

# **Green Hill Solar Farm**

## **EN010170**

### **Outline Battery Storage Safety Management Plan**

Prepared by: Island Green Power / BSTandT

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## Issue Sheet

Report Prepared for: Green Hill Solar Farm

DCO Submission

### Outline Battery Storage Safety Management Plan

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## 1 Executive Summary

- 1.1.1 This report has been prepared on behalf of Green Hill Solar Farm Ltd. (the 'Applicant') in relation to an application made to the Secretary of State (SoS) for the Department for Energy Security and Net Zero, under section 37 of the Planning Act 2008, seeking a Development Consent Order (DCO) for the Green Hill Solar Farm (the 'Scheme').
- 1.1.2 The Scheme is a nationally significant infrastructure project comprising a ground mounted solar photovoltaic generating station with a gross electrical capacity of over 50 megawatts and associated development including Battery Energy Storage System (BESS). The DCO Application (including the Environmental Statement [EN010170/APP/GH6.1 to EN010170/APP/GH6.5] assumes that the form of energy storage will be battery storage and as such, the Energy Storage Facility (as it is termed in the draft DCO), is often referred to as a 'BESS' (Battery Energy Storage System throughout the application documents). The Scheme is to be located at nine distinct areas, as described in Chapter 3: The Development Site [EN010170/APP/GH6.2.3] of the Environmental Statement (ES).
- 1.1.3 The DCO Application proposes that the BESS for the Scheme will be located at Green Hill BESS with option to also install BESS at Green Hill C. As shown within Work No.2 in Chapter 4: Scheme Description [EN010170/APP/GH6.2.4].
- 1.1.4 The Works Plan [EN010170/APP/GH2.4] shows the proposed locations of the two BESS areas (Green Hill BESS and Green Hill C).
- 1.1.5 The solar array Sites, associated substations, and BESS are to be connected to the National Grid at Grendon National Grid Substation. This report outlines the key fire safety provisions that are considered likely to be included in the design of the proposed BESS facilities (Green Hill BESS and Green Hill C).
- 1.1.6 By way of requirement that is secured in the DCO, prior to the commencement of construction of the BESS; the Applicant will be required to prepare a Battery Storage Safety Management Plan (BSSMP) which must be in accordance with this Outline BSSMP (OBSSMP). As part of the BSSMP, the Applicant will take into account the latest good practices for battery system failure prevention and detection, consequence modelling, risk analysis, and emergency response planning, as guidance continues to develop in the UK and around the world.
- 1.1.7 There are several battery storage technologies available to the Applicant. The generic system used for indicative planning purposes is a 4 MWh BESS system integrating ten battery racks. The exact technology and system chemistry type is still to be determined, however, it will be a lithium-ion battery cell type. The common types of this chemistry within the lithium-ion family are Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO<sub>2</sub>) known as "NMC" after the three key cathode materials or Lithium Iron Phosphate (LiFePO<sub>4</sub>) known as "LFP". The final battery chemistry will be confirmed as part of the detailed design prior to the commencement of construction.
- 1.1.8 For the purposes of this document a concept design has been considered that uses a BESS system based upon LFP lithium-ion battery technology that is currently used on other solar projects being developed by the Applicant. This is considered to be a reasonable worst case for the purposes of the assessment in



terms of BESS toxic gas emission potential (Hydrogen Fluoride production) and explosion risk (significant levels of hydrogen produced during thermal runaway).

- 1.1.9 As recommended in National Fire Chiefs Council (NFCC) revised guidelines (2024) (Ref 1) a Plume Analysis study (BESS Fire Emissions Modelling [EN010170/APP/GH6.3.16.2]) has been conducted using the concept design to assess the environmental impact of a BESS thermal runaway incident to sensitive receptors within a 1 km radius of the potential BESS areas (Green Hill BESS and Green Hill C), to assess the potential to cause air quality impacts during a BESS fire. Concentrations of carbon monoxide (CO), formaldehyde, hydrogen chloride (HCl), hydrogen cyanide (HCN), hydrogen fluoride (HF), ammonia (NH<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>) and particulates, were modelled using Atmospheric Dispersion Modelling Software (ADMS) to determine the effects of BESS fire emissions on human health. In line with NFCC recommendations, a high-level visibility assessment has also been undertaken using the modelled particulates results to determine the effect of BESS fire emissions on visibility to the local road network.
- 1.1.10 The BESS will be designed in accordance with the UK and internationally recognised good practice guidance available at the time.
- 1.1.11 The overall approach is to follow the Health and Safety Executive's (HSE) hierarchy of controls (Ref 2):
- Elimination;
  - Substitution;
  - Engineering Controls;
  - Administrative Controls; and
  - Personal Protective Equipment.
- 1.1.12 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 a new battery chemistry may be integrated but this would be fully tested and certified to the latest BESS safety standards and this will be reflected in the final BSSMP approved by the Local Planning Authorities in consultation with Northamptonshire Fire and Rescue Service (NFRS) and the Environment Agency (EA).
- 1.1.13 A summary of the anticipated BESS failure safety provisions 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;
  - The location of the BESS has been chosen to minimise impacts on offsite receptors (albeit this is inherent in the DCO Application, more particularly Embedded Mitigation for the Scheme, as it has been factored into the design process to date);





- Separation distances between components will be applied 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 non-combustible BESS enclosures with high levels of thermal insulation (fire and heat resistance). The BESS facility will be designed with multiple layers of protection to mitigate and minimise the probability of a fire or thermal runaway incident;
- In the case of the BESS design, it will integrate multiple layers of prevention and mitigation features to minimise the chances of a BESS failure incident (equipment failure / burning or gas venting thermal runaway scenario);
- All equipment will be monitored, maintained, and operated in accordance with manufacturer instructions and be compliant with requisite safety standards listed in Section 2.5 Relevant Guidance (UL, IEC, IEEE, NFPA, etc.);
- The BESS design will include integrated fire and explosion prevention and protection systems. Following key industry safety standards i.e. NFPA 855 (Ref 3), UL 9540 (Ref 4), BS EN IEC 62933-5-2 (Ref 5), and based on comprehensive UL 9540A (2025, 5<sup>th</sup> Edition) (Ref 6) and / or 3rd party full scale destruction testing. A BESS system and site-specific Emergency Response Plan (ERP) will be developed at the detailed design stage, based on national and international best practice measures;
- 24/7 remote monitoring of the system via a dedicated control facility. The control facility will have the capability to shut the system down should the need arise and will also be responsible for implementing the emergency plan and acting as a point of contact for the emergency services; and
- Communication with the local fire and rescue services (NFRS) with engagement early in the project and continuing across design and construction phases. This will ensure robust emergency response planning, risk management planning and ensure all safety materials and equipment is available in an emergency for first responders.



