TECHNICAL INFORMATION

Large-scale external lithium-ion battery energy storage systems

1 Purpose

This technical information sheet outlines Fire and Rescue NSW (FRNSW) considerations for facilities containing lithium-ion battery energy storage systems (BESS) that require a preparation of Fire Safety Study (FSS) as a part of Development Consent.

2 Scope

This technical information sheet details:

- general requirements pertaining to the preparation of a FSS
- assessment of potential consequences of credible incidents
- defining of an appropriate fire safety strategy for the facility
- setting expectations for acceptable large-scale fire testing (LSFT)
- separation of BESS enclosures
- fire brigade intervention
- hydrant system
- appropriateness and adequacy of installed fire safety systems and measures
- emergency planning, and
- referencing of applicable codes and standards.

3 Application

This document applies to facilities containing large-scale BESS located externally and not within a building. Such systems are typically associated with supporting and augmenting grid power supply (e.g., renewable energy installations, etc.).

Under the *State Environmental Planning Policy (Resilience and Hazards) 2021*, the consent authority can impose conditions on development including the need to undertake a fire safety study (FSS) in accordance with the *Hazardous Industry Planning Advisory Paper No 2* (HIPAP No. 2) *Fire Safety Study Guidelines*. In such cases, this document should be used when preparing the FSS for a facility that will contain large-scale BESS.

Note: Reference should be made to the FRNSW website at www.fire.nsw.gov.au on how to undertake the *Fire safety study (FSS) process*.

4 Background

The large-scale BESS pose unique challenges to firefighters when responding to and managing an incident. Fire agencies recognise large-scale BESS as a hazardous electrical, chemical and fire risk with potential community consequence that necessitates special consideration throughout the design, installation and lifetime management of the asset.

Large-scale BESS are a relatively new technology with a new risk profile that we have yet to fully understand. FRNSW continues to seek and consider the available knowledge and information on BESS to inform emergency services' preparedness and response to incidents involving these systems.

5 Developing the fire safety study

5.1 Assessment of potential consequences of credible incidents

5.1.1 A failure event involving BESS may eventuate from numerous internal and external mechanisms including mechanical, thermal and electrical abuse or failure, and may result in the expulsion of chemical components, propagation of chemical vapours and/or a thermal runaway event causing fire and/or explosion.

5.1.2 FRNSW consider a credible incident to be one in which a fire propagates within a BESS enclosure, with active fire safety systems disabled, and involves the full BESS enclosure. A BESS enclosure is defined as a compartment separated from adjacent compartments by a distance or by a barrier capable of resisting fire spread from the compartment of fire origin. The effectiveness of the enclosure in containing the fire within the compartment of origin shall be demonstrated by a LSFT, as detailed in Clause 5.3.

5.1.3 When undertaking consequence analysis of an incident, both the direct impacts of an incident and the potential for propagation and secondary incidents should be addressed. This includes management of chemical components or by-products released during an incident and the environmental impacts of toxic water-run off that may be used to mitigate an incident.

5.1.4 The FSS must also consider the broader potential for all credible incident scenarios at the facility. This includes credible incident scenarios involving transformers, inverters, ring main unit (RMU), renewable energy generators (e.g. solar, wind, biofuels), substations and ancillary buildings.

5.1.5 The FSS should be based on the particular batteries proposed to be used on the site.

5.2 Separation between BESS enclosures

5.2.1 The fire safety strategy must be developed to ensure a credible BESS incident is contained to its compartment of origin, preventing propagation to adjacent BESS enclosures, electrical infrastructures and other fire-source features. Similarly, a fire incident of an on-site or off-site infrastructure should be considered and its potential propagation to the BESS unit.

5.2.2 The fire safety strategy should consider the likelihood of occupants being present within the BESS enclosure.

5.3 Large-scale fire testing (LSFT)

5.3.1 LSFT must be conducted as per relevant standards or guidelines to demonstrate effectiveness of the proposed fire safety strategy. The LSFT must:

(a) involve fire propagating and consuming the full BESS enclosure, as per the credible incident identified in clause 5.1.2.

