Hydro One Networks Inc.

BESS Fire Protection Risk & Response Assessment Standard

Prepared for:

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1.0 INTRODUCTION

Fire & Risk Alliance, LLC (FRA) was requested by Hydro One Networks Inc., a licensed electricity transmitter in Ontario, Canada (client or Hydro One) to develop a Fire Protection Risk & Response Assessment Standard (FPRRAS) which defines the required risk analysis, policies, and processes that will be required to ensure that emergencies and fires within Battery Energy Storage System (BESS) sites do not pose a risk to Transmission Facilities.

The FPRRAS is intended to provide a high-level outline of fire protection requirements and best industry practices to an acceptable level of fire protection using active systems, passive systems, and procedural safeguards. The FPRRAS references fire protection requirements of the National Fire Code of Canada (NFC) 2020 and the Fire Code, O. Reg. 213/07 (Ontario) made under the *Fire Protection and Prevention Act, 1997* (Ontario).

Recognizing that current codes, standards, and guidelines do not consider the consequences of any BESS events on Transmission Facilities, this FPRRAS defines setback requirements for the BESS from Transmission Facilities for maintaining reliability and integrity of the transmission system and ensuring long-term resiliency and sustainability. In addition, Good Utility Practice is referenced where applicable.

2.0 PURPOSE

To ensure the protection of Hydro One's assets and continuity of operations associated with BESS interconnections, FRA will provide information within the Fire Protection Risk & Response Assessment Standard to address the following:

- Fire Propagation & Explosion Risk Analysis Requirements
- Hydro One Setback Requirements from Utility Transmission Facilities and Equipment
- Fire Protection System (Detection & Suppression) Requirements
- Fault Condition Assessment
- Explosion Mitigation Requirements
- Commissioning Plan
- Operations & Maintenance Plan
- Decommissioning Plan
- Emergency Response Plan

3.0 APPLICABLE CODES AND STANDARDS

The standards and codes referenced in this document are applicable at the time of issuance and may change over time. The general intent is to apply the current version of the standards in between document revisions.

3.1 Adopted Standards and Codes

- National Building Code of Canada (NBC) 2020
  - NFPA 72, National Fire Alarm and Signaling Code – 2019 Edition
  - NFPA 101, Life Safety Code – 2018 Edition
- National Fire Code of Canada (NFC) 2020
  - NFPA 13, Standard for the Installation of Sprinkler Systems – 2019 Edition
  - NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems – 2017 Edition
  - NFPA 68, Standard on Explosion Protection by Deflagration Venting – 2013 Edition
  - NFPA 69, Standard on Explosion Prevention Systems – 2014 Edition
- Fire Protection and Prevention Act (FPPA) – 1997
- Ontario Fire Code, a regulation under the FPPA – April 11, 2022

3.2 Recommended Industry Applicable Standards and Codes

- National Fire Protection Association – USA
  - NFPA 551, Guide for the Evaluation of Fire Risk Assessments – 2022 Edition
  - NFPA 850, Recommended Practice for Fire Protection for electric Generating Plants and High Voltage Direct Current Converter Stations – 2020 Edition
  - NFPA 855, Standard for the Installation of Stationary Energy Storage Systems – 2023 Edition
- Underwriters Laboratories – USA
  - UL 1973, Batteries for Use in Stationary and Motive Auxiliary Power Applications – 2022 Edition
  - UL 9540, Energy Storage Systems and Equipment – 2020 2nd Edition
  - UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems – 2019 4th Edition
- Institute of Electrical and Electronics Engineers – USA
  - IEEE 979, Guide for Substation Fire Protection – 2012 Edition
  - IEEE 2030.2.1, Guide for the Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Application Integrated with Electric Power Systems – 2019 Edition

4.0 TERMS AND DEFINITIONS

Authority Having Jurisdiction (AHJ) [NFPA 855 §3.2.2]: An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Battery Energy Storage System (BESS) [UL 9540A §4.2]: Stationary equipment that receives electrical energy and then utilizes batteries to store that energy to supply electrical energy at some future time. The BESS, at a minimum consists of one or more modules, a power conditioning system (PCS), battery management system (BMS), and balance of plant components.

Battery Management System (BMS) [NFPA 855 §3.3.3]: A system that monitors, controls, and optimizes performance of an individual or multiple battery modules.

BESS Event: Failure of the BESS equipment or facilities that results in fire and/or emission of pollutants or smoke.

Cell [UL 9540A §4.3]: The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy.

Combustible: Readily or easily ignitable material. Specific definitions vary depending on material: dust, fibers, liquids.

Combustible Liquid [NFC §1.4.1.2]: A liquid having a flash point at or above 37.8°C and below 93.3°C.

Community Risk Analysis (CRA): An evaluation of exposure hazard utilizing a consequence analysis approach for the BESS facility.

Energy Storage Management System (ESMS) [NFPA 855 §3.3.8]: A system that monitors, controls, and optimizes the performance and safety of an Energy Storage System.

Energy Storage Systems (ESS) [NFPA 855 §3.3.9]: One or more devices, assembled together, capable of storing energy to supply electrical energy at a future time.

Energy Storage System Cabinet [NFPA 855 §3.3.9.2]: 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.

Fire Resistance Rating [NFC §1.4.1.2]: The time, in minutes or hours, that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in the National Building Code of Canada (NBC) 2020.

Fire Risk Assessment (FRA): A process to characterize the risk associated with a BESS fire that addresses the fire scenarios of concern, their probability, and their potential consequences.

Good Utility Practice: means any of the practices, methods and acts engaged in or approved by a significant portion of the electrical utility industry in North America during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to optimum practices, methods or acts to the exclusion of all others, but rather to include all practices, methods or acts generally accepted in North America.

Hazard Mitigation Analysis (HMA) [NFPA 855 §3.3.14]: An evaluation of potential Energy Storage System failure modes and the safety-related consequences attributed to the failures.

Lithium-ion battery: A storage battery with lithium ions serving as the charge carriers of the battery. The electrolyte is a polymer mixture of carbonates with an inorganic salt and can be in a liquid or a gelled polymer form. Lithiated metal oxide is typically a cathode and forms of carbon or graphite typically form the anode.

Module [UL 9540A §4.9]: A subassembly that is a component of a BESS that consists of a group of Cells or electrochemical capacitors connected together either in a series and/or parallel configuration (sometimes referred to as a block) with or without protective devices and monitoring circuitry.

Proponents: A person or company advocating and supporting the connection of BESS equipment/facilities to the Hydro One transmission system.

Stationary Energy Storage System [NFPA 855 §3.3.9.7]: An Energy Storage System that is permanently installed as fixed equipment.

Thermal Runaway [UL 9540A §4.11]: The incident when an electrochemical Cell's temperature increases at an accelerating rate in an uncontrollable fashion sufficient to result in damage to the Cell. The Thermal Runaway progresses when the Cell's generation of heat is at a higher rate than the heat it can dissipate. This may lead to fire, explosion and gas and smoke evolution.

