HIGH MATHERNOCK BESS

OUTLINE BATTERY STORAGE SAFETY MANAGEMENT PLAN

VERSION 2

Updates from Version 1:

- Description of development changed to describe reduction of battery units from 87 to 60
- Site layout drawing changed showing reduce footprint; from 3.1ha to 2.7ha

Conclusion including Cumulative Conclusion

Both the Conclusion and Cumulative Conclusion are identical to Version 1 of this report. Main points listed below:

- *"safety will be inherent in the overall design, minimising the risk of a fire event occurring, and reducing the impact of such an event should it occur."*
- From 7 Conclusion (p32)

Outline Battery Storage Safety Management Plan

High Mathernock Battery Energy Storage system (BESS), Kilmacolm

Harmony HM Ltd

Lanpro

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Harmony HM Ltd

October 2025

Lanpro

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Issue Sheet

Document Prepared for Harmony HM Ltd

Lanpro Project Reference - 4886

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Executive Summary

This report has been prepared on behalf of Harmony HM Ltd (the 'Applicant') in relation to an application made to the Scottish Government Energy Consents Unit under Section 36 of the Electricity Act 1989.

This Scheme is located at Higher Mathernock Farm, Auchentiber Road, Port Glasgow, PA13 4SP. It is some 16 miles west of Glasgow City Centre, 2.5 miles to the south of Port Glasgow and west of Kilmacolm, some two miles to the southeast. It seeks consent to construct and operate a 334-Megawatt (MW) battery energy storage system (BESS) (with associated infrastructure) known as Higher Mathernock BESS (hereafter referred to as 'the Proposed Development'). The proposal also seeks consent for a new 400/33 kV grid network substation and is required in order to provide the grid connection point. The site location is driven by an identified need by the grid operator for grid energy storage in this location.

An adjacent site, directly to the west is the subject of proposals for a BESS, with consent granted by the Energy Consent Unit (ECU) on 11th September 2024 (ECU 00004979).. The scheme on 16.4ha of agricultural pasture comprises an up to 700MW BESS facility with associated infrastructure.

Prior to the commencement of construction of the Higher Mathernock BESS, Harmony HM Ltd will be required to prepare a Battery Storage Safety Management Plan (BSSMP) which must be in accordance with this Outline BSSMP. As part of the BSSMP, the Applicant will consider the latest good practice for battery fire detection and prevention, along with the emergency response plan, as guidance continues to develop in the UK and around the world.

There are several battery storage technologies available to system designers. The populated NWI liquid-cooling energy storage container is an integrated high energy density system, which consists of a lithium-ion battery rack system (280Ah new LFP cell), BMS (battery management system), FSS (fire suppression system), HVAC thermal management system and auxiliary distribution system. The exact technology and system chemistry type is still to be determined, but it will be a lithium-ion battery cell type. The popular types of this chemistry within the lithium-ion family are Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2) known as "NMC" after the three key active materials or Lithium Iron Phosphate (LiFePO4) known as "LFP". This is considered to be a reasonable worst case for the purposes of the assessment in terms of safety. The final battery chemistry will be confirmed as part of the detailed design prior to the commencement of construction.

The Higher Mathernock BESS will be designed in accordance with the UK and internationally recognised good practice guidance available at the time. The overall approach is to follow the Health and Safety Executive's (HSE) hierarchy of controls:

- Elimination;
- Substitution;

- Engineering Controls;
- Administrative Controls;
- Personal Protective Equipment.

This document details the types of safety systems available on the market at present, along with risk reduction barriers which are likely to be incorporated into the system to be installed at the Sites. It is possible that by the time of construction that all solid-state batteries, or other battery technologies may be available. This will be reflected in the BSSMP approved in consultation with the HSE, Fire Scotland and the Scottish Environment Protection Agency.

A summary of the anticipated fire safety precautions are as follows:

- The BESS will be designed, selected, and installed in accordance with international guidance, good practice, and related standards.
- Risk assessments will be carried out for the entire system and elements across the project lifecycle.
- Separation distances between components will be selected to minimise the chance of fire spread.
- Equipment will, where possible, be selected to be fire limiting, such as selection of transformer oils with low flammability and the fire resistance of the BESS containers.
- In the case of the BESS, it will be designed with multiple layers of protection to minimise the chances of a fire or thermal runway.
- All equipment will be monitored, maintained, and operated in accordance with manufacturer instructions.
- The BESS will include integrated fire detection with automated suppression systems.
- 24h monitoring of the system via a dedicated control room.
- The Applicant will have a dedicated emergency response plan in place, with consideration of credible plant failure scenarios.

Communication with the local fire services with engagement early in the project and continuing across design and construction phases. This will ensure a robust risk management and emergency response plan are available in an emergency. This engagement will consider any potential cumulative risk scenarios with the adjacent 700MW scheme.

1 Introduction

1.1 Scope

1.1.1 This outline BSSMP document, produced by the Applicant (Harmony HM Ltd), outlines the key fire safety provisions for the BESS proposed to be installed at Higher Mathernock Energy Storage including measures to reduce fire risk and fire protection measures.

1.1.2 This document provides a summary of the safety related information requirements which will be provided in advance of construction of the BESS. The purpose of this outline BSSMP is to identify how the Applicant will use good industry practice to reduce risk to life, property, and the environment from the BESS. It will also discuss cumulative matters to include the adjacent 700MW scheme.

1.1.3 Prior to the commencement of construction of the BESS, the Applicant will be required to prepare a BSSMP which must be in accordance with this outline BSSMP. As part of preparation of the BSSMP, the Applicant will consider the latest good practices for battery fire detection and prevention, along with the emergency response plan, as guidance continues to develop in the UK and around the world.