(b) be conducted with all active fire protection measures within the BESS enclosure disabled.

(c) characterise the types and the amount of gases generated.

(d) include evaluation of deflagration or explosion mitigation measures.

(e) demonstrate that a fire involving one BESS enclosure will not propagate to any adjacent BESS enclosure.

(f) be conducted at or witnessed and reported by an approved testing laboratory by parties who are independent from the battery manufacturer / supplier and be detailed in a separate test report provided by the testing laboratory, detailing who undertook the tests, the test methodology and the results obtained.

Note: Where the testing methodology does not meet an accreditation program, evidence must be provided that measurement and calibration of all equipment used in the testing complies with relevant Australian and/or international standards.

5.3.2 The impacts of environmental conditions (e.g., wind effects) must also be assessed. This should include assessment of flame tilt, etc. Supplementary modelling may be performed to assess the impacts of environmental conditions, provided that:

(a) details of all calculations and analyses are provided in the FSS, containing justification of all inputs and assessment methodology used.

(b) the supplementary modelling should be calibrated against a LSFT.

5.4 Separation of BESS enclosures from other infrastructure and fire-source features

5.4.1 An assessment is required to be undertaken to demonstrate that propagation of the credible incident involving a full BESS enclosure will not occur to other associated infrastructure such as transformers, inverters, RMU, renewable energy generators (e.g. solar, wind, biofuels), substations and ancillary buildings.

5.4.2 An assessment is required to be undertaken to demonstrate that a credible incident involving electrical infrastructure and other fire-source features do not cause fire spread to adjacent BESS enclosures.

5.5 Environmental impacts

5.5.1 When undertaking any hazard identification and consequence analysis relating to a thermal runaway incident, consideration must be given to the potential for the generation of a toxic smoke plume and its subsequent impact on the surrounding environment and communities. This should include demonstrating that toxic gas emissions during such a fire will not impact neighbours, first responders or passers-by, considering credible worst-case scenarios specific to the site.

Note: The results of LSFT may be used for the assessment.

5.5.2 Consideration should be given to the management of contaminated water.

5.5.3 Where a containment system is proposed to be connected to a reticulated stormwater system, provision must be made for the isolation of the system by way of automatically operated valves that close upon activation of any associated fire safety measure.

5.5.4 Appropriate consideration should also be given to the NSW Rural Fire Service *Planning for Bushfire Protection (2019)* when on bush fire prone land.

5.6 Implementation of fire safety systems

5.6.1 The implementation of fire detection and protection measures may be required to ensure the necessary level of safety and performance has been achieved for the site.

5.6.2 The FSS must assume the potential for a hazardous atmosphere to be generated unless suitable evidence is provided that demonstrates otherwise. A subsequent analysis of potential consequences is required to be undertaken to inform the analysis of requirements for detection and protection, such that suitable measures can be selected for implementation.

5.6.3 Supporting analysis and evidence is required to be provided within the FSS to justify the suitability and efficacy of proposed fire detection and protection measures for the site. This evidence is required to demonstrate that the specified performance of individual measures, and the collective system, is adequate to satisfy the objectives of the fire safety strategy.

5.6.4 All fire detection and protection measures relied upon to satisfy the objectives of the fire safety strategy should be automatic in nature (i.e. not manually operated). Supporting evidence is to be provided to demonstrate that individual measures, and the collective system, have capacity to operate at the required level of performance for the full duration of an incident.

5.6.5 Adequate redundancy should be provided to all fire detection and protection measures that are relied upon to satisfy the objectives of the fire safety strategy (e.g. emergency power supply to essential systems is a key redundancy consideration).

5.6.6 Fire suppression system installed within the BESS enclosure shall be validated against a test involving the BESS enclosure to demonstrate its effectiveness. The test shall evaluate deflagration or explosion mitigation measures for its entire duration.