Transmission Facilities: Refers to facilities owned by an electricity transmitter that form part of or all the transmission system owned by that transmitter, and includes any structures, lines, transformers, breakers, disconnect switches, buses, voltage/current transformers, protection systems, telecommunications systems, cables, and any other auxiliary equipment used for the purpose of conveying electricity.

Unit [UL 9540A §4.12]: A frame, rack, or enclosure that consists of a functional BESS facility which includes components and subassemblies such as Cells, modules, battery management systems, ventilation devices and other ancillary equipment.

5.0 MINIMUM DESIGN DOCUMENTATION

The following are the assessments required based on industry practice for proposed BESS installations:

- Code Review
- Hazard Mitigation Analysis (HMA), Including:
  - UL 9540 Listing
  - UL 9540A Test Reports
  - Fault Condition Assessment
- Fire Risk Assessment (FRA), Including:
  - Community Risk Assessment
  - Air/Gas Dispersion Study
- Fire Protection Design Documentation, Including:
  - Passive Fire Protection Systems
  - Active Fire Protection Systems
- Commissioning Plan
- Emergency Response Plan

5.1 Hazard Mitigation Analysis

A Hazard Mitigation Analysis (HMA) is a documented report evaluating the potential BESS failure modes and the safety-related consequences attributed to the failures [NFPA 855 §3.3.14].

A hazard mitigation analysis shall be provided to the Authority Having Jurisdiction (AHJ) for review and approval where any of the following conditions are present [NFPA 855 §4.4.1]:

- Technologies not outside of the threshold quantities for each fire area including battery chemistries not identified by the prescriptive codes
- More than one BESS technology is provided in a single fire area where adverse interaction between the technologies is possible
- Where allowed as a basis for increasing maximum stored energy
- Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements
- Where required for existing lithium-ion BESS systems that are not UL 9540 listed
- Where required for outdoor lithium-ion BESS systems

The HMA shall evaluate the following consequences for failure modes of the BESS [NFPA 855 §4.4.2]:

- A Thermal Runaway or mechanical failure condition in a single BESS Unit

- Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)
- Failure of a required protection system including, but not limited to, cooling system, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection

The HMA is permitted to be approved by the AHJ if the consequences of the document demonstrate that [NFPA 855 §4.4.3]:

- Fires will be contained within unoccupied BESS rooms for the minimum duration of the fire resistance rating specified in 9.6.4.
- Fires and products of combustion will not prevent occupants from evacuating to a safe location.
- Deflagration hazards will be addressed by an explosion control or other system.
- Fires and products of combustion will not adversely impact Transmission Facilities.

HMA requires a Fault Condition and Effects Analysis. The HMA shall also be provided to Hydro One as a part of self-certification document requirement:

5.1.1 Fault Condition Assessment

A fault condition assessment is a tool to evaluate the critical safety components and circuits of an Energy Storage System and system design by identifying the potential failure modes and their potential causes, consequences, and recommended mitigations to reduce risk. The failure modes are to be compared against the existing system installations to identify which could detect the failure mode. Rankings of occurrence and detection are specified to quantify the risk associated with each failure mode. For failure modes with unacceptable risk, mitigations are proposed to reduce the potential risk to adequate/manageable levels.

A fault condition assessment shall be conducted and provided by the [BESS] system manufacturer to the AHJ and Hydro One, which examines the potential causes and effects of specific failures of components of the BESS. The following Fault Conditions shall be assessed as outlined in NFPA 855:

- Thermal Runaway
- Failure of BMS
- Failure of Ventilation or Exhaust System
- Short circuit on load side of BESS
- Failure of fire detection and suppression system
- Spill neutralization
- Protection from external environment

The fault condition assessment is to be presented as a running document with explanatory information or as a diagrammatic Bowtie style report identifying connections between failure modes and their associated effects.

5.2 Fire Risk Assessment

A Fire Risk Assessment (FRA) is a guide intended to aid AHJs in evaluating the appropriateness and execution of a given fire safety problem. The FRA primarily addresses regulatory officials; it is intended for others who review FRAs, such as insurance company representatives and building owners. The FRA does not mandate the methods for use in demonstrating acceptable risk; rather, it describes the technical review process and documentation that are needed in evaluating an FRA [NFPA 551 §1.1].

The perception of risk, and therefore the acceptance of risk, is influenced by the values of the stakeholders. Thus, the values of the stakeholders should be established in the risk metrics which may include life safety, property, business interruption, and intangibles. The metrics associated with these values may be people affected, dollars of loss, acreage, and so forth. The expression of the metric is usually rate based (e.g., frequency, or probability of occurrence over a specified time period). The stakeholders may attach different weights to a given risk, based on their perspective. Hydro One and the local AHJ may have their own weighting depending on role, location, and perceived value [NFPA 551 §1.5].

For fire safety, the hazards are generally fire, explosion, smoke, and toxicity associated with fire products. The likelihoods and corresponding consequences are derived from fire scenarios associated with these hazards. The impacts or harm from the fire scenarios are expressed in the metrics associated with the values, such as number of people affected per location per year [NFPA 551 §1.5.2]. This evaluation considers Community Risk and perceived risk based on the potential air/gas dispersion study.

The FRA is to list fire scenarios for a single or multi-system installation and assess the impact on risk given changes to a number of BESS installations parameters and fire protection systems (active and passive) outlined by stakeholders and involved parties. The assessment will provide numerical values for varying outcomes from the identified fire scenarios for stakeholders to evaluate what systems and criteria are weighed more heavily than others.

This FRA document is essential to the evaluation for each BESS installation to estimate risk associated with a fire event. The document will include a Risk Matrix evaluating probability levels and severity categories to represent a two-dimensional graphic. The ranges will indicate improbable hazards with negligible consequences to frequent hazards with severe consequences [NFPA 551 §5.2.5].

5.2.1 Community Risk Analysis

A Community Risk Analysis (CRA) is to be conducted to evaluate the potential thermal, overpressure and toxic hazards to the site, personnel, and the surroundings. Specifically, the objectives of the CRA study are to identify fire, deflagration, and gas release scenarios from the BESS that may impact the site and population surrounding the BESS facility without any mitigation measures. The CRA also analyzes the consequences of these scenarios to identify those, if any, that have potential for offsite impact as well as provides estimates for on-site impacts.

If applicable, and based on consequence analysis results, combine the hazard zones, frequencies of accident scenarios, and population data to calculate risk to the surrounding population. If applicable, and based on consequence analysis results, present societal risk as frequency versus potential fatality curves (F-N curves). All analysis to be done using module level gas venting calculations supplied by the manufacturer. The CRA is based on information provided by the manufacturer as well as gathered from publicly available sources. Supporting documents provide the information necessary to ascertain the likelihood and impact of hazardous consequences to surrounding populations.