1.1.4 As the operational phase is anticipated to commence no earlier than 2027, reference to current measures and guidelines are included here. However, this document will be updated prior to construction of the BESS to take account of prevailing guidance.

1.1.5 This report has been prepared on behalf of Harmony HM Ltd. (the ‘Applicant’) in relation to an application made. Reference to the adjacent 700MW scheme is based on information provided by that scheme’s promoter and technical team.

1.2 Project Description

1.2.1 The Site is located in rural Inverclyde, approximately 16 miles west of Glasgow City Centre. The site comprises a gross area of 8.48 ha of improved pasture grazing and is surrounded by agricultural land. The site slopes from the Auchentiber Road to the south and east. It is enclosed by a random stone wall to the road frontage and deciduous hedging to the remaining south, east and western boundaries.

1.2.2 It will comprise a BESS of up to 334MW with a substation and ancillary works, landscaping and ecological mitigation and site access. The Scheme will also include for a new 400/33kv substation which is required in order to provide the grid connection point.

1.2.3 Principal elements of the Scheme include:

- electrical substation;
- palisade fencing surrounding the perimeter of the substation compound;

- 60double battery units;
- inverter stations;
- control building;
- LV and HV transformers;
- switchgear container;
- spare parts container;
- access tracks;
- welfare facilities;
- fencing;
- CCTV and motion activated lighting;
- fire suppression system/water storage tank;
- back-up generator;
- temporary construction compound; and
- landscape and biodiversity mitigation and enhancement.

1.2.4 Access will be achieved with the formation of a new priority junction to the Auchentiber Road. A secondary emergency only access will be provided to allow for emergency vehicle access.

1.2.5 Auchentiber Road is accessible to the west via the B788 (Kilmacolm Road), 1.8 miles away. To the east access onto the Auchenbothie Road is achievable 2.8 miles away.

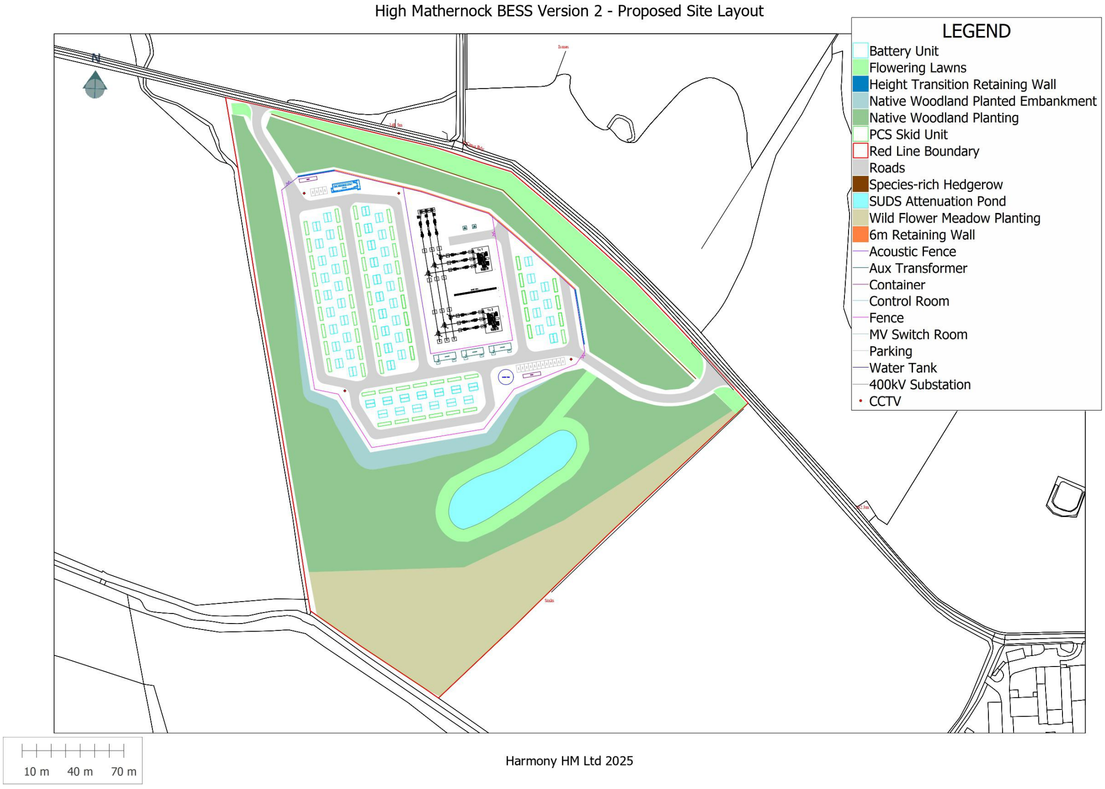
1.2.6 1.2.6 The site is enclosed within an undulating landscape, with improved grass paddocks (with intermittent scrub) the principal adjacent use. Within the wider landscape are scattered belts of primarily coniferous woodland. High Mathernock Farm is the closest residential property some 0.5 mile east of the centre of the site. Associated with the Farmstead are a range of traditional stone buildings along with modern general purpose agricultural sheds.

1.2.7 Port Glasgow is the closest settlement, some 3 miles to the north. Kilmacolm is some 4 miles to the east.

1.2.8 The batteries, inverters, transformers and switchgear ('conversion units') will be mounted on concrete foundations in a single compound as shown on the concept design at Figure 1.1 below.

1.2.9 For the purposes of this document the concept design has been considered that uses a BESS based upon LFP lithium-ion battery technology. This is considered to be a reasonable worst case for the purposes of the assessment in terms of safety.