## 2 Introduction

### 2.1 Scope of this Document

- 2.1.1 This outline BSSMP (OBSSMP) document, produced by the Applicant, outlines the key fire safety provisions for the BESS proposed to be installed at Green Hill Solar Farm (Green Hill BESS and Green Hill C) including measures to reduce BESS failure risks and mitigate credible failure incident scenarios.
- 2.1.2 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 OBSSMP is to identify how the Applicant will use good industry practice to reduce risk to life, property, and the environment from the BESS.
- 2.1.3 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 OBSSMP. As part of preparation of the BSSMP, the Applicant will incorporate the latest good practices for battery storage safety, failure detection and prevention, along with the emergency response planning, as guidance continues to develop in the UK and internationally.
- 2.1.4 While the operational phase is anticipated to commence no earlier than 2029, 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 standards, certifications, guidance, and testing requirements.

### 2.2 Project Description

- 2.2.1 For the purposes of this document a concept design has been considered that uses a BESS system based upon LFP lithium-ion battery technology that is currently used on other solar projects being developed by the Applicant. This is considered a reasonable worst case for the purposes of the assessment in terms of safety (toxic and explosive gas production risks).
- 2.2.2 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 OBSSMP) is required to be submitted to the relevant local planning authority and approved, in consultation with Northamptonshire Fire and Rescue Service (NFRS) and the Environment Agency (EA). The Applicant must operate the BESS in accordance with the approved plan.
- 2.2.3 Further, pursuant to a requirement of the Development Consent Order (DCO), the detailed design of the BESS must be in accordance with the Outline BSSMP (which includes various safety requirements for the BESS design) and the Concept Design Parameters and Principles **[EN010170/APP/GH7.17]**. The Concept Design Parameters and Principles contain controls over the BESS, which include that the energy storage capacity of the BESS will be a lithium-ion battery system.
- 2.2.4 The BESS design and system chemistry type is still to be determined, and the final battery chemistry will be confirmed as part of the detailed design prior to the commencement of construction.
- 2.2.5 The concept design consists of the BESS enclosures and the associated transformers, circuit breakers and inverters with an onsite control room. The



BESS enclosures, and auxiliary systems, such as cooling, uninterruptible power supply (UPS), fire and gas detection, explosion protection mechanisms, suppression system, monitoring and control, will be designed in accordance with internationally recognised standards and good practice guidance available at the time.

- 2.2.6 Once operational, the plant will be designed to operate unmanned with access required for maintenance only, and with an Operational Life of up to 60 years.

### **2.3 Potential BESS Failure**

- 2.3.1 Causes of battery cell failure which could lead to a thermal runaway event include manufacturing defects (contaminants / imperfections), electrical abuse (overcharging / over-discharging), and physical or mechanical damage (puncture / crushing).

- 2.3.2 BESS hazards for first responders in the unlikely situation of a battery failure and thermal runaway event depend on the BESS design but are typically defined as: fire hazards, explosion hazards, electrical hazards (shock or arc flash), and chemical hazards (i.e. the release of toxic gases).

- 2.3.3 Regardless of the type of failure or the cause, the main potential hazard is thermal runaway where a battery cell enters an uncontrolled self-heating state and ultimately, if not controlled, a significant flaming or battery gas venting incident and therefore this plan focusses on reducing fire and explosion risks associated with the BESS and managing the hazard in the unlikely event that it occurs.

- 2.3.4 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.

### **2.4 Safety Objectives**

- 2.4.1 The safety objectives for the design of the BESS are:
- To minimise the likelihood of a failure 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;
  - Final BESS design and site layout should minimise the requirement for direct NFRS intervention in a thermal runaway incident i.e. direct hose streams or spray directly on BESS battery systems. NFRS intervention in worst case scenarios would typically be limited to boundary cooling of





adjacent BESS and Energy Storage System (ESS) units to prevent the fire from spreading. This strategy should be finalised with NFRS and be clearly communicated in the Emergency Response Plan (ERP);

- If the BESS system does not incorporate an automatic fire suppression system and is designed to safely burn out to remove the risk of stranded energy in the battery systems, then full scale free burn testing will have been conducted to demonstrate that loss will be safely limited to one container without the intervention of the NFRS;
- To ensure that fire, smoke, and any release of toxic gases does not significantly impact site operatives, first responders, and the local community; and
- To ensure that firewater run-off is contained and tested before release or, if necessary, removed by tanker and treated offsite.

## 2.5 Relevant Guidance

2.5.1 Guidance documents and standards considered by the Applicant have been used to inform the design of the scheme.

2.5.2 There is currently limited UK specific guidance for BESS, however the Applicant has incorporated good practice from around the world.

2.5.3 The Applicant has developed the BESS in accordance with all relevant legislation and good practice. This document takes into account 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 07-0116: 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. General;
- 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.
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### 3 Consultation

#### 3.1 Northamptonshire Fire and Rescue Service

- 3.1.1 The local fire and rescue service, Northamptonshire Fire and Rescue Service (NFRS) has been consulted during pre-application discussions and as part of Statutory Consultation.
- 3.1.2 Further comments made by NFRS in their responses are set out in the table below.

