Queensland Fire and Rescue Battery Storage Facility Guide

Purpose and scope

Under the *Planning Regulation 2017*, the State Assessment Referral Agency (SARA) is the assessment manager for battery storage facility (BSF) development in Queensland.

State code 27: Battery Storage Facility development (State Code 27) identifies the intent of SARA's assessment and sets state-wide assessment benchmarks to achieve this.

DEFINITIONS:

In the *Planning Regulation 2017*, the term BSF means the use of premises for the operation of one or more battery storage devices; a battery storage device means plant that converts electricity into stored energy AND releases stored energy as electricity AND includes any equipment necessary for the operation of the plant.

Many national and jurisdictional materials refer to a BSF as a Battery Energy Storage System (BESS) Installation.

A BESS unit is an 'enclosure that consists of a functional BESS which includes components and subassemblies such as cells, modules, battery management systems, ventilation devices and other ancillary equipment'(*UL9540A*).

For reference within this guide a BSF may contain one or more BESS units. A BSF has ancillary and other equipment including, but not limited to, transformers, inverters and power control systems. The information in this guide applies to a BSF that is situated externally, and **not** for one or more BESS units located within a building or ancillary to a building.

The assessment of BESS units located in buildings or in proximity to buildings is subject to the National Construction Code (NCC) and is not subject to State Code 27. INFO BOX: This document uses the term 'proponent'. However, the information in this document is relevant to anyone involved in designing, constructing and operating a BSF.

It is the proponent's responsibility to ensure satisfaction of Performance Outcomes stipulated in State Code 27. This guide is intended to assist proponents develop a holistic fire strategy for a BSF.

As part of its assessment process SARA may seek 'third party advice' from the Queensland Fire Department (QFD).

Proponents may also engage with QFD directly, prior to and after engaging with SARA.

This document focuses on fire safety considerations for BSFs within the development footprint of a site (or 'inside the fence'). The terminology inside the fence is used by QFD to identify all the infrastructure located within the enclosure specific to the BSF which may pose a risk if involved in fire.

QFD consists of two streams that are relevant to assessment of these sites. Queensland Fire and Rescue (QFR) consider 'inside the fence' fire strategy, and Rural Fire Service Queensland (RFSQ) considers issues relating to bushfire, specifically avoiding and mitigating bushfire risk for renewable energy developments. This is depicted in Figure 1 below.