Figure 1.1. Higher Mathernock BESS Layout Plan



1.2.10 The precise number of individual battery storage containers will depend upon the duration of energy storage that is available and on the open market at the time of construction. Battery technology is advancing rapidly and as such exact specifications are reserved at this time.

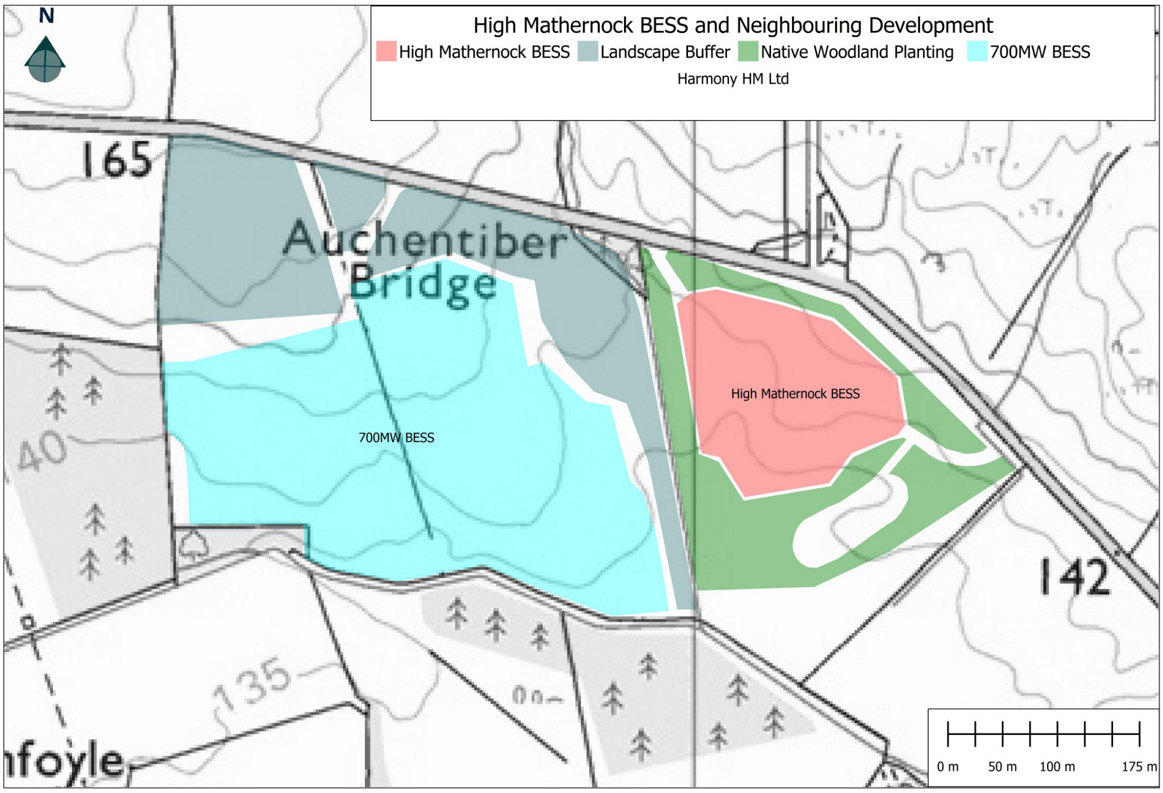
1.2.11 The design of the BESS and its impact are controlled in several ways. Prior to commencement of construction of the BESS, a BSSMP (in accordance with the Outline BSSMP) is required to be submitted to the relevant local planning authority and approved, in consultation with the HSE, Fire Scotland and the Scottish Environment Protection Agency. The Applicant must operate the BESS in accordance with the approved plan.

1.2.12 The concept design consists of the BESS containers and the associated transformers, circuit breakers and inverters. The BESS, containers, and auxiliary system, such as cooling, uninterruptible power supply (UPS), fire detection and suppression systems, monitoring and control, will be designed in accordance with internationally recognised good practice guidance available at the time.

1.2.13 Once operational, the plant will be designed to operate unmanned with access required for maintenance only.

1.2.14 Reference is made to an additional BESS(ECU0004749) of up to 700MW on the neighbouring site granted consent on 11th September 2024. The general site arrangement and location is presented at Figure 1.2 below.

Figure 1.2 Site Location Plan of Higher Mathernock BESS and Neighbouring 700MW scheme



1.3 Potential BESS Failure

1.3.1 There are four main ways in which a lithium-ion cell can fail: thermal, electrical, mechanical, and chemical. The causes of failure could include issues such as: manufacturing defects, overcharging, over-discharging, mechanical damage, overheating or abuse and short circuits; whether internal or external.

1.3.2 Regardless of the type of failure or the cause, the main potential hazard is thermal runaway and ultimately, if not controlled, a fire, and therefore this report focusses on reducing fire risk associated with the BESS and managing the hazard in the unlikely event that it occurs.

1.3.3 Other electrical systems than the batteries which form part of the BESS can carry fire risks, however due to the extensive historic long-term deployment of other technology such as transformers, inverters and switchgear, these risks are better understood and regulated, through longstanding industry guidance and codes. Therefore, only the battery component of the BESS is addressed in this report.

1.4 Safety Objectives

1.4.1 The safety objectives for the design of the BESS are:

- To minimise the likelihood of an event. This is an overriding priority;
- To minimise the consequences should an event occur;
- To restrict any event to the BESS site and minimise any impact on the surrounding
- areas;
- To automatically detect and begin to fight a fire as soon as possible;
- To ensure any personnel on Site are able to escape safely away from the Site;
- To ensure that firefighters can operate in reasonable safety where necessary;
- To ensure that fire, smoke, and the spread of gases do not significantly affect occupants in surrounding buildings and areas;
- To ensure that firewater run-off is contained and treated.