**Table 1: NFRS Comments and Recommendations**

Date and method of contact	NFRS response	Applicant's response
<p>09/07/24 - Teams Meeting with NFRS</p> <p>Fire Protection Officer and Point of Contact (POC)</p> <p>Water Officer</p> <p>Fire Protection Specialist</p> <p>Purpose of the meeting:</p> <ol style="list-style-type: none"><li>1. Introduce NFRS to Green Hill Solar Farm and the BESS plans</li><li>2. Explain the safety measures that will be embedded in the site design</li><li>3. Understand what the NFRS concerns and/or requirements are</li></ol>	<p>Matters raised by NFRS:</p> <ul style="list-style-type: none"><li>• Track width for internal roads would need to be to the FRS specifications.</li><li>• A water pipe to the site has been closed due to a crack pipe.</li><li>• NFRS response to the Scheme will be led by NFCC Guidance and if the applicant designs to this then there should be limited issues.</li><li>• NFRS would accept reduced battery spacing if the updated NFCC guidance allows for this (based on evidence base of each system).</li><li>• NFRS are happy with the proposed locations on the basis that they can be accessed via adopted highway, but junction/access specifications would need to be provided in accordance with the FRS standards to ensure access can be provided for suitable vehicles.</li><li>• NFRS will need to consider implications of prevailing wind on access requirements (and need for multiple access).</li></ul>	<ul style="list-style-type: none"><li>• The Applicant has designed the illustrative BESS area designs to accommodate all NFRS vehicles in all weather conditions.</li><li>• The Applicant will integrate water tanks within the BESS areas to ensure continuity of water supply for NFRS.</li><li>• The Applicant confirmed that the NFCC guidance at the time of procurement of the BESS will be referenced to manage fire safety risks and inform the Battery Safety Management Plan.</li><li>• The Applicant has designed the illustrative BESS areas to most recent NFCC guidance parameters, any reduced spacing will be based on evidence of the proposed system in accordance with guidance.</li><li>• The Applicant noted site access comments and has produced illustrative / indicative site plans for NFRS review and approval.</li><li>• The Applicant has submitted a Plume Study which includes a detailed assessment of site wind conditions, and has designed site access points for NFRS to account for prevailing wind conditions.</li></ul>



Date and method of contact	NFRS response	Applicant's response
	<ul style="list-style-type: none"><li>• The FRS requested that the Applicant needs to make clear the design assumptions when issuing any layouts for consideration and identify where there has been any departure from guidance and the justification for this.</li><li>• NFRS team includes a water and drainage specialist, and the Applicants design and safety team should prioritise including water tanks (possibly hydrants) and drainage on the site design plans and agree on content for inclusion in documentation.</li><li>• FRS confirmed that Fire Protection Officer will be the main point of contact, and he will liaise internally with any other FRS colleagues to provide a single response to any requests.</li></ul>	<ul style="list-style-type: none"><li>• The Applicant noted the comments on design assumptions and will share the OBSSMP and site designs with NFRS which will satisfy these requirements, once documents are ready for DCO submission.</li><li>• The Applicant noted these comments, has prioritised integration into the Scheme and will share all relevant materials covering firefighting water and drainage strategy with NFRS when they are ready for DCO submission.</li><li>• The Applicant agreed to share site design and safety principles that would be used as a template for the scheme with NFRS at the DCO document submission stage. .</li></ul>
<p>09/07/2024 - The Applicant emailed the Fire Protection Officer with key safety information identified during the Teams meeting:</p> <ol style="list-style-type: none"><li>1. A document which lays out the key safety distances allowed for site indicative design.</li><li>2. A document containing data the Applicant has used to put together preliminary site design plans. This data includes recent plume studies (toxicity / visibility), equipment spacing test data, first responder best practice data, IFC FRS road access guidelines, NFCC FRS response requirements, and</li></ol>	<ul style="list-style-type: none"><li>• The Fire Protection Officer promised to share with the NFRS team before putting any further initial questions or observations to the Applicant.</li></ul>	<ul style="list-style-type: none"><li>• The Applicant agreed to share further BESS safety materials with NFRS to help better inform emergency response training and knowledge.</li></ul>



Date and method of contact	NFRS response	Applicant's response
BESS water capture / drainage solutions.  3. A BESS safety peer review conducted for the Applicant laying out the key safety principles that should be embedded in site design, equipment procurement and safety documentation.		
22/07/2024 – Fire Protection Officer (NFRS POC) emailed the Applicant	<p>The Fire Protection Officer confirmed the following points for the Applicant:</p> <ul style="list-style-type: none"><li>• NFRS is satisfied with the information provided to this point and look forward to receiving more detailed plans as and when they become available.</li><li>• NFRS have no specific comments to make at this point, but expect the Applicant to continue to have regard to NFCC guidance around grid-scale energy storage systems as the project develops.</li><li>• NFRS have previously provided our pre-planning guidance, containing details of the access routes required for our appliances, once NFRS have also established our BESS page they will notify the Applicant.</li></ul>	<ul style="list-style-type: none"><li>• The Applicant confirmed that NFRS vehicle access requirements would be incorporated into site design</li><li>• The Applicant confirmed that they will share scheme BESS safety and site design with NFRS when completed.</li></ul>
26/04/2025 – The Applicant emailed NFRS Fire Protection Officer (POC) to advise that all documentation for the Scheme will be submitted to the planning inspectorate during May. The Applicant confirmed they will share all the requisite documentation with NFRS and would like to arrange a meeting / site visit once NFRS has had the opportunity to review all documentation.	07/05/2025 – NFRS Fire Protection Officer (POC) emailed confirmed receipt of materials and agreement to a future meeting / site visit at a date to be confirmed.	13/05/2025 – The Applicant emailed NFRS with two potential meeting / site visits dates during June, 2025.





