Firefighters Guidance Note 6-53: Energy Storage Systems

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Background

According to NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems (most current version), Energy Storage Systems (ESS) are one or more devices, assembled together, capable of storing energy to supply electrical energy at a future time. These types of systems are becoming more common and can be found and used in residential, commercial and industrial applications/locations. There are a variety of forms of these systems that include but is not limited to:

Capacitor Energy Storage System - An electrical energy storage system using capacitors as a storage media.

Electrochemical Energy Storage System - An energy storage system that converts and stores chemical energy to electrical energy and vice versa.

Mechanical Energy Storage System - An energy storage system that converts and stores mechanical energy to electrical energy and vice versa.

Energy Storage System Cabinet - An enclosure containing components of the energy storage system where personnel cannot enter the enclosure other than reaching in to access components for maintenance purposes.

Energy Storage System (ESS) Dedicated-Use Building - A building that is only used for energy storage, or energy storage in conjunction with energy generation, electrical grid-related operations, or communications utility equipment.

Energy Storage System Walk-In Unit - A structure containing energy storage systems that includes doors that provide walk-in access for personnel to maintain, test, and service the equipment and is typically used in outdoor and mobile energy storage system applications.

Mobile Energy Storage System - An energy storage system capable of being moved and utilized as a temporary source of power.

Portable Energy Storage System - An energy storage system suitable to be lifted and moved by a single person without mechanical aid and not permanently connected to an electrical system.

Stationary Energy Storage System - An energy storage system that is permanently installed as fixed equipment.

It is not uncommon for these systems to include an Energy Storage Management System (ESMS) – A system that monitors, controls and optimizes the performance and safety of an energy storage system.

Concerns/hazards

There are a variety of concerns and hazards related to Energy Storage Systems that includes:

Thermal Runaway - Thermal runaway is a term used for the rapid uncontrolled release of heat energy from a battery cell; it is a condition when a battery creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighbouring cells. As this process continues, it can result in a battery fire or explosion. This can often be the ignition source for larger battery fires.

Stranded Energy - As with most electrical equipment there is a shock hazard present, but what is unique about ESS is that often, even after being involved in a fire, there is still energy within the ESS. This is difficult to discharge since the terminals are often damaged and present a hazard to those performing overhaul after a fire.

Stranded energy - Can also cause reignition of the fire hours, days, or even weeks later.

Toxic and Flammable Gases Generated - Most batteries create toxic and flammable gases when they undergo thermal runaway. If the gases do not ignite before the lower explosive limit is reached, it can lead to the creation of an explosive atmosphere inside of the ESS room or container.

Deep Seated Fires - ESS are usually comprised of batteries that are housed in a protective metal or plastic casing within larger cabinets. These layers of protection help prevent damage to the system but can also block water from accessing the seat of the fire. This means that it takes large amounts of water to effectively dissipate the heat generated from ESS fires since cooling the hottest part of the fire is often difficult.

Actions for employers

Employers should:

- Provide information and instructions to familiarize firefighters with the hazards of the Energy Storage Systems
- Where possible, train firefighters on the methods provided by manufacturers to shut down, control or extinguish Energy Storage System fires
- Establish and continually update standard operating guidelines for responding to emergencies related to Energy Storage Systems
- Pre-plan and train for emergency responses when it becomes known that an Energy Storage System is in place at a specific location
- Where possible, pre-planning information regarding Energy Storage Systems should be uploaded into the Computer Aided Dispatch System under a Site Hazard Area of the software to provide responding crews with this information

- Include measures for limiting interaction with lithium-ion batteries and when crews should allow the lithium-ion batteries to continue to burn
- During (where possible) call taking, have dispatch assess whether an Energy Storage System is involved and its location in or near a structure (home, garage and parking garage, etc.)

Considerations

Fire departments should ensure the hazards posed by Energy Storage Systems are mitigated safely and effectively through early identification, assessment, appropriate personal protective equipment (PPE) use and proper scene management. Some key points/considerations to consider are:

<u>Where are Energy Storage Systems Located</u>

- Residential settings, usually near the electrical panel
- Microgrids
- Commercial
- Critical infrastructure
- Utilities

<u>Mitigation and Emergency Response</u>

- Is the system active or shut down?
- Are there abnormal temperature readings? Is there smoke or toxic or flammable gas present?
- Has the fire suppression system been activated?
- Qualified personnel should be contacted to determine system status and implement response procedures

<u>Identify the Hazard</u>

- Location and type of battery systems
- Reference any pre-planning documents
- Reference any safety data sheets

<u>Shutdown</u>

- Communicate shutdown to all personnel – level of shutdown may depend on level of incident

- Secure all non-essential power (may require a qualified person to assist)
- Shut down small breakers before the main breaker
- Shut off main battery disconnect; energy storage systems may still provide power
- Do not enter utility substations, battery installations, or other facilities
- Do not attempt to operate equipment without qualified utility personnel