1.5 Relevant Guidelines

1.5.1 Guidance documents and standards considered by the Applicant have been used to inform the design of the scheme. There is currently limited UK specific guidance for BESS, however the National Fire Chiefs Council (NFCC) consulted on 'Grid Scale Battery Energy Storage System Planning – Guidance for FRS' in Summer 2024. Consultation responses are currently being reviewed, with the new Guidance not yet adopted. NFCC indicate it will be published in early 2025. As it is well-advanced, it is considered of relevance to this outline BSSMP.

1.5.2 The draft NFCC Guidance for FRS document recognises that Grid scale Battery Energy Storage Systems (BESS) are a fundamental part of the UK's move toward a sustainable energy system and the installation of BESS systems both in the UK and around the globe is increasing at an exponential rate. Learning from incidents that have taken place continues to emerge. The document gives an overview of how fire and rescue services should approach a comprehensive risk management process and what they should expect of the operators to identify hazards and risks. It provides guidance to support fire and rescue services developing robust Emergency Response Plans. This outline BSSMP considers the recommendations set out in the draft NFCC Guidance for FRS.

1.5.3 The Applicant has developed the BESS in accordance with all relevant legislation and good practice. This document also considers the recommendations of the following good practice documentation used in the UK for similar sites, including:

- National Fire Chiefs Council (NFCC) Grid-Scale Battery Energy Storage System planning – Guidance for FRS (2023 and draft revision 2024 – at the time of writing it is anticipated the new revised version of the BESS guidance will be published in 2025);

- National Fire Protection Agency (NFPA) 855 (2023): Standard for the Installation of Stationary Energy Storage Systems;
- NFPA 68 (2023): Standard on Explosion Protection by Deflagration Venting;
- BS EN 14797 (2006): Explosion venting devices;
- NFPA 69 (2024): Standard on Explosion Prevention Systems;
- Underwriters Laboratories (UL) 9540A (2025) Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems;
- UL 1642 (2020): Standards for Lithium Batteries;
- UL 1973 (2022): Batteries for Use in Stationary and Motive Auxiliary Power Applications;
- UL 9540 3rd Edition (2023): Standard for Energy Storage Systems and Equipment;
- UL 2941 (2023) Outline of Investigation for Cybersecurity of Distributed
- Energy and Inverter-Based Resources;
- IEEE 2686 (2025) standard: Recommended Practice for Battery Management Systems in Stationary Energy Storage Applications;
- FM DS 5-33 (2023) FM Global Datasheet. Lithium-Ion Battery Energy Storage Systems;
- UN 38.3: Recommendations on the Transport of Dangerous Goods – Manual of Tests and Criteria – (Lithium Metal and Lithium-Ion Batteries);
- United Kingdom Power Networks (UKPN) Engineering Design Standard 070116: Fire Energy Storage Systems, 2016;
- DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid-Connected Energy Storage Systems, 2017;
- Scottish and Southern Energy TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide, 2019;
- BS 5839 Part 1 2017: Fire Detection and Fire Alarm Systems for Buildings;
- BS 9990: 2015: Non-automatic firefighting systems in buildings - Code of practice;
- The Regulatory Reform (Fire Safety) Order (RRO) 2005;
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) Assessment;
- BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC – AC;

- BS EN IEC 62619 (2022) Secondary cells and batteries containing alkaline or other non-acid electrolytes. Safety requirements for secondary lithium cells and batteries, for use in industrial applications;
- BS EN IEC 62933-5-2 (2020) Electrical Energy Storage (EES) systems.
- Part 5-2: Safety requirements for grid integrated EES systems. Electrochemical-based systems;
- BS EN IEC 62281: 2019 + A2:2023: Safety of primary and secondary lithium cells and batteries during transport;
- BS EN IEC 62477-1 (2022) Safety requirements for power electronic converter systems and equipment;
- BS EN 16009 (2011) Flameless Explosion Venting Devices;
- BS EN 14373 (2021) Explosion Suppression Systems;
- BS EN IEC 61000-6-2 (2016) Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments; and
- BS EN IEC 61000-6-4 (2018) Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.

2 Consultation

2.1 Scottish Fire and Rescue Service

2.1.1 The Scottish Fire and Rescue Service (SFRS) will be consulted at the application stage and a draft version of this document shared with them. Any recommendations will be incorporated into the design as well as procedures and protocols during the construction, operation and decommissioning phases of the Project.

2.1.2 Equally, any comments submitted in response to the adjacent planning application will be considered.

3 BESS Safety Requirements

3.1 Safe BESS Design

3.1.1 The BESS will be designed to address prevailing industry standards and good practice at the time of design and implementation.

3.1.2 The current industry standard is NFPA 855, Standard for the Installation of Stationary Energy Storage System (Ref 1-1) and the Applicant also require any system selected to comply with UL9540 (Ref 1- 2), which demonstrates the fire propagation for lithium-ion batteries at cell, module unit level.

3.1.3 In addition to this, draft NFCC Guidance for FRS requires the following information to be provided:

- The battery chemistries being proposed.
- The battery form factor (e.g. cylindrical, pouch, prismatic)
- Type of BESS e.g. container or cabinet
- Number of BESS containers/cabinets
- Size/capacity of each BESS unit (typically in MWh)
- How the BESS units will be laid out relative to one another.
- A diagram / plan of the site.
- Evidence that site geography has been considered (e.g. prevailing wind conditions).
- Access to, and within, the site for FRS assets
- Details of any fire-resisting design features
- Details of any:
  - a) Fire suppression system
  - b) On site water supplies (e.g. hydrants, EWS etc)
  - c) Smoke or fire detection system
  - d) Gas detection systems
  - e) Temperature management systems
  - f) Ventilation systems
  - g) Exhaust system
- Deflagration venting system

- Identification of any surrounding communities, sites, and infrastructure that may be impacted as a result of an incident.