5.2.2 Air/Gas Dispersion Study

Accidents begin with an incident, which usually results in a release of hazardous, toxic, or flammable material from a storage site or facility. A consequence analysis evaluates the expected outcome of an event and is measured or expressed as a hazard distance, hazard zone, or a hazard value at a specific location. A quantitative consequence analysis is carried out using mathematical models and computer software addressing the physical and chemical phenomenon.

Before conducting a consequence analysis, it is necessary to identify events that could follow the release of a hazardous material. The consequence analysis considers a range of potential hazards. In general, a hazardous material release may exhibit one or more of the following types of hazards:

- Flammable exposure (thermal radiation, flame impingement)
- Explosions (blast overpressure)
- Toxic vapor exposure or dispersion

A site-specific consequence analysis of the accidental release scenarios is to be conducted using the commercially available tool such as Process Hazards Analysis Software Tool (PHAST) consequence modeling software, or approved equivalent. PHAST can be used to determine the fire, toxic, and blast overpressure hazard consequences. The TNO Multi-Energy methodology within the PHAST tool can be used to evaluate any potential vapor cloud explosions.

5.3 Fire Protection Design Documentation

Fire protection design documents (e.g., design drawings, permit drawings, shop drawings, etc.) should be submitted in accordance with the requirements of the permitting AHJ as the project progresses. Documents shall be prepared in accordance with the applicable codes and standards listed herein and any local-authority specific requirements. Documents should be submitted for each type of system provided in the BESS installation for coordination and review.

6.0 BESS CLASSIFICATION AND SPATIAL SEPARATION

6.1 BESS Installation Classifications and Code Requirements

NFPA 855 requirements pertaining to BESS equipment must be applied for the site if the BESS threshold energy capacity is greater than shown in Table 1. Energy Storage System Threshold Quantity [NFPA 855 Table 1.3].

Table 1. Energy Storage System Threshold Quantity [NFPA 855 Table 1.3]

Technology	Energy Capacity
Lithium-ion Batteries	20 kWh
Lead-Acid	70 kWh
Ni-Cad, Ni-MH, Ni-Zn	70 kWh

If a single installation of a BESS system exceeds the energy threshold capacity, the requirements of NFPA 855 are to be applied. For all installations over the threshold quantity the documentation outlined in Section 5.0 Minimum Design Documentation is to be provided to Hydro One and the AHJ.

For outdoor BESS installations, NFPA 855 provides code requirements based on the proximity and location of the BESS equipment from adjacent lot lines. The installation classifications are listed below in Section 6.2 BESS Installation Location Classifications.

6.2 BESS Installation Location Classifications

BESS installations can be categorized into two types of locations per NFPA 855 §9.3. The installation classifications are as follows:

- Indoor Installation
  - *Dedicated-use Buildings:* The building shall only be used for energy storage, or energy storage in conjunction with energy generation, electrical grid-related operations, or communications utility equipment.
  - *Non-Dedicated-Use Buildings:* The building shares its uses with installation and occupiable spaces not related to the BESS installation.
- Outdoor Installation
  - *Remote Locations*: BESS located more than 100 ft (30.5 m) from buildings, lot lines that can be built upon, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.
  - *Locations Near Exposures*: BESS locations that do not comply with remote outdoor location requirements.
  - Specific outdoor locations
    - *Rooftop Installations*: BESS installations located on the roofs of buildings.

- *Open Parking Garage Installations*: BESS installations are those located in a structure or portion of a structure with the openings on two or more sides that is used for the parking or storage of motor vehicles.

BESS installations typically fall under two of the categories listed above: Outdoor Installation and Indoor Installation.

The NFPA requirements for remote locations classification are less stringent compared to locations near exposures classification, and less stringent compared to dedicated use building classification, and so on. In rural applications, some project sites may not meet the definition of remote locations classification but have no significant exposure hazards. For such cases, dialogue with the local AHJ may permit re-classification of the BESS facility.

NFPA 855 provides requirements on system installations based on proximity and location of the BESS. The table involving outdoor installations is included below.

Table 2: NFPA 855 Table 9.5.2 Outdoor Stationary ESS Installations

Compliance Required	Remote Locations	Locations Near Exposures	NFPA 855 Reference
Administrative	Yes	Yes	Chapters 1-3
General	Yes	Yes	Sections 4.1-4.7
Maximum size	Yes	Yes	Section 9.5.2.4
Clearance to exposures	NA	Yes	Section 9.5.2.6.1
Means of egress separation	NA	Yes	Section 9.5.2.6.1.7
Walk-in units	Yes	Yes	Section 9.5.2.3
Vegetation control	Yes	Yes	Section 9.5.2.2
Enclosures	Yes	Yes	Section 4.6.12
Size and separation	No	Yes	Section 9.4.2
Maximum stored energy	No	Yes	Section 9.4.1
Smoke and fire detection	Yes	Yes	Section 9.6.1
Fire control and suppression	Yes	Yes	Section 9.6.2
Water supply	Yes	Yes	Section 9.6.3
Signage	Yes	Yes	Section 4.7.4
Occupied work centers	Not allowed	Not allowed	Section 9.5.1.2.1
Technology-specific protection	Yes	Yes	Section 9.6.5

Table 3: NFPA 855 Table 9.5.1 Indoor ESS Installations

Compliance Required	ESS Dedicated Use Buildings	Non Dedicated Use Buildings	NFPA 855 Reference
Administrative	Yes	Yes	Chapters 1-3
General	Yes	Yes	Sections 4.1-4.7
Size and separation	Yes	Yes	Section 9.4.2
Maximum stored energy	No	Yes	Section 9.4.1
Elevation	Yes	Yes	Section 4.7.7
Fire Barriers	NA	Yes	Section 9.6.4
Smoke and fire detection	Yes	Yes	Section 9.6.1
Fire control and suppression	Yes	Yes	Section 9.6.2
Water supply	Yes	Yes	Section 9.6.3
Signage	Yes	Yes	Section 4.7.4
Occupied work centers	Not allowed	Yes	Section 9.5.1.2.1
Technology-specific protection	Yes	Yes	Section 9.6.5

The BESS system is required to be separated from adjacent exposures per NFPA 855. The indicated minimum separation clearance requirement is permitted to be reduced based on the UL 9450A test result and approvals from the AHJ. The BESS shall not be located such that it is a direct exposure to stored combustibles, other exposure hazards not associated with electrical grid, and means of egress. The required separation distance is permitted to be reduced to 3 feet when a 1-hour freestanding fire barrier is installed between exposures and the BESS assembly.

6.3 Maximum Allowable Quantities (MAQ)

NFPA 855 requires that all areas containing BESS shall not exceed the Maximum Allowable Quantity (MAQ) of energy capacity shown in Table 4. However, where approved by the fire code official, areas containing BESS that exceed the MAQ shall be permitted based on a HMA and fire testing conducted in accordance with the requirement of NFPA 855 [NFPA 855§9.4.1].

