generation – a "Golden" window of time in which fire can be prevented

Stage 3 – Smoke generation – at this point, thermal runaway has occurred and a catastrophic event is imminent

Stage 4 – Fire generation – propagation occurrence takes place

The initial battery abuse and off-gas generation stages are where protection mechanisms utilized during these two stages is essential to help prevent battery failure.

Many current protection systems provide hazard detection at Stage 3, which occurs after battery failure is imminent.

A more practical solution that meets the requirement of NPFA 855 is available to detect these types of failures at an early stage before thermal runaway occurs.

The NFPA 855 defines Energy Storage Management System (ESMS) as a system that monitors, controls, and optimizes the performance of ESS and has the ability to control the disconnection of the ESS in the event of abnormal conditions.

Section 4.2.9.2 states "The ESMS shall electrically isolate the components of the ESS or place it in a safe condition if potentially hazardous temperatures or other hazardous conditions are detected."

Catching Thermal Runaway Early

The Honeywell/Nexceris Li-Ion Tamer Rack Monitor System supports compliance with the requirements of NFPA 855 Section 4.2.9.2 in its ability to detect the initial off-gassing of a cell and send a signal to the Battery Management System for initiating a safe shut down and activating an alert signal prior to catastrophic battery failure.

This product is a low powered calibration-free device compatible with all lithium-ion battery form factors and chemistries.

Contact MicroWatt Controls today to obtain more information about the Li-Ion Tamer product and specifications.

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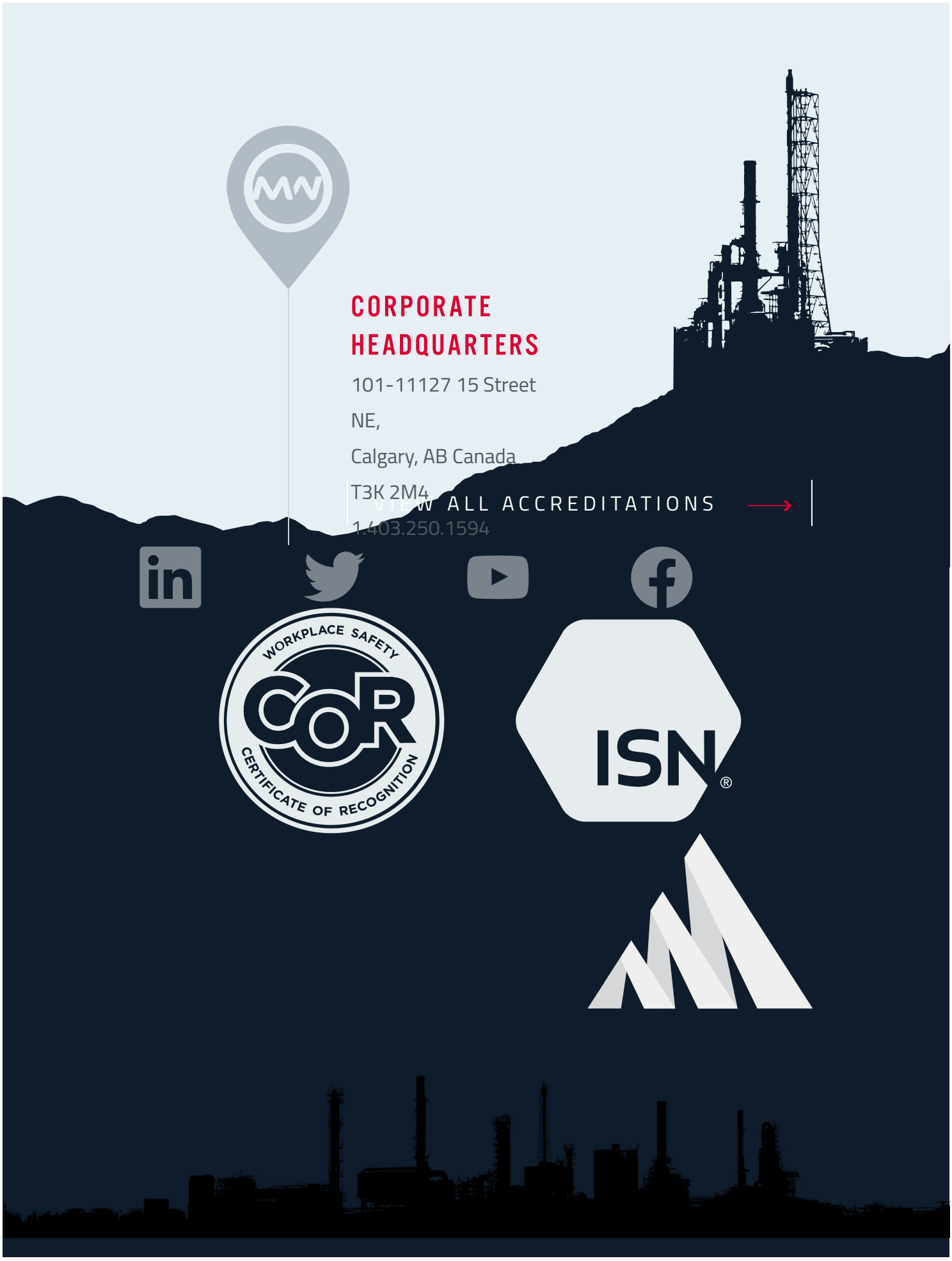
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