3.1.4 It also requires design features to be made clear. These may include:

- Rack layout and setup
- Thermal barriers and insulation
- Container layout and access arrangements

3.1.5 Good practice guidance for electrical sites within the UK has been consulted with regards to Site layout and separation distances for the transformers and inverters.

3.1.6 Fire safety provisions typically found within battery system design are as follows:

Battery modules with safety features designed into the cell level such as:

- Internal fuses;
- Contactor at rack/string and bank level;
- Overcharge safety device;
- Internal separating layers;
- Venting device;
- Thermal monitoring.

3.2 System Location

3.2.1 The draft NFCC Guidance for FRS acknowledges that Individual site designs will mean that distances between BESS units and occupied buildings/site boundaries will vary. It states that proposed distances should consider risk and mitigation factors and an initial minimum distance of 25 metres is proposed prior to any mitigation such as blast walls. Where possible buildings should be located upwind.

3.2.2 The location of the proposed BESS is more than 250m from any residential properties. This has the benefit of reducing the visual and noise

3.3 System Layout

3.3.1 The draft NFCC Guidance for FRS suggests a standard minimum spacing between units of 6 metres unless suitable design features can be introduced to reduce that spacing. If reducing distances a clear, evidence based, case for the reduction should be shown. Any reduction in this separation distance should be design based by a competent fire engineer.

3.3.2 The separation distance between the battery containers will be in accordance with NFPA 855 which recommends 3m separation. The draft NFCC Guidance for FRS recommends a standard minimum spacing between units of 6m based upon FM Global (2017) Property Loss Prevention Data Sheets: Electrical Energy Storage Systems, para. 2.3.2.2. This recommends that a 6m distance is necessary, but only if the thermal barrier proposed is less than 1 hour. The Canadian Solar Solbank 3 containers upon which this oBSSMP is based have a 90-minute fire retardant barrier as standard and therefore a 3.0 metre separation distance is suitable. The battery storage containers will not be stacked he proposed layout of the system will provide separation between key components or groups of key components. The BESS will be broken into discrete groups consisting of battery containers and inverters and transformers. Each group will be separated from the next. This separation will limit any fire that is not able to be contained to the affected group or part of the battery system and also allow emergency access in case of an intervention.

3.3.3 The draft NFCC Guidance for FRS suggests individual site designs will mean that distances between BESS units and occupied buildings/site boundaries will vary. Proposed distances should consider risk and mitigation factors. However, an initial minimum distance of 25 metres is proposed prior to any mitigation such as blast walls. It states that reduction of distances may be possible in areas of lower risk (e.g. rural settings).

3.3.4 This site is situated in a rural location as described at section 2.2 above and the proposed BESS is more than 250m from any residential properties. Therefore, a 6m distance to site boundaries is appropriate and is in accordance with NFPA 855 which recommends 3m separation to boundaries. The site layout plan shows a minimum of 6m separation from the battery containers to the site boundary, exceeding the current NFPA guidance. 3.3.5 The separation of the inverters and transformers will, depending on the architecture, be optimised at detailed design stage to minimise the likelihood of any spread of fire between adjacent components.

3.3.5 NFPA 855 recommends the following separation distances for BESS located outdoors:

3.3.6 BESS should be separated by a minimum 3m (10 ft) from the following exposures:

- Site boundaries;
- Public rights of way;
- Buildings;
- Stored combustible materials;
- Hazardous materials;
- High-piled stock;

Other exposure hazards not associated with electrical grid infrastructure.

3.3.7 These limits may be reduced to 1m where testing to UL9450 has been undertaken.

3.3.8 **BR 187 External fire spread**: building separation and boundary distances (BR 187 2nd edition).

3.3.9 Separation distances in England are generally calculated based on the recommendations of BR 187 External Fire Spread: Building Separation and Boundary Distances (Ref 1-3). Although the BESS containers are not classified as buildings the separation requirements of the BR 187 is easily satisfied by the construction of the containers when they achieve 60 minutes fire resistance for integrity and insultation.

3.3.10 This means that in the unlikely event that all of the system design mitigations and preventative measures fail that should a fire occur, it should be limited to the part of the system that is on fire, (i.e., the overall size of the battery system is inconsequential to the outcome); an event should be limited in size to only that equipment within a group, whether there are one or any number of groups.

3.4 Battery System Containers

3.4.1 Battery containers will house the energy storage electrochemical components and associated equipment. Being either one, or multiple containers joined, or close coupled to each other. They will be mounted on a concrete foundation.

3.4.2 The battery containers will be designed and constructed by the manufacturer in accordance with the good practice available at the time, such as the current guidance outlined in the NFPA 855, Standard for the Installation of Stationary Energy Storage Systems. This will ensure the containers will be of robust construction.

3.4.3 The BESS containers will be locked to prevent unauthorised access and, where required, will have a fire rating of 60 minutes (the length of time that the container can withstand a standard fire resistance test) the concept design is rated E160 as per ISO 13501-2.