Date and method of contact	NFRS response	Applicant's response
<p>The Applicant also emailed additional safety materials for NFRS regarding:</p> <ul style="list-style-type: none"><li>• ERP drafting information</li><li>• BESS full scale destruction test data</li></ul>		



## 4 BESS Safety Requirements

### 4.1 Safe BESS Design

- 4.1.1 The BESS will be designed to address prevailing industry standards and good practice at a time of design and implementation. BESS system and components used to construct the facility will be certified to UL 9540 (2023) (Ref 4) and/or BS EN IEC 62933-5-2 (2020) (Ref 5) standards (or any future standards which supersede this).
- 4.1.2 As a minimum, the battery system will have completed unit or installation level UL 9540A (5<sup>th</sup> Edition) testing (Ref 6), demonstrating that either thermal runaway propagation will not spread between modules or between battery racks or full-scale free burn (destruction) testing has validated that loss will be safely limited to one BESS enclosure and demonstrate that deflagrations do not occur or can be safely contained. UL 9540A heat flux test data can establish safe distances between BESS enclosures and ESS equipment but will not be conclusive if full propagation of the battery system does not occur in the test.
- 4.1.3 NFPA 855 (2023) (Ref 3) currently provides the most comprehensive guidelines for BESS design and site installation specifications. BESS design structural integrity will be demonstrated through full-scale destruction performance testing and / or by integrating rigorously tested NFPA 69 (explosion prevention) and NFPA 68 (Explosion protection through deflagration venting) features.
- 4.1.4 If the BESS design integrates hybrid systems, sparkler system or performance design explosion protection systems should be validated through BESS full-scale destruction testing, lean gas mixture testing and requisite pressure testing required by NFPA and EN standards.
- 4.1.5 If a BESS automatic fire suppression system or Thermal Runaway Propagation Prevention (TRPP) system (engineered to directly access cells within battery modules) is integrated within each BESS enclosure, this will conform to NFPA 855 standards and be tested to UL 9540A protocols or through significant scale third party fire and explosion testing. The suppression or TRPP system will be capable of operating effectively in conjunction with a gas exhaust / ventilation system to minimise deflagration risks. The system design must be capable to control or fully suppress a fire, without the direct intervention of NFRS. Fire suppression system performance should be benchmarked against free burn testing. An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results plus any additional fire and explosion test data which has been provided and validate the suppression system design.
- 4.1.6 If the BESS design does not integrate automatic fire suppression systems and a dry pipe sprinkler or spray system is integrated, then NFCC (2024) (Ref 1) revised guidance will be followed. Connections to any dry pipe systems that are required to be installed on the BESS Area should be installed in accordance with BS 9990 Non-automatic firefighting systems in buildings code of practice (Current Edition) (REF 9) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (Current Edition) (Ref 10). If a dry pipe system is integrated for the scheme, NFRS instantaneous connection points will be located at a safe distance from enclosures and clearly signed for NFRS response, in accordance with NFCC



guidelines. Water supply for this type of system will be separate from the water supply designated for NFRS boundary cooling firefighting requirements.

- 4.1.7 If the BESS enclosure is a walk-in design (this is a very low probability because most BESS designs are cabinet systems that can be fully serviced without entering the enclosure), an automatic water fire suppression system must be installed. The suppression system must be capable to operate effectively in conjunction with a gas exhaust / ventilation system to minimise deflagration risks. System design and water supply requirements will be fully agreed with NFRS.
- 4.1.8 If the BESS system is designed to safely burn out without internal fire suppression systems (to remove the risk of stranded energy in the battery systems), full-scale destruction performance testing will be conducted to demonstrate that loss will be safely limited to one BESS enclosure without the intervention of NFRS. UL 9540A heat flux test data can also establish safe distances between containers and ESS equipment but will not be conclusive if full propagation of the battery system does not occur in the test.
- 4.1.9 As best practice, additional third-party fire and explosion testing should be utilised by the BESS Original Equipment Manufacturer to demonstrate that structural integrity is maintained and toxic gas emissions to the closest receptors are below relevant public health exposure limits when the battery system is fully consumed (burnt out). An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results and any additional 3rd Party fire and explosion test data which has been provided and share conclusions with NFRS i.e. the need for additional water supply for boundary cooling or a dry pipe sprinkler system.
- 4.1.10 In addition to this, good practice guidance for electrical sites within the UK has been consulted with regards to BESS area layouts and separation distances for the transformers and inverters.
- 4.1.11 Safety Certifications and mitigation features typically found within battery module design, which the Applicant will commit to for the Scheme, include:
- Internal fuses;
  - Liquid cooling system;
  - Active thermal management system (TMS);
  - Contactor at rack/string and bank level;
  - Overcharge safety device;
  - Internal passive protection products;
  - Venting systems and gas channels; and
  - Thermal or multi-sensor monitoring devices.
- 4.1.12 Battery cell certified to UL 1973 (Ref 11) and/or BS EN 62619 (Ref 12) and tested to UL 9540A unit or installation level for BESS designs (Ref 6)
- 4.1.13 Module design will be certified to UL 1973 (Ref 11) and/or BS EN 62619 (Ref 12) and tested to UL 9540A unit or installation level (Ref 6).



### System Location

- 4.1.14 Within both Green Hill BESS and Green Hill C, the identification of the proposed locations for the BESS sites has been based on a number of factors. The most pertinent factor being the selected Sites have tried to minimise the proximity to receptors of any nuisance with the distance to properties maximised where possible. This has the benefit of reducing the visual and noise impact but also minimises any potential impacts on the local population should an event occur. The location of Green Hill BESS area is 201m from the closest residential property, with Green Hill C area located 338m from the closest residential property.

### System Layout

- 4.1.15 The Illustrative Site Layout Plans (Green Hill BESS and Green Hill C) **[EN010170/APP/GH6.4.4.4.3, EN010170/APP/GH6.4.4.9.3 and EN010170/APP/GH6.4.4.9.4]** and the final detailed site design will provide separation between key system components or groups of key system components.
- 4.1.16 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.
- 4.1.17 National Fire Protection Agency (NFPA) 855 (2023) (Ref 3) defines basic operation Health & Safety (H&S) protocols for all BESS site designs which should be incorporated into emergency response plans:
- Potential debris impact radius is defined as 100 feet (ft) or 30.5 metres (m) i.e. this is a typical explosion risk safe exclusion zone radius as modelling and previous BESS incidents typically show 25 m to be maximum radius; and
  - Automatic building evacuation area is defined as 200 ft or 61 m from the affected BESS enclosure.
- 4.1.18 NFPA 855 (2023) (Ref 3) also defines five BESS hazard categories – hazards are assessed under both normal operating conditions and emergency / abnormal conditions:
- Fire and explosion hazards;
  - Chemical hazards;
  - Electrical hazards;
  - Stored / stranded energy hazards; and
  - Physical hazards.
- 4.1.19 The indicative minimum separation distance between the BESS enclosures and Order limits boundary are 35 metres on Green Hill BESS and 19 metres on Green Hill C.