Table 4. Energy Storage System MAQ [NFPA 855 Table 9.4.1]

Battery Type	MAQ Energy Capacity
Lithium-ion	600 kWh
Lead-Acid	Unlimited
Nickel	Unlimited

NFPA 855 does not limit MAQ for outdoor remote installations. An HMA is required for all BESS installation that exceed 600 kWh regardless of MAQ.

6.4 BESS Spatial Separations

Spatial separation distance is measured as a straight line from the BESS equipment edge to the exposure of concern or to the anticipated flame front. Spatial separation is an effective method for reducing fire spread damage.

6.4.1 BESS Clearance to Exposures

BESS equipment is required to be separated from adjacent exposures as shown in Table 5: BESS Clearance to Exposures [NFPA 855 §9.5.2.6.1. Note: NFPA 855 does not require clearance to exposures for remote locations classification.

Table 5: BESS Clearance to Exposures [NFPA 855 §9.5.2.6.1]

Adjacent Exposures	Minimum Clearance NFPA 855 §9.5.2.6.1
Lot Lines	10 feet (3 m)
Public Way	10 feet (3 m)
Buildings	10 feet (3 m)
Stored combustible materials	10 feet (3 m)
Hazardous Materials	10 feet (3 m)
High-Piled Stock	10 feet (3 m)
Other Exposure Hazards	10 feet (3 m)

The following exceptions can be used to reduce the clearance limit for BESS facilities with limited spacing.

- Exception 1 [NFPA 855 §9.5.2.6.1.1]: Clearances are permitted to be reduced to 3 feet (0.9 m) where a 1-hour free-standing fire barrier, suitable for exterior use, and extending 5 feet (1.5 m) above and 5 feet (1.5 m) beyond the physical boundary of the BESS installation is provided to protect the exposure.
- Exception 2 [NFPA 855 §9.5.2.6.1.2]: Clearances to buildings are permitted to be reduced to 3 feet (0.9 m) where noncombustible exterior walls with no openings or combustible overhangs are provided on the wall adjacent to the BESS and the fire-resistance rating of the exterior wall is a minimum of 2 hours. Openings consist of doors, windows, vents, louvers, etc.
- Exception 3 [NFPA 855 §9.5.2.6.1.4 & §9.5.2.6.1.5]: Clearance to exposures other than buildings shall be permitted to be reduced to 3 feet where fire and explosion testing of the BESS demonstrates that a fire within the BESS enclosure will not generate radiant heat flux sufficient to ignite exposures. Clearances to buildings and exposures shall be

permitted to be reduced to 3 ft (0.9 m) where the enclosure of the ESS has a 2-hour fire resistance rating established in accordance with ASTM E119 or UL 263.

6.4.2 BESS Means of Egress Separation

Outdoor BESS are to be separated from any means of egress component from buildings as required by the code official to ensure safe egress under fire conditions, but never less than 10 feet (3 m) [NFPA 855 §9.5.2.6.1.7(A)]. The separation code requirement includes the exterior exit discharge path.

Means of egress is comprised of three distinct components: exit access, exit, and exit discharge. Where BESS units are installed adjacent to occupiable buildings (i.e., office buildings, warehouses, factories, etc.), close attention to means of egress separation is required to ensure safe passage of the building occupants. BESS facilities with unmanned electrical grid infrastructure buildings typically do not need to account for means of egress separation.

Where approved by the AHJ, clearances are permitted to be reduced to 3 feet (0.9 m) where fire and explosion testing demonstrates that a fire within the BESS will not adversely impact the means of egress [NFPA 855 §9.5.2.6.1.7(B)].

The 10 feet minimum separation to means of egress components should be adhered to for all BESS installations. Where 10 feet (3 m) separation is not possible, the BESS equipment is able to utilize reduced 3 feet (0.9 m) separation with approval of the HMA by the AHJ.

6.4.3 Vegetation

Forest and grass fires can expose the BESS equipment to conductive smoke, fire plumes, radiant heat, and soot. Similarly, BESS equipment failure may expose the surrounding forested or vegetative areas to radiant heat.

Areas within 10 feet (3 m) on each side of outdoor BESS shall be cleared of combustible vegetation and other combustible growth [NFPA 855 §9.5.2.2.1]. Single specimens of trees, shrubbery, or cultivated ground cover such as green grass, ivy, succulents, or similar plants used as ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire [NFPA 855 §9.5.2.2.2].

In addition, the surrounding vertical vegetation (i.e., trees) heights should be analyzed to minimize fall potential that exists to the BESS facility.

6.4.4 General Spatial Separation of Oil-Insulated Equipment

Equipment and buildings should be separated from oil-insulated equipment to minimize the impact of a major fire. The spatial separation between the electrical equipment and oil-insulated equipment should be taken from the equipment edge to the anticipated flame front for large (i.e., >500 gallons [1,900 liters]), oil-filled equipment. The grid transformers are typically the largest oil-insulated equipment found in an electrical substation with a typical oil capacity of 3,000 – 7,000 gallons (11,400 – 26,500 liters). It is recommended that the oil filled equipment be separated based on the volumes identified in Table 6: Recommended Oil-Insulated Equipment Separation Distance [NFPA 850 Table 6.1.4.3].

Table 6: Recommended Oil-Insulated Equipment Separation Distance [NFPA 850 Table 6.1.4.3]

Equipment Oil Volume	Minimum Separation Distance
< 500 gallons (1,900 liters)	5 feet (1.5 m) 10 feet (3 m)
500-5,000 gallons (1,900 – 19,000 liters)	25 feet (7.6 m)
> 5,000 (19,000 liters)	50 feet (15.2 m)

Where oil containment is provided, the boundary of the oil containment should be considered as the anticipated flame front. Where oil containment is not provided, the spatial separation should consider the resulting anticipated flame spill area with permeability of the ground surface material. For equipment with oil volume more than 500 gallons (1,900 liters), the spatial separation should be taken from the equipment edge.

Where oil containment pits are provided with stone flame suppression, the spatial separation may be reduced pending AHJ approval, given that stone flame suppression surface is well maintained and free of dirt, debris, and organic matter that could prevent oil absorption.

The spatial separation between electrical equipment and small oil-filled equipment greater than 500 gallons (1,900 liters) should be taken from equipment edge to equipment edge. Small oil-filled equipment commonly found in BESS facilities consists of inverter transformers, medium voltage skids, and auxiliary transformers. General electrical equipment should be provided with 5 feet (1.5 m) minimum separation and BESS should be provided with 10 feet (3 m) separation.

As a good engineering practice, BESS equipment and other critical buildings should not be installed down slope of large oil-insulated equipment where failure of equipment or oil containment could engulf BESS equipment and critical buildings with combustible liquids.