3.5 Fire Detection and Suppression

3.5.1 The draft NFCC Guidance for FRS requires that an effective and appropriate method of early detection of a fault within the batteries should be in place, with the ability to disconnect the affected battery/batteries remotely. Should thermal runaway conditions be detected then there should be the facility in place for the early alerting of emergency services. Detection systems should also be in place for alerting to other fires that do not involve thermal runaway (for example, fires involving electrical wiring). Continuous combustible gas monitoring within units should also be provided. External audible and visual warning devices (such as cabinet level strobing lights), as well as addressable identification at control and indicating equipment, should be linked to the battery management system and detection and suppression system activation to enable first responders to understand what the warning is in relation to.

3.5.2 In order to achieve the safety objectives, the Scheme will employ monitoring systems that will help identify any abnormal operation and safely shutdown the system before it develops. These systems will be independent of the control systems and equipment that can cause the abnormal event and avoid the use of Safety Integrity Level (SIL) rated risk controls. Other measures include:

- Thermal monitoring of the battery containers and automated cut-out beyond safe parameters (further information on monitoring is provided below at Section 5.1: Control Room and Section 5.2: Control Architecture below);
- An external audible and visual warning device, and addressable identification at control and indicating equipment linked to the battery management system and detection and suppression system;
- Battery cooling systems with automated fail-safe operation;
- Emergency Stop – both remote and local;
- Fire detection suitable to the architecture such as:
    - ➢ Very early smoke detection by aspiration (VESDA) system.
    - ➢ Gas detection such as H2 and CO; as

3.5.3 The draft NFCC Guidance for FRS requires the installation of suitable fixed suppression systems and current research indicates the installation of water-based suppression systems is more effective than gaseous systems. Water run-off and potential impact on the environment, along with mitigation measures, should be considered and detailed in the Emergency Response Plan.

3.5.4 The system will have a suppression system embedded in the design to prevent spread of the fire/propagation.

3.6 Safe BESS Construction

3.6.1 The BESS would be constructed in 2 distinct phases. Firstly, the civil works and balance of plant equipment would be started. Then at a suitable point the BESS equipment would be delivered to be installed on the foundations and connected to the balance of plant.

3.6.2 The installation would be subject to pre-requisites such as a contractor emergency protocol detailing the actions to be taken in an emergency, including a construction emergency response plan that would be coordinated with the relevant stakeholders and emergency services. In addition, installation would not take place until practical provisions were completed such as the water tanks being installed and filled for use in an emergency.

3.6.3 The transportation of the system from the factory will be a combination of sea and land freight. The system is certified for transportation in all potential environmental conditions. The equipment will be certified for transport to UN 38.3. Transportation will be managed in accordance with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2019 and the UK guidance on the transport of dangerous goods “Moving dangerous goods, Guidance” Government webpage (Ref 1- 4).

3.6.4 The concept design includes BESS equipment prepopulated with batteries and will have undergone Factory Acceptance Testing (FAT). By definition, the FAT testing will be undertaken away from Site reducing the risks during on-Site construction with visual inspections and functional testing undertaken before any Site Acceptance Testing (SAT). Site installation will be supervised by the Original Equipment Manufacturer and done in a hierarchical way to ensure that all necessary systems are available before the next step is required. The outline sequence which is laid out in the manual is as follows:

- Inspect the items in the protective covers;
- Unpack and inspect the items;
- Install on the foundations;
- Once stable inspect the internal components;[1]
- Mechanically anchor the unit to the foundations;
- Connect any dry riser pipes and or the fire suppression system & strobe and siren;
- Install the grounding;
- Electrically interconnect the equipment DC, AC and comms.;
- Cold commission the equipment;
- Hot commission the equipment;
- Test the equipment.

3.6.5 By following a logical sequence of works with each step being built upon the preceding one the system can be safely assembled without risk and all mitigations against issues in place before the next step occurs.

[1] *Procedures will be in place with appropriate equipment to deal with any damaged equipment firstly to secure it, then quarantine it before returning for return or replacement.

4 Safe BESS Operation

4.1 Control Room

4.1.1 The BESS will be monitored by the on-Site control systems as well as 24/7 monitoring by a remote-control room.

- The control room will also monitor several other sites across the UK, staff will be fully trained and familiar with the technology.
- The control room will also be responsible for the security of the Site with state-of-the-art detection and monitoring systems. These can be repurposed in an emergency to support first responders.
- The control room will have the ability and authority to immediately shut the system down should the need arise.
- The control room will be responsible for the implementation of the emergency plan acting as a point of contact to emergency services.
- The BESS Compound will have signage in accordance with the relevant Electrical Regulations but will also have the control room emergency telephone number should a member of the public or Emergency Services need to make contact.

4.2 Control Architecture

4.2.1 Different battery systems have different topologies of control and safety systems that extend all the way to, in some measures, cell level. However, it is likely that the selected system will have:

- A module monitoring system;
- Each rack or string will typically have a rack/string monitoring system, receiving information from each module;
- Each bank will have a monitoring system, receiving information from each rack/string;
- A Battery Management System (BMS) with built in fail-safe automated algorithms.

4.2.2 The battery system components communicate with a master controller(s) that reads and records this information and uses algorithms to enable to safe operation of the system within these parameters.

4.2.3 These control systems will be failsafe by design with automatic shutdown of parts, or of the whole system, depending on circumstance.

4.2.4 The BMS will identify any failed cells and disconnect them, reducing the risk of a minor cell failure escalating to a failure of cell electrolyte containment. Individual cells will also be enclosed in battery banks, providing secondary containment, with the battery banks then enclosed in 'blocks' or shipping containers, providing tertiary containment against pollution.

4.2.5 The likely chosen technology will include:

4.2.6 ***Fire Resistant Construction*** - Container walls with 90-minute fire rating (European standard EN 14470-1) with lockable doors and door sensors ensure safe operation by personnel.