- 4.1.20 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.
- 4.1.21 The layout of the Scheme provides adequate separation between enclosures, additional ESS (Energy Storage System) equipment, and other key site structures and infrastructure. The UK National Fire Chiefs Council (NFCC) 'Grid Scale Battery Energy Storage System planning – Guidance for FRS (2023 and 2024 draft revision)' (Ref 1) will be followed at an indicative design stage, which comprises:
- To protect BESS enclosures from exterior risks, they shall be provided with impact protection to prevent damage to battery enclosures by vehicles or construction equipment and use Damage Limiting Construction (DLC) techniques;
  - The indicative BESS layout conforms to NFPA 855 (2023) (Ref 3) standard allowing a separation distance of 3.5 m between BESS blocks and 4 m to ESS equipment, and 0.9 m between adjacent and back-to-back BESS enclosures. This conformity to NFPA 855 (2023) equipment spacing recommendations (if UL 9540A (Ref 6) testing shows propagation does not occur) is considered safe practice by revised NFCC;
  - NFCC guidelines allow reduced separation distances if suitable design features can be introduced. If the BESS system is designed to safely burn out to remove the risk of stranded energy in the battery systems, then full scale free burn / destruction testing will have been conducted to demonstrate that loss will be safely limited to one BESS enclosure without the intervention of NFRS;
  - If reducing distances, a clear, evidence-based case for the reduction will be shown in the detailed design phase and agreed with NFRS i.e. UL 9540A (Ref 6) unit or installation testing and / or third party full scale destruction testing heat flux data. An independent Fire Protection Engineer specialising in BESS will validate all UL 9540A and / or third party test and site specific consequence modelling data which has been provided;
  - 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;
  - Areas within 10m of BESS enclosures do not contain combustible vegetation and would not be planted with any new combustible vegetation wherever possible. Where this is not feasible a full risk assessment would be conducted, and mitigation features applied if required by the NFRS. Any other vegetation on site would be kept in a condition such that they do not increase the risk of fire on site;
  - The BESS enclosure would have an internal fire resistance rating of at least one hour (according to NFPA 855, BR 187 and FM Global Datasheet 5-33);
  - The BESS area would be designed to integrate pressure fed (pump driven) fire hydrants and/or static water tanks for firefighting, dependent on





available water supply. Water tanks will be located at least 10m from the nearest BESS enclosure. Water access points, whether hydrants or tank connections, would be located in consultation with the NFRS to provide redundancy and safe operating distances for firefighters with 30 – 50m, which is considered an optimal safe distance; and

- Tanks and water outlets would be clearly labelled with appropriate signage and marked on site plans. Additionally, to avoid any mechanical damage, outlets and hard suction points would be safeguarded with bollards.

4.1.22 By adhering to the separation distances noted above, risk should be adequately minimised to limit a fire event to a single BESS or ESS structure.

#### **Battery System Enclosures**

4.1.23 Battery enclosures will house the battery systems, 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 slab.

4.1.24 Each BESS Enclosure will be installed by a certified and qualified installer. Each BESS Enclosure will be UL 9540 (Ref 4) and / or BS EN IEC 62933-5-2 (Ref 5) certificated. Ingress protection testing of BESS enclosures is conducted under UL9540 and/or IEC62933-5-2 certification of any BESS system. IEC Factory Acceptance Testing (FAT) or an independent manufacturing audit will be carried out to ensure the supplied BESS enclosures comply with the requisite certified ingress protection levels.

4.1.25 Ingress Protection (IP) ratings of BESS containers will be shared with NFRS at the detailed design stage so that risks associated with boundary cooling can be understood and implemented into the ERP. Potential boundary cooling water ingress points such as Heating, Ventilation and Air Cooling (HVAC) systems and deflagration vents will be considered as part of an incident response strategy.

4.1.26 BESS Enclosure gas exhaust vents and deflagration panels must direct flaming or toxic gases away from site personnel or first responders in line with NFCC guidance and NFPA 68 (Ref 8) and BS EN 14797 (Ref 13) standards, doors cannot be used as sole deflagration vents.

4.1.27 The BESS containers will be locked to prevent unauthorised access and, will have an internal fire resistance rating of at least one hour (according to NFPA 855 (Ref 3), BR 187 (Ref 14) and FM Global Datasheet 5-33 (Ref 15)).

4.1.28 Where required, BESS enclosure walls will have a minimum one hour fire resistance rating to BS EN 13501-2 (Ref 16) and BS EN 1364-1 (Ref 17) standards.

#### **Detection and Suppression systems**

4.1.29 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;
- Battery liquid cooling systems with automated fail-safe operation (air cooling systems will not be considered for the Scheme);
- Emergency Stop – both remote and local;
- 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 BESS Enclosure. However, the batteries within the BESS Enclosures 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 BESS Enclosures, and this will inform the strategy for firefighting in the emergency response plan (ERP) drafted at the detailed design stage;
- The fire and gas detection system for the Scheme will comply with NFPA 855 (2023) (Ref 3) and NFPA 69 (Ref 7) standards. This means that smoke, fire and gas detection equipment will be installed on site. BESS multi-sensor equipment which measures combinations of air temperature, hydrogen, volatile organic compounds, overpressure, shock and vibration, and moisture ingress will also be considered if fully tested with the specific BESS design. The gas detection systems should have external BESS beacon and audible alert facility. All fire detection systems should be installed and commissioned to BS EN 54 (Ref 18), BS EN 9999 (Ref 19), NFPA 855 (Ref 3), NFPA 850 (Ref 20). The final BESS failure detection design will be validated by an independent Fire Protection Engineer under the responsibility of the Operations, Engineering and Maintenance Contractor prior to construction, and will be approved by NFRS;
- If the BESS design does not integrate internal fire and gas detection equipment in alignment with NFPA standards and instead monitors failure parameters through a local Supervisory Control and Data Acquisition (SCADA) system, then fire and explosion mitigation protection systems must be validated through full scale destruction testing and deflagration modelling i.e. Tesla Megapack 2XL design. The final fire detection design (BESS enclosure and BESS site) should be validated by an independent Fire Protection Engineer prior to construction and will be approved by NFRS;
- NFPA 855 (2023) (Ref 3) confirms that water is the most effective battery fire suppression agent, therefore a dedicated water-based suppression system may be provided within each BESS Enclosure designed to control or fully suppress a fire, without the intervention of NFRS. The suppression system must be capable to operate effectively in conjunction with a gas exhaust / ventilation system to minimise deflagration risks;
- If a BESS automatic fire suppression system or Thermal Runaway Propagation Prevention (TRPP) system (engineered to directly access cells within battery modules) is integrated within each BESS enclosure, this will conform to NFPA 855 (Ref 3) standards and be tested to UL 9540A (Ref 6)