For BESS sites where spatial separations to large oil-insulated equipment greater than 500 gallons (1,900 liters) cannot be provided due to site restrictions or limitations, the following options could be used:

- Fire barriers
- Calculated spatial separation

6.4.5 Fire Barriers

Passive fire protection using fire barriers of suitable construction may be installed as a means of spatial separation protection when the recommended separation distances cannot be achieved. Suitable construction may involve fire-resistive materials such as reinforced concrete, concrete masonry units (CMU), composite materials, or brick masonry.

For separation of BESS units to oil-insulated equipment greater than 500 gal (1,900 liters), a 2-hour fire barrier is recommended. The fire barrier construction should extend vertically and horizontally to block the line of site between the BESS unit to the exposure hazard.

6.4.6 Calculated Spatial Separation

As an alternative to prescriptive methods and separation distances, the minimum spatial separation may be derived from deterministic heat flux calculations. This method of calculated spatial separations is unique to the specific BESS project site and requires involvement of fire protection consultants/scientists and AHJ approval. This calculation method does not guarantee a successful outcome and end recipient of any calculations should be cautious of outcomes.

Example of project site specific parameters considered for calculated spatial separation analysis are as follows:

- Type and quantity of oil in the equipment
- Size of possible oil spill (surface area and depth)
- Type of construction of adjacent structures
- Type and amount of exposed equipment
- Power rating of exposed energized electrical equipment
- Provided fire protection systems
- Provided oil-filled equipment passive protection systems

Additional site-specific parameters may be needed for analysis depending on site specific conditions. This method is only recommended where the project site limitations do not permit prescriptive separation.

7.0 HYDRO ONE SETBACK REQUIREMENTS FOR CRITICAL TRANSMISSION INFRASTRUCTURE

7.1 Introduction

High voltage Transmission Facilities are part of the critical infrastructure and are extremely important for a safe, secure, and reliable supply of electricity. An outage on these facilities can result in power interruptions over a widespread area far from where the facility may be located. In Ontario, the Transmission System Code (TSC) requires the transmission company to maintain the reliability and integrity of its transmission system. It is therefore of the utmost importance that Hydro One ensures that the operation of these facilities is not affected by any BESS event.

In addition to the general requirements by the national and international codes for product and public safety, the setback distance for a BESS from high voltage Transmission Facilities, not addressed by the current codes and standards, depends on several factors, including local regulations, safety considerations, and project-specific requirements. Some general guidelines and considerations are as follows:

- Local regulations and codes: Different jurisdictions may have specific regulations or codes that dictate setback distances for BESS facility from Transmission Facilities. These regulations are typically in place to ensure safety and mitigate potential risks.
- Safety considerations: Safety is a crucial factor in determining setback distances. Lithium-ion batteries used in ESS have the potential to generate heat and, in rare cases, pose fire risks. Setback distances are established to minimize the risk of fire propagation and to provide adequate separation between the ESS and the Transmission Facilities.
- Emergency access and maintenance: Sufficient setback distances should be provided to allow for emergency access and maintenance activities for both the ESS and the Transmission Facilities. Adequate space is necessary for trucks and heavy machinery to conduct routine inspections, repairs, and emergency response activities to ensure safe, secure, and reliable operation of both systems.
- Transmission Facilities expansion plans: Sufficient setback distances should be provided to allow space for future transmission system expansion, and the BESS should not restrict the expansion of existing transmission right of ways or stations. For example, BESS should not limit the egress of new transmission circuits from transmission stations. Consideration should be given to ensure there is sufficient space around Transmission Facilities (both lines and stations)

It is strongly recommended that the transmitter be consulted for any location that is in proximity to the Transmission Facilities.

7.2 Safety and Design Approach for Minimizing Impact on Transmission Facilities

As mentioned above, high voltage Transmission Facilities are critical for ensuring a safe, secure, and reliable supply of electricity. It is therefore of the utmost importance that the operation of these facilities is not affected by any BESS failure event. A two-step approach is to be followed to minimize, control, or eliminate the impact of BESS events on the Transmission Facilities.

The first set of requirements are design and testing of the BESS based on existing standards and industry experiences that minimize the adverse impacts from a BESS event, along with adequate protection and control, and spatial separation within the BESS facility itself. Most of the current safety requirements documented by the NFPA and others are targeted towards minimizing the possibility of the BESS event happening. This is covered by rigorous BESS design and testing requirements according to various codes as described earlier in Section 3. Design documentation and spatial separation between battery Units are covered in Sections 5 and 6. The primary purpose is to reduce the probability of initiating an event in the first place. However, if it were to happen, the goal is to minimize the spread of the ensuing fire from a worker and public safety perspective, and also minimize the number of battery units affected.

The second set of requirements and/or considerations are to establish and maintain appropriate spatial separation of the BESS facility from the Transmission Facilities. A spatial separation ensures that BESS facility results in minimal or no impact on the present and/or future expansion of Transmission Facilities and the impact of the event is confined to the immediate BESS area. However, the 100 ft (30.5 m) separation for larger BESS facilities in standalone locations (classified as Outdoor Remote according to NFPA) is a NFPA requirement and does not provide guidance on separation from Hydro One's critical Transmission Facilities.

The key considerations from a transmitter perspective to assure the safe, secure, and reliable design and operation of BESS are:

- There must be sufficient setback distances for multiple purposes: to allow safe operation of the transmission system and to allow for maintaining, connecting, and expanding the transmission system as needed.
- The BESS event must not result in an outage of an adjacent transmission line or transmission station due to direct impact of smoke, combustion particles and/or fire.
- The BESS must not restrict or inhibit operation or expansion of Transmission Facilities (transmission line and/or transmission station).
- The BESS must not restrict egress or entry of transmission lines in and/or out of an adjacent transmission (or distribution?) substation.
- The BESS event must not result in a situation where the first responders to the BESS event require the Transmission Facility to be taken out of service to ensure a safe work area.

In addition, this helps ensuring long-term resiliency and sustainability of the transmission system.

7.3 Hydro One BESS Setback Requirement

Hydro One previously provided setback requirements for BESS facilities in its Transmission Generation Interconnection Requirement document in December 2022. These setback requirements have been reviewed based on the considerations presented above in Sections 7.1 and 7.2, and are summarized below:

Table 7 Hydro One Required BESS Facility Separation Distance Requirements

Item #	Hydro One Facilities	Hydro One Setback Distance[1,2]
1	Hydro One - 500 kV Right of Way (ROW)	150 meters
2	Hydro One - 230 kV ROW	100 meters
3	Hydro One - 115kV ROW	60 meters
4	Hydro One - 500 kV Substation	300 meters
5	Hydro One - 230kV Switching Substation	200 meters
6	Hydro One 115kV Switching Substation or Hydro One 230kV & 115kV step down Substation	120 meters

1. All distances are from the edge of right of way or Hydro One station property line.

2. For proponents that have acquired property rights or own the BESS property prior to January 1, 2023, and cannot meet the above distances, the layout must be discussed with Hydro One for assessment and approval.