Note: Gaseous or dry powder extinguishing agents do not stop thermal runaway, resulting in accumulated flammable gas within the enclosure and an increased risk of explosion.

5.6.7 Provision should be made for monitoring of the Alarm Signalling Equipment (ASE) where a fire detection system is provided as part of the fire safety system for a site and a readily available response from a permanent fire brigade is available.

6 Fire brigade intervention

6.1 Hazardous materials

6.1.1 An emergency involving large-scale BESS may be considered a "hazardous material incident" under the *Fire and Rescue NSW Act 1989*. Substantial resources may be required to confine or end the incident and to render the site of such an incident safe.

Note: FRNSW may be entitled to recover charges from a hazardous material incident.

6.1.2 Large-scale BESS and supporting infrastructure are a major electrical hazard and fire brigade intervention will be undertaken similar to other electrical infrastructure (e.g. substations, switchyards, etc.) where firefighters may not enter the affected area until an appropriate electrical company representative is in attendance and has confirmed power is isolated.

Note: The electrical company representative may be required to provide safety and technical advice to assist firefighters determine what intervention activities and firefighting operations can be safely undertaken.

6.2 Fire brigade access

6.2.1 Fire brigade access is to be provided around the site as outlined in FRNSW guideline *Access for fire brigade vehicles and firefighters*.

6.2.2 Signage warning of electrical and chemical hazards present should be provided at appropriate locations including, but not limited to, all entrances to the facility and the main control room.

Note: Section 7 of AS/NZS 5139:2019 *Electrical installations — Safety of battery systems for use with power conversion equipment* provides useful guidance on labels and safety signage that can still apply to BESS having a capacity greater than 200 kWh.

6.3 Fire hydrant system

6.3.1 A fire hydrant system must be installed in accordance with AS 2419.1:2021 and meet the requirements for "open yard protection".

6.3.2 Each hydrant outlet should be located at least 10 m from the nearest electrical infrastructure that they are intended to serve. The hydrant outlets must be strategically positioned to provide coverage to all parts of the BESS compounds.

6.3.3 For this document, an open yard is defined as the area encompassing all BESS enclosures and associated infrastructures (including PCUs, transformers, etc). Clusters of enclosures may be considered as a separate open yard when a minimum separation distance of 6 m is provided between clusters for the determination of yard area. If the LSFT indicates that a greater separation distance is required that distance should be adopted.

6.3.4 For DC-coupled BESS installations located adjacent to renewable energy generation infrastructure, including solar farms, FRNSW recommends a firefighting water supply be provided for each BESS compound or cluster of BESS enclosures. The water supply should be located so that it is readily accessible to firefighters and capable of supporting defensive firefighting operations, including exposure protection to adjacent BESS enclosures, power conversion units, transformers and other associated infrastructure.

6.3.5 A site-specific water supply arrangement may be acceptable where the Fire Safety Study demonstrates that the proposed arrangement provides an adequate level of operational capability for fire brigade intervention.

6.4 Occupiable BESS enclosures

6.4.1 Flammable vapours and gases confined within a BESS enclosure can result in a hazardous atmosphere and harm to persons. Signage should be provided at appropriate locations including, but not limited to, an entrance to the enclosure warning persons that a potentially hazardous atmosphere may be present inside.

6.4.2 A visual warning device should be provided at the entrance of the BESS enclosure and activate from any detection or protection measures provided, with associated signage provided stating a fire safety measure has activated and warn persons that a potentially hazardous atmosphere may be present inside.

7 Site management

7.1 Emergency planning

7.1.1 An emergency plan is to be developed for the site in accordance with *Hazardous Industry Planning Advisory Paper No 1* (HIPAP No. 1) *Emergency Planning*. The emergency plan should include, but not be limited to:

(a) details on how the owner / operator is alerted to abnormal operation, fault or hazard in a BESS.

(b) details on how fire services are notified of an incident.