protocols or through significant scale third party fire and explosion testing. The suppression or TRPP system will be capable of operating effectively in conjunction with a gas exhaust / ventilation system to minimise deflagration risks. The system design must be capable to control or fully suppress a fire, without the direct intervention of NFRS. Fire suppression system performance should be benchmarked against free burn testing. An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results plus any additional fire and explosion test data which has been provided and validate the suppression system design. System design and water supply requirements must be fully agreed with NFRS;

- If a BESS enclosure design does not integrate automatic fire suppression systems and a dry pipe sprinkler or spray system is integrated, then NFCC (2024) (Ref 1) revised guidance will be followed. Connections to any dry pipe systems that are required to be installed on the BESS Area should be installed in accordance with BS 9990 Non-automatic firefighting systems in buildings code of practice (Current Edition) (Ref 9) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (Current Edition) (Ref 10). If a dry pipe system is integrated for the scheme, NFRS instantaneous connection points will be located at a safe distance from enclosures and clearly signed for NFRS response, in accordance with NFCC guidelines. Water supply for this type of system will be separate from the water supply designated for NFRS boundary cooling requirements;
- The NFPA 855 (2026) working group is also proposing to prohibit the use of clean agent or aerosol fire suppression systems within BESS enclosures unless fire and explosion testing can demonstrate that use of such systems does not present a deflagration hazard. If an aerosol fire suppression system (FSS) is integrated into each BESS enclosure, then the system must be designed and certified to discharge specifically for an 'electrical fault' fire and shall not discharge in any thermal runaway scenario ensuring a gas exhaust system can remain in operation;
- Draft NFCC (2024) (Ref 1) revised guidance acknowledges that it is increasingly common for BESS enclosures to be designed without integrated automatic fire suppression systems because high levels of thermal insulation are integrated which allows enclosures to be closely spaced whilst preventing propagation of fire to adjacent BESS. If the BESS system is designed to safely burn out to remove the risk of stranded energy in the battery systems, then full scale free burn / destruction testing will have been conducted to demonstrate that loss will be safely limited to one container without the intervention of NFRS;
- If the BESS system is designed to safely burn out without internal fire suppression systems, UL 9540A (Ref 6) heat flux test data (if full propagation of battery system occurs) will establish safe distances between BESS enclosures and ESS equipment and additional 3rd Party fire and explosion testing will be required to also demonstrate that structural integrity is maintained and toxic gas emissions to the closest receptors are below relevant public health exposure limits when the battery system is fully consumed (burnt out). An independent Fire Protection Engineer specialising



in BESS will review all UL 9540A test results and any additional 3rd Party fire and explosion test data which has been provided; and

- A post-incident recovery plan shall be developed, as recommended by the NFCC guidance that addresses the potential for reignition of BESS battery systems, as well as removal and disposal of damaged equipment. A fire watch will be present until all potentially damaged BESS equipment batteries are removed from the area following a fire event. The water supply for suppression systems and / or firefighting will be replenished as quickly as feasible.

4.1.30 Other measures to minimise the risk and consequences of a BESS failure event that could be implemented include:

- As a minimum, a BESS active ventilation system will comply with NFPA 855 (2023) (Ref 3)/ NFPA 69 (Ref 7) guidelines which require the prevention of a dangerous build-up of explosive gases (25% LEL). The gas exhaust / ventilation system must have redundancy and can be separate to any HVAC system providing climate control. Heating and cooling of the battery modules will be provided by an independent liquid cooling system which is separate to any HVAC system providing climate control for the BESS enclosure. Backup power for the gas detection system must have a 24-hour duration in standby and 2 hours in alarm, as demonstrated via NFPA 72 (Ref 21) compliant battery calculations and required by NFPA 855;
- When mechanical ventilation is required to maintain concentrations below the required limits, it shall be interlocked, so that the system shuts down upon failure of the ventilation system. Where emergency ventilation is used to mitigate an explosion hazard, the disconnect for the ventilation system should be clearly marked to notify personnel or first responders to not disconnect the power supply to the ventilation system during an evolving incident;
- The ventilation / gas extraction system shall also be designed to exhaust flames and gases safely outside the BESS enclosure, without compromising the safety of first responders. The ventilation system shall be provided with suitable ember protection to prevent embers from penetrating BESS enclosures (HVAC, gas exhaust, deflagration panels). An NFPA 69 (Ref 7) compliance report should be provided to demonstrate the compliance of the gas exhaust system with NFPA 855 (Ref 3) explosion prevention system requirements;
- Explosion protection systems not covered directly by NFPA 68 (Ref 8) and 69 (Ref 7) standards are commonly referred to as performance design explosion mitigation systems, these include automatic doors or vents which open to ventilate explosive gas mixtures and / or relieve pressure. If the BESS design integrates hybrid systems, sparker system or performance design explosion protection systems it should be validated through BESS free burn testing, lean gas mixture testing and requisite pressure testing required by NFPA and EN standards. Further, the BESS enclosure should have completed full UL 9540A testing or large-scale Third-Party Fire and Explosion testing without pressure waves occurring or shrapnel being



ejected. An independent Fire Protection Engineer specialising in BESS should review all UL 9540A (Ref 6) test results and any additional fire and explosion test and modelling data which has been provided; and

- The BESS enclosure will be designed to withstand overpressures generated by the battery system during thermal runaway. As a minimum, an explosion prevention system to NFPA 69 (Ref 7) standards will be integrated which should be complimented by an explosion protection system to NFPA 68 (Ref 8) and BS EN 14797 (Ref 13) standards. NFPA 68 design key performance requirements are: a) The enclosure strength shall exceed the vent opening pressure by a safety factor of over two (including the doors) b) The total vent size shall be selected such that the reduced deflagration pressure (Pred) is below two thirds (2/3) of the enclosure strength. Any BESS explosion prevention or control / protection system should be validated through full scale BESS destruction testing, lean gas mixture testing and requisite pressure testing required by NFPA and EN standards. An independent Fire Protection Engineer specialising in BESS should review all UL 9540A (Ref 6) test results and any additional fire and explosion test and modelling data which has been provided.