The above separations are the minimum Hydro One requirements. It is suggested/expected that BESS Proponents promptly discuss the BESS layout and location with Hydro One to ensure it is not in conflict with Hydro One's Transmission Facilities including future expansion plans.

Two general depictions of common Transmission Facilities can be seen in Figures 1 and 2 below. Note that the figures are for visualization purposes only and multiple transmission lines of different voltages may enter and exit from a transformer station or substation in varying directions. The distances are from edge of the right of way or the transformer station property line.

Figure 1 Setback distance from substation property line

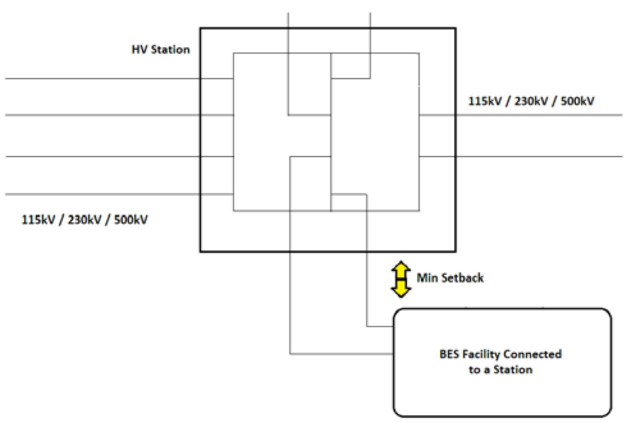
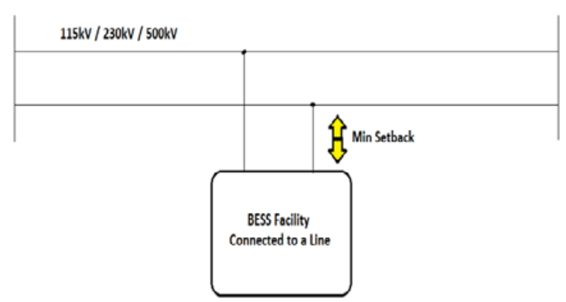


Figure 2 Setback distance from edge of right of way



These setback distances achieve multiple purposes: allow safe operation of the grid, allow for maintaining, connecting, and expanding the transmission system or transformer station as needed, and reduce the potential for the BESS facility to damage Transmission Facilities in case of unplanned events. In addition, it allows access in case of emergency on the transmission system or the BESS installation. Note that Proponents must meet all the applicable setback requirements.

Prior to connecting to the transmission system, the BESS facility Proponent is required to provide a signed self-certification document provided in Section 14 indicating that the following assessments as shown in the table below have been carried out and that the BESS poses no known safety risks or unmitigated hazard to the Hydro One employees and Hydro One's transmission system. The assessment reports will be made available to Hydro One, if/when requested, within 15 days of the request being made.

Table 8 Hydro One Required Assessments

Required Assessments	Up to 250m from Lines ROW	Up to 400m from Stations Property Line
• Hazard Mitigation Analysis (HMA) o Code Review o UL 9540 Listing o UL 9540A Test Report o Fault Condition Assessment	Required	Required
• Fire Risk Assessment (FRA) o Community Risk Assessment o Air/Gas Dispersion Study	Required	Required
• Fire Protection Design Documentation o Passive Fire Protection System o Active Fire Protection Systems	Required	Required
• Commissioning Plan	Required	Required
• Decommissioning Plan	Required	Required
• Emergency Response Plan o Fire Department Training	Required	Required

8.0 FIRE PROTECTION SYSTEM REQUIREMENTS

8.1 Fire Alarm & Detection System

An approved automatic smoke detection system shall be installed for each outdoor BESS. Where the BESS manufacturer does not permit smoke detector installation, a BESS site facility radiant energy-sensing fire detection shall be installed. The fire alarm system shall annunciate alarm, trouble, and supervisory conditions in accordance with the applicable codes.

Alarm signals from the detection systems shall be transmitted to a central station, proprietary, or remote station service in accordance with NFPA 72 [NFPA 855 §4.8]. The Fire Alarm and Control Panel (FACP) could alternatively be monitored by the substation SCADA system for alarm, trouble, and supervisory (where applicable) conditions if approved by the Hydro One and the AHJ for variance. If desired, trouble and supervisory signals can be combined into a single point monitored by SCADA.

Smoke and fire detection systems protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply in accordance with NFPA 72 capable of 24 hours in standby and 2 hours in alarm [NFPA 855 §4.8.3].

8.1.1 Types of Fire and Smoke Detection Devices

8.1.1.1 Spot Type Smoke and Heat Detector

Spot type smoke and heat detectors are the most commonly used detection methodology in the fire protection industry. A brief explanation of smoke and heat detector operational principal is provided below:

- Smoke detector, ionization – Operates using a radioisotope that detects the presence of smoke through current change via ionized particles. Ionization detectors are more sensitive to flaming fire.
- Smoke detector, photoelectric – Operates using a light-emitting diode and a photocell that detect the presence of smoke through current change with smoke obscuration. Photoelectric detectors are more sensitive to smoldering fires.
- Heat detector, fixed temperature – Operates using a heat-sensitive alloy that melts to produce a fire signal.
- Heat detector, rate of rise temperature – Operates using two thermocouples to detect a rapid rise of heat.

The two smoke detector types and fixed temperature heat detector are sometimes provided in a combined unit. The rate of rise heat detection is standalone and typically not combined with smoke detector. Possible combinations are as follows:

- Combination smoke detector (ionization/photoelectric)
- Combination heat detector (fixed temperature/rate of rise)
- Combination smoke/heat detector (ionization or photoelectric/fixed temperature)

The combination detector provides additional risk reduction by allowing the detector to respond faster to two types of fire.

8.1.1.2 Aspirating Smoke Detector

Aspirating smoke detectors (ASD) are a type of smoke detector that utilizes a centralized detector that continuously draws air into the detector from a sampling pipe network. ASD can be configured with multiple alarm thresholds providing detection capabilities for all fire stages from very early warning smoke detection at an incipient stage to fully developed fire. ASD piping network is highly configurable with capability to draw sampling air from the ceiling as well as from ducts and electrical cabinets. The ASD can be configured to provide additional gas detector sensors such as hydrogen gas and carbon monoxide.

8.1.1.3 Flame Detectors and Video Analytics

Flame detectors operated by detecting UV and/or IR radiation signature generated by a hydrocarbon and hydrogen flaming fires. Flame detectors could be integrated with a video camera similar to a surveillance camera. Proprietary video analytic software can be provided to scan the video feed for generated smoke to signal an alarm.