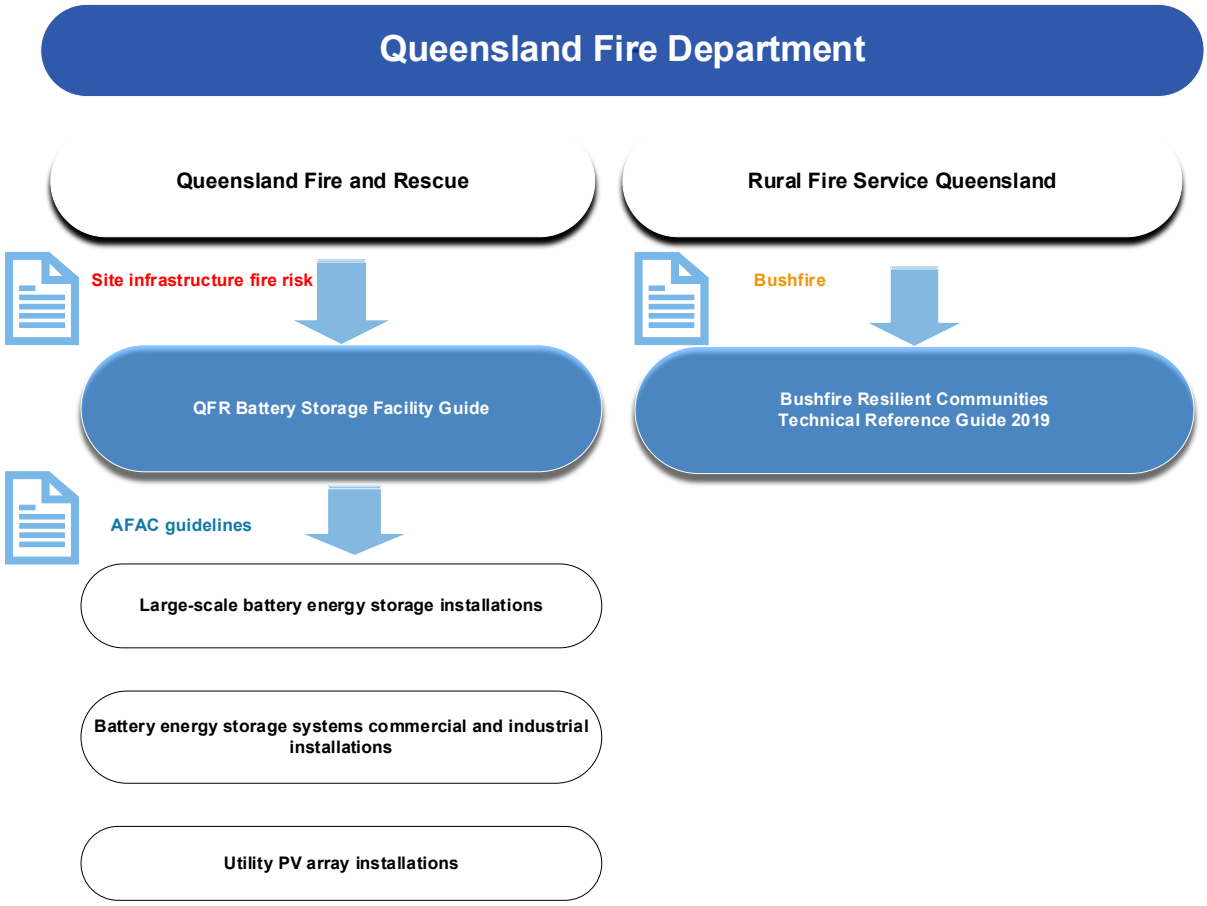

Figure 1- Queensland Fire Department guidelines, and affiliated AFAC guidelines for renewable energy developments

The matters covered in this document are within the remit of QFR.

Information about bushfire considerations can be found here – Bushfire resilient communities - Information for Land Use Planning Practitioners.

INFO BOX: Other relevant documents include –

UL 9540A Test Method for BESS

NFPA 855 Standard for the Installation of Stationary Energy Storage Systems

AS 2067 Substations and high voltage installations exceeding 1 kV a.c.

AS 5139 Electrical installations - Safety of battery systems for use with power conversion equipment

SA TS 5398:2025 Preliminary Technical Specification Electrical Energy Storage Equipment - Safety Requirements

AFAC Guideline Large-scale battery energy storage system installations (Doctrine ID: 3105)

Performance Outcomes relevant to site infrastructure fire risk

There are 35 performance outcomes outlined in State Code 27. Seven of these directly relate to advice that QFD may be requested to provide in relation to the fire strategy for the development. These are as follows:

Risk Mitigation

PO2	Development is designed, sited and constructed to ensure that risks from physical hazards, chemical hazards and battery failure hazards are avoided and/or mitigated with respect to: • human health and safety; and • the built and natural environment.
PO3	Development mitigates the risks of fire, explosion and thermal runaway from battery storage infrastructure.
PO4	Development is designed to ensure fire and thermal events can be contained and isolated to prevent escalation and propagation to other developments and uses on and offsite.

Incident Response

PO5	Development is designed to facilitate effective and efficient emergency service access and response in the event of a fire, bushfire (including cleared firefighting areas at the interface of hazardous vegetation), explosion, contamination leak or any other incident requiring an emergency service response.
PO6	The development: • provides appropriate fire detection, monitoring and notification to the site operator; and • ensures the electrical safety of the facility, in the event of an incident requiring emergency response.
PO7	Development demonstrates that there is capacity to provide a reliable, sustainable and fit-for-purpose water supply.

Protecting water quality and stormwater management

PO18	Development prevents the release of contaminants to surface water or groundwater in the event of an incident, including a fire or explosion.