## 4.2 Safe BESS Construction

- 4.2.1 The BESS would be constructed in 2 distinct phases. Firstly, the civil works and balance of non-BESS plant and equipment construction 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.
- 4.2.2 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.
- 4.2.3 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 (Ref 22). Transportation will be managed in accordance with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2019 (Ref 23) and the UK guidance on the transport of dangerous goods "Moving dangerous goods, Guidance" Government webpage (Ref 24).
- 4.2.4 The appointed contractor will ensure the transported BESS equipment will be prepopulated with batteries and will have undergone Factory Acceptance Testing (FAT) to IEC 62933-5-2 (Ref 5) standards. Site Acceptance Tests (SAT) will follow IEC 62933-5-2 and IEEE 2962 (Ref 25) (in development) standards and protocols.
- 4.2.5 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.





### 4.3 Safe BESS Operation

#### Control Room

- 4.3.1 The BESS will be monitored by two on Site control facilities, one control room located on Green Hill BESS site and one located at Green Hill C site, as well as 24/7 monitoring by a remote-control facility provided by the BESS manufacturer or operator.
- The control room (when operational) will 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 (when operational) will be responsible for the implementation of the emergency plan acting as a point of contact to emergency services;
  - Staff will be fully trained and familiar with the BESS technologies and will be responsible for alerting NFRS and if required, for connecting NFRS with BESS incident Subject Matter Experts (SMEs);
  - The 24/7 remote control facility will monitor the security of the BESS site, and monitoring and detection systems will be repurposed in an emergency to support first responders. NFPA 855 (2023) (Ref 3) defines the minimum monitoring and control standards;
  - The 24/7 remote control facility will have the capability to immediately shut the system down should an incident occur, and the need arise. It can also implement the ERP, acting as a point of contact to the emergency services;
  - In some circumstances it will be necessary to discharge the batteries to enable the first / second responders to deal with the incident. This capability could potentially be achieved through the 24/7 remote control facility. The precise methodology in this regard will be agreed in the ERP once the detailed design of the BESS is known. This will be prepared in conjunction with NFRS and is secured through this document; and
  - Signage should be installed in a suitable and visible location on the outside of the BESS units, identifying the presence of a BESS system. Signage would be as per NFCC guidelines and will also include details of:
    - Relevant hazards posed i.e., the presence of High Voltage DC Electrical Systems is a risk, therefore their location should be identified;
    - The type of technology associated with the BESS;
    - Any suppression system fitted;
    - 24/7 Emergency Contact Information; and



- Signs on the exterior of a building or enclosure will be sized such that at least one sign is legible at night at a distance of 30m or from the site boundary, whichever is closer.

### Control Architecture

- 4.3.2 NFPA 855 (2023) (Ref 3) stipulates that a BMS should at a minimum provide the following safety functions:
- High cell temperature trip to isolate the module or rack when detecting cell temperatures that exceed limits;
  - Thermal runaway trip to isolate the battery system when a cell is detected to have entered a thermal runaway condition;
  - Rack switch fail-to-trip to disconnect the rack if any failure is detected. Inverter / charger fail-to-trip to isolate the BESS enclosure at the breaker if the inverter/charger fails to respond to a trip command; and
  - Inverter/charger fail-to-trip (supervisor level): This function initiates a trip command to an upstream breaker to isolate the ESS if the inverter/charger fails to respond to a trip command. The 'supervisor' control system controls the entire system, including the combination of racks, the environmental support systems, and the charging/discharging status. The supervisor level should isolate the ESS if the inverter/charger fails to trip on an appropriate signal, or if communication is disrupted between the inverter/charger and the supervisor control.
- 4.3.3 Energy Management Systems (EMS) / Battery Management Systems (BMS) controls should as a minimum incorporate NFPA 855 (2023) (Ref 3) monitoring and control features and conform to the new IEEE 2686 (2025) standard: Recommended Practice for Battery Management Systems in Stationary Energy Storage Applications. Additional IEEE standards in development (IEEE P2688 (Ref 26) and IEEE P2962 (Ref 25) should also be adopted by the BESS system provider, these cover BESS data analytics, electrical controls and maintenance / replacement of battery components / systems.
- 4.3.4 If data analytics are not directly integrated by the BESS Original Equipment Manufacturer or BESS integrator, the Applicant will ensure a Data Analytics package is integrated to provide a greater range of performance and safety data i.e. predict ageing of the cells in battery systems, alert BMS faults or malfunctions, identify electrical abuse during operations, alert the operator when modules need maintenance or decommissioning. Data Analytics facilitate more accurate assessment of operating temperature variations, voltage anomalies, State of Charge (SOC), and State of Health (SOH). Data Analytics can also monitor complimentary BESS safety features i.e. smoke and gas sensors, BESS multi-sensor equipment, ground fault detectors, etc.
- 4.3.5 Cybersecurity will form a fundamental part of the system design and architecture as there is an increasing focus in this area from national and international regulatory bodies. International standards such as IEC 62443 (Ref 28), UL 1741 (Ref 29), IEEE 1815 (Ref 30), and IEEE 1547.3 (Ref 31) will be consulted and guidance from national sources such as National Cybersecurity Centre inform the



implementation and protection measures. Reference should be made to the Health and Safety Executive (HSE) Operational Guidance document OG86 (Ref 32).