Flame detectors, with or without video analytics, could be a useful tool for outdoor BESS installations to provide additional layer of protection. However, for indoor installation, flame and smoke signatures detection is much delayed compared to the ASD early warning detection capabilities. The video camera option may prove useful for monitoring of BESS room conditions during fire events. However, continual monitoring during fire events may be hindered due to smoke obscuration.

8.1.1.4 Thermal Imaging Detectors

Thermal imaging operates by detecting thermal radiation generated by a heated surface. Thermal imaging may be applicable for lithium-ion battery failure by detecting small changes in temperature prior to Thermal Runaway or gas venting. This detection method requires line of sight to batteries and its effectiveness is reduced for BESS units with covered batteries.

8.2 Gas Detection System

Gas detection systems are used for monitoring gas concentration build up inside of BESS enclosures to monitor the level of combustible gasses off-gassing by the battery Cells. Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following [NFPA 855 §9.6.5.6.7]:

- The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the lower flammability limit (LFL) of the gas mixture or of the individual components.
- The combustible gas concentration reduction system shall remain on, continually monitoring conditions, to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components. The LFL values

should be reported to the facility BMS or fire alarm panel/first responder panel where approved the AHJ.

8.3 Annunciator Panel (First Responder Panel)

A typical BESS installation will encompass the installation of a firefighter first responder panel to display information to the responding fire department and substation/BESS personnel. A typical configuration for the annunciator panel to display information to the first responders is a textual output using LED display.

If desired by the AHJ or fire department, a complex building custom graphical annunciator or an interactive touchscreen annunciator may be provided to display information. A touchscreen annunciator provides automatic navigation to the emergency event location and is specific to a fire event. In addition, a time sequence display of fire detector activation provides easier capability to pinpoint the source of the fire and tracking of fire event progression.

8.4 Fire Suppression System

8.4.1 Water Based Suppression

Water is the most commonly used fire suppression medium. NFPA 855 requires automatic sprinkler systems be installed for BESS systems located inside buildings. NFPA 855 §4.9.2.1 requires a sprinkler water density of 0.3 gpm/sqft over an area of 2,500 sqft, a hose demand of 500gpm, and a duration of 120 min for buildings or walk-in enclosures.

A brief explanation of water-based fire suppression system types is provided below:

- Wet pipe fire sprinkler system – The most typical installation. Sprinkler pipes are filled with water which release upon operation of a closed sprinkler.
- Dry pipe fire sprinkler system – Sprinkler pipes are filled with pressurized air or nitrogen. Pipes are filled with water upon loss of pressure from closed sprinkler operation. Normally used for unconditioned outdoor spaces.
- Pre-action fire sprinkler system – Sprinkler pipes are filled with pressurized air or nitrogen. Single interlock operation fills the pipe with water upon smoke/heat detector activation. Double interlock operation filles the pipe with water upon smoke/heat detector activation and loss of pressure from closed sprinkler operation. Normally used for unconditioned indoor spaces or for water sensitive equipment.
- Deluge fire sprinkler system – Sprinkler pipes are open to air with open sprinklers. Pipes are filled with water with all sprinkler operating upon smoke/heat detection.
- Foam fire sprinkler system – Water based system with foam additives. Not recommended as foam insulates BESS fire event equipment increasing heat absorption of neighbouring Cells and equipment.

NFPA 855 allows for alternative automatic fire control and suppression systems based on NFPA 9540A large-scale fire testing result [NFPA 855 §4.9.3].

NFPA 855 allows fire suppression system omission for outdoor remote BESS installations based on large scale fire testing where the BESS fire event does not compromise the means of egress, does not present an exposure hazard, and is approved by a code official [NFPA 855 §4.9.1.6].

8.4.2 Fire Fighting Water Supply

Firefighting water supplies are essential for the BESS installation life cycle from the arrival of materials to the final stage of installation. An adequate water supply for firefighting shall be provided as soon as combustible or encapsulated mass timber construction material arrives on the site [NFC2020 §5.6.3.5]. The water supply may be either natural or developed and need not be the final water supply for the building or facility [NFC2020 §A.5.6.3.5(1)].

8.4.3 Clean Agent and Aerosol

Clean agent systems operate by disrupting the fire chemistry or creating an inert environment by reducing the oxygen concentration. Clean agent system will extinguish a fire but will not stop Thermal Runaway or off-gassing of Cells.

Aerosol systems operate by disrupting the fire chemistry and will extinguish a fire but will not stop Thermal Runaway or off-gassing of Cells.

Clean agent or aerosol systems, if provided, should not serve as a primary fire suppression system where required. If these systems are installed, there should be large-scale test data demonstrating their effectiveness and they should be backed up by a water-based fire sprinkler system.

If a clean agent or aerosol system is to be selected, the system should not inhibit/stop the normal operation of other building/enclosure mitigation systems such as an NFPA 69 ventilation system.

8.5 Fire Protection System Signage

NFPA 855 requires equipment signage provided with the installation of any new BESS Enclosure. The signage is to follow NFPA 704 *Standard System for the Identification of the Hazards of Materials for Emergency Response* identification markings and ANSI Z535.

8.6 Fire Department Access

NFPA 855 required fire department access roads shall be provided for outdoor BESS installations in accordance with local fire code [NFPA 855 §4.7.11]. An approved fire department apparatus access road shall be provided to each building by means of a street, private roadway, or yard [NBC2020 §9.10.20.3].

9.0 EXPLOSION MITIGATION REQUIREMENTS

9.1 Explosion Protection Systems

BESS equipment and/or buildings in which they are installed are required to be provided with an explosion protection system in accordance with NFPA 68 (deflagration venting), NFPA 69 (flammable gas ventilation), or an alternate performance-based design in accordance with NFPA 855. The ventilation system installation is required by NFPA 855 and is an industry practiced installation for BESS locations.

9.1.1 Deflagration Venting [NFPA 68]

The BESS should be equipped with NFPA 68 deflagration vents located on the roof or walls of the equipment enclosure or installed building. Deflagration vents are to be installed in locations where the potential for gas build up could occur in a confined space. Care should be taken to not block or install equipment that may obstruct the operation of the deflagration vents.

Where BESS is installed in geographic locations with routine ice and snow, any accumulation should be removed to ensure proper function of the deflagration vents. For these locations, it is recommended to provide flammable gas ventilation system as the primary explosion protection system.

9.1.2 Flammable Gas Ventilation System [NFPA 69]

The BESS or installed building may alternatively be provided with a NFPA 69 flammable gas ventilation system. The ventilation system is activated upon hydrogen or other appropriate gas sensor activation. Computational fluid dynamics (CFD) modeling is a tool for modeling the gas development and movement within a given defined boundary. The CFD model will illustrate the locations within a BESS enclosure with a lack of air movement or gas build up. This model is a performance-based approach to the development of a NFPA 69 ventilation system for gas build up relief. This model or an equivalent assessment is recommended for evaluation of all BESS enclosure installations.