Note: Notification of the fire services should be automatic when fire is detected in a BESS or on the site when an automatic fire detection system activates.

(c) details of effective communication strategy with remote operator representative for incident duration.

(d) suitable arrangements for attendance on site by an appropriately qualified representative during any incident.

(e) details on how battery status and information is relayed to emergency services, including items such as deployment of deflagration panels, etc.

(f) detailing the hazards during fire, gases released, extinguishing agents to use or avoid, spill procedures, and safe handling or disposal instructions, like that of a safety data sheet (SDS) specific to the BESS.

Note: The results of LSFT may be used to inform the emergency plan.

7.1.2 The emergency plan should identify a procedure for the removal and disposal of contaminated firefighting water.

7.1.3 The emergency plan should identify post-incident management and monitoring procedures as per Section 9.7.7 of NFPA855:2026. Authorised service or hazard support personnel should manage damaged BESS, monitor for re-ignition, and assist emergency responders until the hazard is mitigated and the site is rendered safe.

Note: Handling and removing of damaged BESS are the responsibility of the owner and/or operator and FRNSW are not responsible for assisting or facilitating such actions.

7.2 Emergency services information

7.2.1 An emergency services information package (ESIP) should be developed for the site, as detailed in FRNSW guideline *Emergency services information package and tactical fire plans*.

7.2.2 The ESIP should include, but not be limited to, the following specific information:

(a) a site plan identifying the layout of the site including the location of emergency vehicle access, buildings and exposures, high-risk areas, and installed firefighting systems.

(b) details of installed firefighting equipment including a copy of any fire hydrant system block plan, water supply details (e.g. water capacity, flows and pressures)

(c) details of emergency shutdown equipment including type, activation conditions, system overrides, and any other relevant procedures (e.g. system resetting).

(d) details of the personal protective equipment (e.g. breathing apparatus) or clothing required to be worn by emergency service personnel.

(e) details of fire water run-off containment including relevant procedures, isolation valve locations, capture capacity, drainage catchment mapping (showing terrain fall).

(f) details of any hazards that may impact fire brigade intervention (e.g. electrical substations, high-risk exposures, environmental risk, transport infrastructure in proximity).

(g) contact details of a site representative available 24/7 who can liaise with emergency service personnel.

7.3 Future upgrades or modifications

7.3.1 Any battery modules within a BESS enclosure shall be replaced with identical battery modules, as tested in the LSFT.

7.3.2 BESS enclosures shall not be retrofitted with battery modules of a different type or chemistry unless a LSFT has been conducted for the proposed configuration, demonstrating effectiveness of the existing fire safety strategy.

7.3.3 When an upgrade or modification is proposed, an updated FSS or an addendum report shall be submitted to FRNSW for review, including the following:

(a) description of the proposed changes, including details of replaced or retrofitted battery modules or configurations.

(b) an updated assessment demonstrating that the existing fire safety strategy remains effective, and if it is not effective what additional measures need to be introduced.

(c) supporting data, test results, and other relevant evidence.

7.3.4 The emergency plan shall be updated and submitted to FRNSW for review when any upgrades or modifications are implemented.

7.4 Reference documents

7.4.1 The following documents may be considered:

(a) FM Global (2025) Property Loss Prevention Data Sheet 5-33: *Lithium-Ion Battery Energy Storage Systems*. Johnston, Rhode Island: FM Global.

(b) National Fire Protection Association (NFPA) (2026) NFPA 855: *Standard for the Installation of Stationary Energy Storage Systems*. Quincy, Massachusetts: NFPA.

(c) UL Standards & Engagement (2026) *ANSI/CAN/UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*. Northbrook, Illinois: UL Standards & Engagement.

(d) CSA Group (2025) *CSA/ANSI C800:25: Battery Energy Storage Systems*. Toronto, Ontario: CSA Group.

8 Contact us

For further information contact the Fire Safety Branch on (02) 9742 7434 or email firesafety@fire.nsw.gov.au.

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