4.2.7 ***Fire Detection*** - Gas, smoke and heat detection with automatic activation to detect and suppress a fire to prevent it from spreading to the cells. Controlled shutdown can be manually activated by first responders or automatically triggered by internal safety features.

4.3 Security

4.3.1 The Site security profile will be assessed by the Applicant's dedicated security team and the output from this assessment will inform the level of security measures used.

4.3.2 As a minimum, the BESS will have security fencing clearly signed identifying the dangers within the Site and the Control Room freephone telephone number for use in case of emergency.

4.3.3 The Site will also have high quality CCTV with video analytics to identify and prevent unauthorised access to enable the correct security response to be undertaken by the control room.

4.4 Maintenance

4.4.1 The BESS will be maintained and operated by skilled personnel ensuring that the system is in optimal condition and that all parts of the system are fully serviced and functional at all times.

4.4.2 Maintenance is likely to be undertaken on the BESS equipment twice a year. This typically consists of a major maintenance period and a minor maintenance period. The major is relatively non-intrusive and involves checking connections and inspections from the transformer down to the module level. This will encompass all BESS equipment supplied by the original Equipment Manufacturer including the fire system. The minor maintenance is typically a visual inspection and rectification of any accumulated noncritical defects.

4.4.3 All maintenance will be undertaken in a carefully controlled manner.

4.4.4 During operation all works on the Site will be controlled under safe systems of work. This will mean all work is risk assessed to protect both personnel and equipment. Therefore, safety systems such as fire systems will not be stopped or taken out of service without appropriate mitigation, following the system being made safe so far as is reasonably practicable, and only for the minimum time required to undertake any specific maintenance tasks.

4.4.5 The draft NFCC Guidance for FRS requires that sites should be maintained in order that, in the event of fire, the risk of propagation between units is reduced. The scheme will therefore ensure that combustibles are not stored adjacent to units and access is clear and maintained. Areas within 10 metres of BESS units will be cleared of combustible vegetation. This will include regular grass mowing (secured through the Landscape Management Plan) and any other vegetation on site will be kept in a condition such that it does not increase the risk of fire on site.

4.5 End of Life / Disposal

4.5.1 For decommissioning of the BESS, the requirements will be determined at the procurement contract stage. This will make clear to the contractor that they are the producer of the battery components and the party placing the battery components on the UK market pursuant to the Waste Batteries and Accumulators Regulations 2009 (as amended) and pursuant to the Waste Batteries and Accumulators Regulations 2009 (or such equivalent regulations in force at the time of decommissioning) (Ref 1-5) it has certain obligations in respect of battery disposal.

4.5.2 All components replaced during the defects notification and warranty period will be taken back and recycled.

4.5.3 The Applicant will follow the hierarchy of waste management through the life of the Scheme as follows:

- **Reduce –** the lithium-ion batteries have finite life based on a number of factors, primarily the total number of cycles undertaken. The operation will attempt to manage the degradation by the selection of services and cycling that maximises the overall life. Consideration will be given to supplementation of the equipment or operation at a lower output.
- **Reuse –** If the batteries are no longer suitable for use by the Applicant there may still be opportunities to use the batteries for second life applications, such as domestic or windfarm storage.
- **Recycle –** The supplying manufacturer will have obligations under the Waste Batteries and Accumulators Regulations 2009 (as amended) (or such equivalent regulations in force at the time of decommissioning) and will be contractually obliged to offer a recycling service.
- **Recovery –** The recycling should allow any useful materials to be recovered and re-enter the supply chain.

- **Disposal** – Any disposal of batteries shall be undertaken in compliance with all applicable Laws and regulatory requirements, product stewardship, registration disposal and recycling or take back requirement.

4.5.4 In the event of a fire, the operator will develop a post-incident recovery plan that addresses the potential for reignition of the energy storage system and deenergising the system. Removal and disposal of damaged equipment will be in accordance with the measures set out above. This accords with the requirements of draft NFCC Guidance for FRS.

5 Firefighting

5.1 Fire Service Guidance

5.1.1 Guidance for the Fire Service for dealing with sites such as powerplants, substations etc. is contained in the Fire Service Manual Volume 2 Fire Services Operations – Electricity (Ref 1-6).

5.1.2 The Fire Service Manual stipulates that in all cases involving electrical apparatus, it is essential to ensure, on arrival, that the apparatus is electrically isolated and safe to approach. This should be carried out by the operator at the premises concerned. It is strongly advised that electrical or associated equipment should not be touched or even approached unless it is confirmed to be isolated and safe.

5.1.3 In the event of a fire, the battery system and the transformers serving the BESS will be automatically electrically isolated when a fire is detected within a container. However, the batteries within the containers will still hold charge in the event of a fire, even after the electrical system is isolated. It will not be possible to confirm that there is no residual risk from the energised batteries within the container, and this will inform the strategy for firefighting in the emergency plan.

5.2 Fire Service Access

5.2.1 Draft NFCC Guidance for FRS advises that suitable facilities for safely accessing and egressing the site should be provided and that these should be developed in close liaison with the local Fire and Rescue Service due to variations in vehicles and equipment. In line with best practice the following has been provided:

- Two separate access points have been provided at the northern end of the site to allow one way traffic within the site.
- Access roads and hard standing have been designed to ensure they are capable of providing unobstructed access to all areas of the facility and accommodating fire service vehicles in all weather conditions and that there is adequate space for manoeuvring and turning.
- Access will be designed such that emergency services are able to access the Site easily with Site roads being clearly laid out and sign posted.