The power feeding the ventilation system is to be redundant and should be provided via two independent electrical utility grid connections or via an automatic transfer switch connected to a single electrical utility grid connection and a backup generator. NFPA 855 also requires a minimum of 2 hours of mandatory backup period for a flammable gas ventilation system/fan.

10.0 COMMISSIONING PLAN

Commissioning plans should be established for the fire protection features and BESS electrical utility interface.

10.1 Fire Protection and BESS - Acceptance Testing

The procedures and requirements for acceptance testing vary between different AHJs. The acceptance testing requirements should be verified during the start of the project. Some AHJs will require that they be notified and witness all fire protection systems acceptance tests. Other AHJ may allow or permit requests for a qualified third party to witness acceptance testing.

Prior to the final acceptance testing, the fire protection installing contractor should provide a written acknowledgement or certificate that a complete pretest of the system has been conducted and that all deficiencies found during pretest have been corrected.

All BESS electrical utility interface and BESS equipment is to be coordinated and confirmed with Hydro One and the Proponent prior to system installation. Testing and acceptance criteria shall be in line with the manufacturer’s requirements and NFPA 855.

10.2 Fire Protection and BESS - Record of Completion

The fire protection installing contractor is to furnish a signed Record of Completion for final signoff by the AHJ, the AHJ designated inspector, and / or a qualified third party after the successful completion of the final acceptance test.

Written documentation for all fire protection system testing should be maintained by the BESS fire protection system owner through the duration of the system’s existence.

Final acceptance records of completion documentation shall be provided to Hydro One for the BESS equipment and connections to the transmission system upon final completion of the facility installation.

11.0 OPERATIONS & MAINTENANCE PLAN

Inspection, testing, and maintenance (ITM) is critical to the continued proper function of fire protection features provided for the BESS facility. All fire protection features should be inspected, tested, and maintained according to applicable NFPA standards and vendor recommendations. Fire alarm and gas detector (if installed) ITM should follow recommendations provided in NFPA 72. All water-based fire protection systems ITM should follow recommendations provided in NFPA 25.

The BESS manufacturer's manual includes the required maintenance to meet BESS specific requirements. Site level equipment is not included in O&M manual.

12.0 DECOMMISSIONING PLAN

12.1 Process Area

A process area must be established to receive modules removed from the container. Consideration for the location of the process area is as follows:

- They should respect the setback requirements from Transmission Facilities.
- Should Cells begin to vent the process area should not be within 50-feet of any ignition sources.
- Should Cells unexpectedly enter the Thermal Runaway phase, a non-combustible surface area should be used for the process area.
- The process areas should be located within 100-feet of a hydrant with fire department accessibility.
- The process area should not be located within 50-feet of combustible materials.
- The area should have one access point for control, staffed to ensure access only as needed.

12.2 Required Personal Protective Equipment

Personal protective equipment (PPE) required for the removal of any battery modules will be defined by the hazards found during the post-fire assessment. The decommissioning personnel must consider the potential hazards present to identify what level of PPE is appropriate for the hazard and the duration of use.

12.3 Removing Modules

All modules involved in fire or having exceeded the critical threshold temperatures should be disposed or recycled. Prior to removing modules, they should be assessed to ensure they are not in a state of venting.

12.4 Managing Stranded Energy/Reignition

The risk associated with transporting modules that do not have a zero state of charge is mitigated with the use energy absorbing materials. An environmentally friendly, mineral-based extinguishing agent should be used for suppression of problematic fires associated with the disposal of Lithium-Ion batteries.

12.5 Packaging and Transportation

A shipping package that can accommodate the dimension and weight of a module must be obtained. The container should be vented and transported on an open rack-body vehicle. Transportation manifests shall detail the contents of the containers and the state of charge of the batteries not compromised by fire.

13.0 EMERGENCY RESPONSE PLAN

13.1 Emergency Response Plan Document

An emergency response plan (ERP) shall be readily available at each BESS facility for use by facility operators, maintenance personnel, and the fire department [NFPA 855 §4.3.2.1.1]. The ERP is a living document that should be updated when conditions for the substation/facility change that affect the response considerations and procedure changes. At minimum, the ERP shall include the following [NFPA 855 §4.3.2.1.4]:

- Procedures for safe shutdown
- Procedures for inspection and testing
- Procedures in response to notifications of system alarms or out-of-range conditions
- Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, or damage to critical moving parts
- Response considerations for surrounding public area
- SDS (safety data sheets)
- Procedures for dealing with BESS equipment damaged from an emergency
- Other procedures determined as necessary by the AHJ (e.g., mitigation measures to minimize environmental impacts)
- Procedures and schedules for conducting drills

13.2 Fire Department Training

NFPA 855 requires the owner of the BESS unit or their authorized representative engage in emergency planning and training of emergency responders such that any foreseeable hazards associated with the outdoor BESS units can be effectively addressed [NFPA 855 §4.3.1].

13.3 Integrator Training

It is typically industry practice for the system integrator to conduct training on the new BESS enclosure; integration training is provided by the manufacturer to the Hydro One team members. This training typically looks at equipment usage and normal operation considerations rather than emergency response.

14.0 APPENDIX 1 - SIGNED AND SEALED DOCUMENT ASSEMBLY – RISK AND RESPONSE ASSESSMENT STANDARD SELF CERTIFICATION DOCUMENT

Proponent Company Name
Proponent Company Address
Proponent Company Logo

Proponent Certifying Individual's Name
Certification or Credential Criteria (Ontario Professional Engineer)

RE: Risk and Response Assessment Standard Certification for the Connection of BESS Facility Project Name located at BESS Facility Project Address ("**BESS Facility**")

Dear Hydro One Networks Inc.:

Individual Name with Proponent Name has read and understands the requirements of Hydro One's Risk and Response Assessment Standard ("**Standard**") and hereby certifies that the assessments required in the Standard to be performed have been performed and the associated documentation is accurate and complete for the BESS Facility Name connection to Hydro One's transmission system at [described Connection Point] and meets the requirements of the Standard.

Individual Name with Proponent Name also certifies that the BESS facility poses no known safety or outage risk or unmitigated hazard to Hydro One employees and Hydro One's transmission system.

Assessments	
Code Review	☐
Hazard Mitigation Analysis (HMA), Including	
• UL 9540 Listing	☐
• UL 9540A Test Reports	☐
• Fault Condition Assessment	☐
Fire Risk Assessment (FRA)	
• Community Risk Assessment	☐
• Air/Gas Dispersion Study	☐
Fire Protection Design Documentation, Including:	
• Passive Fire Protection Systems	☐
• Active Fire Protection Systems	☐
Commissioning Plan	☐
Decommissioning Plan	☐
Emergency Response Plan	☐
• Fire Department Training	☐

This letter is to certify that documentation is complete and accurate and will be made available to Hydro One, when requested, within 15 days of Hydro One making the request. Additional documentation outside the above list is not included in this certification declaration.

Signature

Name
Title Stamp or Seal
Date