Watch

- Hazardous energy may still be available in the battery even after shutdown
- Continue to monitor energy storage systems to avoid future fires (may take hours or days)
- Conduct air monitoring and provide proper ventilation
- Avoid any liquid
- Beware of trapped gas and explosion hazards
- Do not approach or attempt entry of a battery room suspected of thermal runaway and off-gassing if life is not at risk

Identify

- Electrolyte Spills
  - Identify the chemistry involved to know the response
  - Reference any pre-plan info available
  - Interview knowledgeable staff
  - PPE and SCBA offer limited protection
  - Dike area around spread – clean up needs to be completed by qualified personnel

Overheated Batteries

- Overheating can be evident by bulging or other deformities
- Air monitoring and ventilation should be ongoing
- If you can see the battery, monitor with a thermal imager for changes in temperature
- When batteries are shut off, they should cool, but it may take time – if temperatures do not go down or continue to rise, there may be a fire

Energy Storage System Fires

- Ensure full PPE and SCBA are being used in firefighting operations
- Review safety data sheets or pre-plans to know battery chemistry and hazards
- Secure water supply
- Evacuate area affected by fire
- Consider turning off HVAC but keep dedicated exhaust for energy storage systems
- Attempt to extinguish the fires (not for sodium sulfide (NaS) battery-type fires)
- Apply water directly to cells if possible to remove heat – if direct water application isn't possible, apply water to protect exposures

- Continue temperature monitoring (may take hours or days to cool, continued explosive and toxic off-gassing, and re-ignition, is possible)
- After the fire, monitor for flammable or toxic gases (always monitor for pockets of stranded gas and never attempt to overhaul a damaged ESS)
- For emergency incidents involving Fixed Energy Storage Systems emergency response personnel should follow the following:

BATTERY ENERGY STORAGE SYSTEM (BESS) EMERGENCIES

QUICK REFERENCE GUIDE

General Warning and Cautions

In the event of damage or fire Involving battery energy storage systems (BESS):

- Always assume the batteries and associated components are energized and fully charged
- Safety Data Sheets (SDS) can provide important information regarding battery chemistry
- Exposed electrical components, wires, and batteries present potential shock hazards
- During incidents involving a BESS, responders should follow the steps: IDENTIFY, SHUTDOWN, WATCH OUT
- Wear all PPE and look away when operating disconnects to protect against arc flash injuries
- Locate building personnel responsible for the system and/or locate emergency contact numbers
- Be prepared to control HVAC systems to prevent spread of smoke and toxic/flammable gases

ALARM ACTIVATIONS		**FIRES**	
Overheated Batteries/Gas Sensor Activation	**Electrolyte Spill**	**Small Fires**	**Large Fires**
• Shutdown of system may not be required, especially if critical systems will be disabled • Monitor battery for potential ignition with thermal imaging camera (TIC)	• Spill may not be visible if batteries are mounted inside a cabinet • Ventilate battery room as necessary	• SHUTDOWN/STOP entire system • Control ventilation of smoke and toxic gases	• SHUTDOWN/STOP entire system • Control ventilation of smoke and toxic gases • Secure adequate water supply

• Check for deformities or bulging of batteries • Check for electrolyte spills • Monitor for toxic /flammable spills • Turn over incident to a qualified responsible party for additional monitoring	• Check safety data sheet for specific hazards and mitigation information • Wearing PPE with SCBA, contain the spill (ensure compatibility with spilled product) • Neutralize and absorb corrosive liquids by qualified personnel • Decontaminate PPE • Turn over incident to a qualified responsible party for additional monitoring	• If applicable, use a dry chemical extinguisher to extinguish the fire • Do not overhaul electrical components • Check for electrolyte spills • Monitor for re-ignition • Turn over incident to a qualified responsible party for additional monitoring	• Extinguish the fire using a fog pattern from a sufficiently sized hose line (Except Sodium Sulfur BESS) • Do not overhaul electrical components • Check for electrolyte spills • Monitor for re-ignition • Turn over incident to a qualified responsible party for additional monitoring

Applicable regulations and acts

Read:

- *Occupational Health and Safety Act*

  Section 25 (1) An employer shall ensure that,
  - (a) the equipment, materials and protective devices as prescribed are provided;
  - (b) the equipment, materials and protective devices provided by the employer are maintained in good condition;
  - (c) the measures and procedures prescribed are carried out in the workplace;
  - (d) the equipment, materials and protective devices provided by the employer are used as prescribed
  - clause 25(2)(h) for taking every precaution reasonable to protect workers

  Duties of workers
  - 28 (1) A worker shall,
  - (a) work in compliance with the provisions of this Act and the regulations;
  - (b) use or wear the equipment, protective devices or clothing that the worker's employer requires to be used or worn;

Applicable standards

NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems (most current version),

Hydro One BESS Fire Prevention Risk & Response Assessment Standard

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Related

Guidance Note 4-1 Firefighters Protective Clothing

Guidance Note 6-1 Hygiene and Decontamination

Guidance Note 6-50 Lithium-Ion Batteries (Coming soon. Not yet posted)