5.3 Fire Water

5.3.1 The Applicant will engage with Fire Scotland at the application phase (See section 3 above) and their requirements in terms of fire water will be incorporated within the scheme. This is in line with the draft NFCC Guidance for FRS which advises that proposals for water supplies should be developed following liaison with the local fire and rescue service considering the likely flow rates required to achieve tactical priorities. As a minimum it is recommended that hydrant supplies for boundary cooling purposes should be located close to BESS containers (but considering safe access in the event of a fire) and should be capable of delivering no less than 1,900 litres per minute for at least 2 hours.

5.3.2 The site design for the Scheme includes the following for the purposes of firefighting:

- External firefighting water storage structures will be available on site.
- The external firefighting water storage units will provide capacity to ensure that they are above the minimum requirement.
- The Illustrative Site Layout Plan (see Figure 1.1) shows the proposed location of the water storage tower.

5.4 Emergency Planning

5.4.1 The BESS will have robust and validated emergency plans. These emergency plans will accord with the requirements of draft NFCC Guidance for FRS (or its subsequent update) and will include:

Risk Management Plan

- The hazards and risks at and to the facility and their proposed management.
- Any safety issues for firefighters responding to emergencies at the facility.
- Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems.
- The adequacy of proposed fire detection and suppression systems (e.g., water supply) on-site.
- Natural and built infrastructure and on-site processes that may impact or delay effective emergency response.

Emergency Response Plan

- How the fire service will be alerted
- A facility description, including infrastructure details, operations, number of personnel, and operating hours.
- A site plan depicting key infrastructure: site access points and internal roads; firefighting facilities (water tanks, pumps, booster systems, fire hydrants, fire hose reels etc); drainage; and neighbouring properties.
- Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eyewash and shower facilities; spill

containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid.

- Up-to-date contact details for facility personnel, and any relevant off-site personnel that could provide technical support during an emergency.
- A list of dangerous goods stored on site.
- Site evacuation procedures.
- Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire, grass and bushfire.

5.5 Firefight Consequences

5.5.1 As the BESS will not have access for personnel into the battery containers, there is unlikely to be any immediate threat to life, only property which forms part of the Scheme.

5.5.2 The emergency services would most likely commit to fighting fire by using water on neighbouring areas such as battery containers, trees, and structures to cool down and prevent further fire spread.

5.5.3 It is not anticipated that firefighting techniques will involve direct jets of water onto equipment and will be limited to containment and cooling of adjacent units to prevent the fire from spreading. This strategy will be finalised with the local fire authority and be made clear in the emergency plan.

5.5.4 The 'Air Quality Impact Assessment of Battery Energy Storage Systems (BESS) Fire' (and associated Appendices) assesses the battery fire emission impact on the surrounding area (including residential receptors). It considers a number of scenarios within the BESs, as well as the potential cumulative effects of an event including the adjacent 700MW facility.

5.5.5 Based on the factors of distance to the nearest property and the short-term nature of a fire incident, the assessment concludes that there will not be adverse effects at the closest receptor locations as a result of a BESS fire incident. Notwithstanding, whilst there is low risk of adverse effects at the closest receptors, the emergency response plan will incorporate the following measures:

- to inform any potentially affected residents especially those located at downwind locations to the BESS fire and advise the public about health effects of smoke, related symptoms, and ways to reduce exposure;
- to cancel outdoor events; and keep windows closed for any potentially affected residents, especially those which are located at downwind locations to the BESS fire; and,
- to stop any farming activities and to move farmers/workers within 500m of the BESS fire to a cleaner air location.

5.5.6 In addition, a post incident recovery plan will be drawn up that will determine any immediate and follow up actions required to an event.

5.5.7 There are many factors which would inform the design of an investigation following an incident which ultimately account for the volume and concentration of the loss. In the case of a fire to a BESS unit, variables to be considered include:

- Extent of the fire: including duration, number of BESS units impacted, number of adjacent assets impacted;
- Firefighting method: whilst defensive techniques are anticipated, larger volumes of water may be required to dampen and cool adjacent assets, alternative techniques to fight any adjacent fires;
- Location of the fire: adjacent to drainage or close to soft ground;
- Existing Site conditions: recent weather and precipitation levels.

6 Pre-Construction Information Requirements

6.1 Summary

6.1.1 The detailed design phase will determine the approach to addressing the following specific requirements, which will be updated prior to construction of the BESS and submitted to the local planning authority as a detailed BSSMP prior to the commencement of construction. The detailed BSSMP must include:

- The detailed design, including drawings of the BESS;
- A statement on the battery system specifications, including fire detection and suppression systems;
- A statement on operational procedures and training requirements, including emergency operations;
- A statement on the overall compliance of the system with applicable legislation;
- An environmental risk assessment to ensure that the potential for indirect risks (e.g., through leakage or other emissions) is understood and mitigated;
- A Risk Management Plan detailing the hazards and risks at and to the facility and their proposed management, safety issues for fire fighters and safe access;
- An Emergency Response plan covering construction, operation and decommissioning phases developed to include the adequate provision of firefighting equipment on-Site.

6.1.2 Provision of the above information will demonstrate prior to construction that all of the considerations and requirements in this document have been addressed, and the BESS installation is safe.

7 Conclusion

7.1 Summary

7.1.1 The Applicant is committed to developing a safe BESS that will provide long dependable operation. It is in everyone's interest that the selected BESS technology is robust, in particular to safe operation.

7.1.2 Cumulative matters have been considered in respect of the adjacent 700MW BESS.

7.1.3 This report demonstrates that, the Applicant has relevant experience of BESS systems; that the relevant stakeholders have been consulted (and their responses have informed the design of the Scheme), and therefore safety will be inherent in the overall design, minimising the risk of a fire event occurring, and reducing the impact of such an event should it occur.