Hazards associated with BSF

Below is a list of the known hazards associated with BSF. Consideration of these factors when addressing the performance outcomes is recommended. BESS technology presents unique hazards and challenges to firefighters. Hazards associated with BESS units include:

- **Thermal Runaway and Fire:** This is a rapid, uncontrolled release of heat and energy from a battery cell, which can cascade to neighbouring cells, leading to fire and/or explosion, often initiated by internal cell defects, overcharging, or physical damage, causing temperatures to rise rapidly. BESS fires are difficult to extinguish and can re-ignite hours or days later.
- **Explosion Risk:** If battery gases (e.g. hydrogen, methane) build up in an enclosed space without adequate venting or explosion suppression, an ignition source can lead to a deflagration or explosion, which can result in severe injuries to emergency responders.
- **Toxic Gas Release:** Failing batteries release hazardous, toxic and flammable vapours, including hydrogen fluoride (HF), which is corrosive and dangerous to skin, eyes, and lungs. Gases such as carbon monoxide, hydrogen cyanide, and hydrogen chloride are also released, endangering surrounding communities and first responders.
- **Electrical Hazards (Arc Flash and Shock):** Interconnected battery banks can create high voltage levels, causing severe electric shock. Short circuits or improper maintenance can lead to arc flashes with temperatures exceeding 12,000°C.
- **Stranded Electrical Energy:** Even after a fire is extinguished, damaged BESS modules may retain electrical energy, posing a major risk of re-ignition and electric shock to first responders.
- **Chemical Spills:** Ruptured battery casings can leak corrosive electrolyte.
- **Long Duration of Brigade Intervention:** Incidents can be resource-intensive, requiring protracted extinguishment and cooling operations with large volumes of water.
- **Contaminated Run-off:** Firefighting water can become heavily contaminated and pose a significant environmental and health risk.

There is also ancillary equipment to consider, including but not limited to transformers, inverters or power control systems. For hybrid facilities, the BSF also includes the source of electricity power generation, such as solar or wind. All these present their own hazards and potential escalation between equipment items.

Risk Mitigation - PO2 to PO4

To satisfy performance outcomes PO2 to PO4, a fire strategy i.e. a set of measures that deliver the objectives for fire safety, including designing for adequate response to potential fire, should be developed by the proponent with an understanding of the available capability and time for fire brigade intervention.

A Risk Management Assessment Report (RMAR) and a Fire Safety Study (FSS) are assessments which each inform the development and implementation of an emergency management plan and provision of emergency information for responders. These are discussed below.

Risk Management Assessment Report

The RMAR forms supporting material that is required at lodgement with SARA as per State Code 27. The proponent should consider conducting a site-wide risk assessment in accordance with **AS/NZ ISO 31000:2018 Risk Management – Principles and Guidelines**, and associated guidance in **SA/SNZ HB89 Risk management – Guidelines on risk assessment techniques**. Alternatively, proponents may utilise equivalent risk assessment processes.

The RMAR should include identification of credible fire and explosion hazards and assessment of the potential consequences. Prevention and mitigation measures should be identified.

The RMAR should be informed by the information relating to the proposed site and equipment. The following may be considered:

- **Site Information:**
  - Site layout drawings.
  - Proximity to neighbours, sensitive uses (e.g. hospitals, schools), nearby occupants and waterways.
- **BESS Equipment Details:**
  - BESS equipment manufacturer, model, and variant.
  - Cell chemistry (e.g. LFP, NMC) and Safety Data Sheets (SDS).
  - Total site capacity (MWh) and individual unit capacity.
  - Manufacturer's data and test reports (e.g. **UL 9540A** test data for thermal runaway propagation). This is critical for undertaking deterministic assessment in the FSS.
- **Ancillary Equipment:**
  - Transformers, inverters, switchgear, and other high-voltage infrastructure.
  - Details of any hazardous materials stored on-site (e.g. spare battery modules, transformer oil).
- **Safety and Suppression Systems:**
  - In-built fire safety systems (Battery Management System, electrical fault protection, deflagration vents, active ventilation).
  - Details of any installed fire detection or suppression systems (e.g. gas suppression, water mist).
- **Environmental Hazards:**
  - Bushfire.
  - Flood inundation.
- **Firefighting Provisions:**
  - Proposed water supply (static/mains) and hydrant system design.
  - Proposed containment systems for contaminated firefighting water.

Fire Safety Study (FSS)

The development of a fire strategy is best achieved by undertaking a FSS for the proposed site.

The FSS builds on the site-wide risk assessment and specifies mitigation strategies. It should include the following steps:

1. **Identification of Credible Scenarios Leading to Thermal Runaway, Fire, Explosion:** Analysis of credible scenarios (e.g. BESS unit fire, transformer fire, construction-initiated fire, bushfire impact) and potential for escalation. These scenarios would be identified from the hazard identification exercise undertaken as part of the risk assessment; recommended scenarios for assessment in Standards such as NFPA855 and AS2067 may also be considered.
2. **Consequence Assessment:** Modelling of on-site and off-site consequences (e.g. fire spread, radiant heat, explosion, toxic gas dispersion), and assessment of those consequences against criteria that lead to injury, fatality and adverse health.
3. **Fire Mitigation Measures:** Detailed description of all active and passive fire prevention and protection measures, which may consider the following:
   - **Fire Prevention:** Implementation of engineering and administrative controls to prevent a fire from starting (e.g., Battery Management System, thermal management).
   - **Propagation Prevention:** Design of the facility to prevent a fire in a BESS unit from spreading to other units or spreading off-site (e.g. separation distances, fire-rated barriers).
   - **Detection and Notification:** Installation of reliable systems to detect a fire in its earliest stages and automatically notify the site operators.
   - **Firefighting Provisions:** Provision of adequate infrastructure (water, access) for QFD to conduct operations safely.
4. **Water Demand:** Calculation of firewater demand and confirmation of supply adequacy.
5. **Containment Strategy:** Design of containment for contaminated firewater runoff to protect the environment.
6. **Emergency Response:** The basis for the site's Emergency Response Plan (see Section 0).

More advice on undertaking a FSS can be found in the AFAC Guideline Large-scale battery energy storage system installations (Doctrine ID: 3105).

Key Design and Prevention Measures

Further details of protection measures are discussed below.

Separation of Equipment

Separation of equipment is a critical control to prevent a single failure from propagating to other units or escalating beyond the site.

- Proponents should undertake a deterministic analysis (e.g. fire engineering evaluation) demonstrating that fire will not propagate from the initiating BESS unit to other exposures (e.g. other BESS units, transformers, control rooms, site boundary).
- Credible fire scenarios should be assessed, informed by data from the manufacturer's thermal runaway/fire testing (e.g. UL 9540A).
- Separation distances from engineering standards and from manufacturer's data, may not consider all impacts to adjacent equipment.
- Consideration should be given to fire from ancillary equipment inducing thermal runaway in BESS units, and conversely fire spread from BESS units to ancillary equipment.

Bushfire Hazard Assessment

For development in bushfire (including grassfire) prone areas, QFD advice can be found at QFD's Bushfire Resilient Communities website. Decisions on the location, siting and design of a BSF should consider bushfire risk.

- The FSS should incorporate the findings of a Bushfire Hazard Assessment prepared in accordance with the Bushfire Resilient Communities Technical Reference Guide (2019), as well as Bushfire Attack Level (BAL) assessment conducted in accordance with AS 3959 for relevant buildings in designated Bushfire Prone Areas.
- Asset Protection Zones (APZs) should be established and maintained around the BESS installation. Proponents are referred to QFD's Bushfire Resilient Communities website and Bushfire Resilient Communities 2019 Technical Reference Guide; however standard APZ distances may not be sufficient for critical infrastructure in a BSF, and deterministic assessment may be required to validate APZ distances.
- The design should ensure that exposure from bushfire (radiant heat, ember attack) does not degrade BESS units or cause thermal runaway.
- An on-site Vegetation Management Plan should be implemented to maintain fuel loads (e.g. grass) within the installation perimeter.

Flood Mitigation

The FSS should report on whether a flood mitigation study is necessary and has been conducted for the site. If so, the FSS should confirm the appropriate flood mitigation measures, which would include positioning BESS units and critical controls to prevent inundation from flood events.

The site's emergency management plan should include specific actions to be taken following a flood.

Incident Response - PO5 to PO7

To satisfy performance outcomes PO5 to PO7, the systems and arrangements described below should be considered.

An **Operational Emergency Management Plan** would document these arrangements. *Queensland's Work Health and Safety Regulation 2011* (section 43) stipulates that all workplaces have a duty to prepare, maintain and implement an emergency plan. This should include, but is not limited to, emergency response for events identified in the RMAR and FSS.

Access

Effective and efficient emergency service access **means:**

- Clear Entry Points: clearly identified site access that can accommodate fire appliances. A minimum of two points of access/egress to the facility should be provided.
- Unobstructed Internal Roads: The site plan must show internal roads with adequate turning circles and a

minimum width, so firefighters have adequate means of prompt relocation of vehicles during a shifting fire plume.
- Perimeter Access: A dedicated access track around the entire battery compound is essential for fighting the fire from any wind direction.
- Bushfire considerations: The layout must provide enough room for crews to set up equipment without being directly exposed to radiant heat from a failing battery unit or an incoming bushfire.

Emergency Notification and Information

Rapid notification and clear information are essential for responder safety.

Firefighters and emergency teams require real-time data – temperatures, gas levels, and system status – to make informed decisions.

Note: The thermal imaging cameras used by the fire brigade have a limited capability to obtain an accurate picture of the internal state of an enclosure, and firefighters will not be opening BESS units.

Therefore, **appropriate fire detection, monitoring and notification to the site operator** means that the site operator has the **capability** to notify the brigade and to communicate the plant status to the brigade.

Systems such as the:

- Battery Management System (BMS) continuously monitor the state of charge (SOC), voltage, current, and temperature at the cell, module, and rack levels.
- Gas and Smoke Detectors detect early off-gas emissions that occur before visible smoke or flames, allowing for pre-emptive action, such as emergency shutdowns and ventilation.
- Environmental/Vibration Sensors detect potential physical abuse or damage to the units.
- The site external security CCTV and/or Perimeter Intrusion Detection (PID) monitor for unauthorised access or vandalism; particularly in remote areas of Queensland.

These are relayed to a 24/7 site monitoring system (either on-site or off-site), with operator representatives having the capability to communicate system information to brigade personnel.

If the 24/7 monitoring facility is off-site, additionally, there should be on-site **System Status Visibility,** positioned sufficiently away from the plant so that persons viewing this are not adversely impacted from accidents on site, but also positioned to provide the status for on-site brigade response.

A BSF is a live, high-voltage environment. When crews arrive, they need to know what is 'live' and how to direct the on-site facility management to safely disconnect the power. There should be procedures for safe shutdown, de-energising, or isolation of equipment and systems under emergency conditions to reduce the risk of electrocution.

Note: QFD will not perform isolations and shutdown, this is the responsibility of the proponent/operator.

Tactical Site Information: We strongly recommend a weatherproof 'red box' at the primary entrance containing:

- Site Layout Diagram showing on site System Status Visibility, BESS units, transformers, control rooms, hydrants, water supplies, and isolation points.
- Manifests of hazardous chemicals.
- Contact details: 24/7 Emergency Contact Numbers for the site operator and a qualified BESS specialist/technical support.
- Shutdown Procedures: Clear, simple, step-by-step procedures for safe shutdown, de-energising, and isolation of equipment.
- Emergency Procedures: Checklists for fire, gas release, or other dangerous conditions.
- Fire System Details: Information on installed fire detection, suppression, and ventilation systems.

Firewater

The *Fire Services Act 1990* Chapter 4B Part 1 149I states that an authorised fire officer may take any reasonable measures to protect persons, property or the environment from danger or potential danger caused by a fire or a hazardous materials emergency.

Intervention from fire crews will require the provision of onsite firewater.

Thus, a controlled burn strategy does not negate the need for the provision of fire water on-site. Fire water may be required for cooling of adjacent exposures, smoke, gas and vapour knockdown, and the management of grassfires.

A fire hydrant system that is installed must be done so in accordance with the requirements of AS 2419.1: 2021 Alternatively, any fire water system not meeting AS 2419.1:2021needs to be risk assessed and outcomes reflected within the FSS. Lithium-ion batteries are classified as special hazards in that standard, recognising the challenging nature of such fires. The firewater system should enable firefighters to provide effective response considering credible worst-case scenarios assessed in the FSS. Firewater would need to be available for the evaluated anticipated timeline and the estimated duration of the burn.

QFD requests evidence that water is delivered from each single fire hose at a minimum of 10 litres per second at 700 kPa at the most disadvantaged area of the site. This must be evaluated whether there is hydrant system or if there is reliance on static water tanks supplying water via a fire appliance. In addition, the static water tanks should have connection adapters for both rural and urban fire appliances.

Fire hydrants

· The fire hydrant system must be installed in accordance with AS 2419.1.

Water storage tank fittings

· Urban appliance connections for hard suction are 150mm Storz connector with a 125 mm Storz reducer

· Rural brigade appliances 50 mm camlock with 40 mm adapter

· Shared water tanks for urban and rural should have both fittings

· Water supply should be designed to provide filling points for bushfire near to the entrance, e.g. a storage of 45,000L is recommended for re-filling of rural brigade tankers (solar farm and wind farms)

The system needs to be reliable; reliability in remote areas is frequently impacted by factors less common in urban environments. Proponents should ensure that there are arrangements for required maintenance to the regularity of the standards, such that all components of the installation are in a fit state of repair and good working order.

The water volume designated for firefighting must be reserved. In areas where reticulated water is unavailable or unreliable, and there is reliance on static stored supplies, the proponent needs to demonstrate how the availability of that water is ensured.

The fire water system should be shown on a plan providing firefighters with a layout of the site and hydrant system and its design capacity, flows and pressures and valve and pipework configuration. Thus, block plans should be fade resistant or etched, and waterproof.

Protecting Water Quality and Stormwater Management - PO18

To satisfy performance outcomes PO18, the FSS should detail the containment strategy for contaminated firefighting water (e.g. bunding, diversion to sacrificial ponds) to prevent environmental pollution. The assumptions and calculations on which the system and arrangements are based and justification for the design should be provided in the FSS.

Actions required by on-site personnel or emergency responders to initiate or manage these systems should be detailed in the Operational Emergency Management Plan.

Engaging with QFD

N.B.: Early engagement with QFD services.

The aim of liaising with QFDs services is to develop a fire strategy with adequate arrangements for intervention. Consideration of potential incident scenarios, and hence operational challenges that may be presented, should be undertaken as early as possible in the design stage. This ensures that key aspects of the fire strategy are clarified and understood by all stakeholders.

Proponents may engage with QFD as follows:

(i) directly, prior to engaging with the State Assessment Referral Agency (SARA) under the provisions of the *Planning Regulations 2017*.

(ii) directly as part of the Social Impact Assessment within the Community Benefit System (for those sites with a maximum instantaneous power output of 50MW or more), under the provisions of the Planning Regulations 2017.

(iii) during the SARA assessment process - specific commentary relating to the performance outcomes in State Code 27 will be provided during this engagement.

(iv) following the SARA assessment process, at the pre-operational, commissioning and operational phases.

INFO BOX:

'Inside the fence' –
More information including links to relevant legislation and guidelines is available on the QFD **renewable energies** website which can be accessed under the Compliance and Planning tab.

Should a proponent wish to request advice from QFD in relation to fire safety matters 'inside the fence' of a BSF, QFD's Complex Infrastructure Section can be contacted via email at **CIS@fire.qld.gov.au.**

Should a proponent wish to initiate a preliminary meeting to discuss a site specific RMAR and FSS prior to SARA lodgement, they can do so by visiting the QFD **renewable energies** page, filling in the CSO-094 Request for Preliminary Meeting form, and emailing it to **CIS@fire.qld.gov.au**

An owner/site manager may request to have local QFD firefighting crews familiarise themselves with the relevant infrastructure. This will enable crews to obtain site-specific information prior to its full commissioning. To initiate this request, proceed to the QFD **renewable energies** page and fill in the CSO-095 Request for Site Visit form and email it to **CIS@fire.qld.gov.au** Please note: Site familiarisation visits are subject to resource availability based on your geographic location.

'Outside the fence' –
Should a proponent wish to engage with QFD for advice relating to avoiding and mitigating bushfire risk for renewable energy developments, please visit https://www.fire.qld.gov.au/compliance-and-planning/bushfire-planning/brc and review the Bushfire Resilient Communities 2019 Technical Reference Guide. The Bushfire Resilient Communities team can be contacted via email at BRC@fire.qld.gov.au.

Role of QFD During an Emergency

During an emergency incident –

- **QFD will:**
  - Respond to Triple Zero (000) calls or automatic alarm notifications.
  - Prioritise protection of life (responders and community), property and environment.
  - Conduct defensive firefighting to limit fire spread and protect exposures (e.g., protect adjacent units or prevent bushfire spread).
  - Manage hazardous substance control and mitigation.

- **QFD will not:**
  - Open a BESS pod, unit, or enclosure. This action must only be undertaken by a qualified site operator or BESS specialist.
  - Perform isolation or shutdown procedures.

Provision of specialist technical assessment and assistance, including site electrical status and making a BESS unit safe, is the responsibility of the operator.