- 4.3.6 UL published 'UL 2941 (2023) Outline of Investigation for Cybersecurity of Distributed Energy and Inverter-Based Resources' (Ref 33). UL 2941 provides testable requirements for photovoltaic inverters, electric vehicle chargers, wind turbines, fuel cells and other resources essential to advancing grid operations. These new requirements prioritise cybersecurity enhancements for power systems that deal with high penetration inverter-based resources, including those interfacing with bulk power systems for periods of instantaneous high wind, solar and hybrid/storage generation. UL 2941 promotes the necessity to have cybersecurity designed into new inverter-based resources (IBR) and distributed energy resource (DER) systems, and the BESS system supplier at the detailed design stage will conform to these requirements.

#### Security

- 4.3.7 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.
- 4.3.8 Where practical and required by NFRS or risk assessment, the BESS areas will have security fencing with a minimum of two points of ingress / egress for first responders and will be clearly signed, with incident emergency response contact details, clear identification of BESS site hazards, details of site access arrangements such as key codes, which will be provided to the NFRS.
- 4.3.9 The Site will also have Thermal Imaging Cameras to alert and locate on site fire risks and integrate high-definition CCTV with video analytics to alert and respond to unauthorised site access.

#### Maintenance

- 4.3.10 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.
- 4.3.11 Routine maintenance will be undertaken on the BESS equipment every 6-12 months depending on the risk profile of equipment. This typically consists of a major maintenance period and a minor maintenance period. This will encompass all BESS and supporting equipment supplied by the Original Equipment Manufacturer including the fire protection and explosion prevention system. Minor maintenance is typically a visual inspection and rectification of any accumulated noncritical defects. All maintenance will be undertaken in a carefully controlled manner following the Site safety rules and in accordance with the Outline Operational Environmental Management Plan (OOEMP) [EN010170/APP/GH7.2] submitted as part of this DCO Application.
- 4.3.12 During operations 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.

4.3.13 The operations of the BESS will be managed in accordance with the OOEMP.

#### End of life/Disposal

4.3.14 Regarding the decommissioning of the BESS, the requirements will be determined at the procurement contract stage, with the contractor remaining clear 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 (Ref 34) (or such equivalent regulations in force at the time of decommissioning) it has certain obligations in respect of battery disposal.

4.3.15 In the event of a defective battery module or cell being identified, the defective module shall be immediately placed out of service and be electrically disconnected from the system. A specific risk assessment shall be conducted prior to the removal of the defective module to ensure the safety of employees and contractors.

4.3.16 Once a defective module is safely removed in accordance with the specific risk assessment, it shall be placed in an approved protective container prior to being transported from the defective unit to a dedicated safe location for inspection by an authorised manufacturer's representative.

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

4.3.18 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;
- 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; and
- Disposal – Any disposal of batteries shall be undertaken in compliance with all applicable laws and all regulatory requirements, product stewardship, registration disposal and recycling or take back requirement.



## 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 35).
- 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 BESS hazards for first responders and site operatives once a BESS failure event occurs depend on both the failure scenario and the BESS design but are typically defined as: fire, explosion, chemical hazards, carbon monoxide, carbon dioxide, hydrocarbon gases, and hydrogen. Full Personal Protective Equipment (PPE) should be worn, and operations should not generally be conducted within any identified blast exclusion zones (close proximity to doors and deflagration vents).
- 5.1.4 In the event of a BESS failure, the battery system and the transformers serving the BESS will be automatically electrically isolated when a burning or venting thermal runaway incident is detected within an enclosure. However, the batteries within the enclosures 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 enclosure, and this will inform the strategy for firefighting in the emergency plan.
- 5.1.5 Fire Hydrants and connections to any dry pipe systems that are required to be installed on the BESS Areas should be installed in accordance with BS 9990 (Non-automatic firefighting systems in buildings - Code of Practice) (current edition) (Ref 9) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (current edition) (Ref 10).
- 5.1.6 If a dedicated automatic water-based suppression system or TRPP system (engineered to directly access cells within battery modules) is provided within each BESS enclosure this will be tested at UL 9540A (Ref 6) installation level or through significant scale third party fire and explosion testing. The suppression or TRPP system will be capable of operating effectively in conjunction with a gas exhaust/ventilation system to minimise deflagration risks. The system design must be capable to control or fully suppress a fire, without the direct intervention of NFRS.
- 5.1.7 The Applicant has consulted NFCC guidelines and engaged with NFRS throughout the pre-application phase and will ensure that the detailed BSMP will include any subsequent revisions made to NFCC guidelines. Close consultation will continue with NFRS throughout the planning process.

### 5.2 Fire Service Access

- 5.2.1 Access will be designed such that emergency services are able to access the Site easily with Site roads being clearly laid out and signed in accordance with the following:





- 5.2.2 The proposed access-route width around the BESS area will be 4.5m and there are no dead-end access routes or extremes of grade (accessible in all weather conditions).
- 5.2.3 Road networks within the Order limits will enable unobstructed access to all areas of the BESS sites, two separate NFRS access points to the BESS sites have been integrated to ensure firefighters do not have to drive through a smoke or gas plume to access the BESS.
- 5.2.4 Signage will be installed in a suitable and visible location on the outside of BESS enclosures identifying the presence of a BESS system. Safety signage will be installed in accordance with Health and Safety (Safety Signs and Signals) Regulations 1996 (Ref 36). Signage will include details of:
- Relevant hazards posed;
  - The type of technology associated with the BESS;
  - Any suppression system fitted; and
  - 24/7 Emergency contact information.
- 5.2.5 Signs on the exterior of a building or enclosure should be sized such that at least one sign is legible at night at a distance of 30 metres or from the Order limits, whichever is closer.
- 5.2.6 A swept path analysis for emergency vehicles has been undertaken and the roads have been confirmed as suitable for emergency vehicle access.
- 5.2.7 In accordance with latest NFCC revised guidance (2024) (Ref 1) the final BSMP will include a site plan that shows all sensitive receptors within a 1 km radius of the Order limits that could be affected by a fire. The plan will have a compass rose showing north and the prevailing wind direction.
- 5.2.8 A site plan will be provided at the detailed design stage to NFRS that may include, as relevant:
- The layout of buildings;
  - Any areas where hazardous and flammable materials are stored on site (location of gas cylinders, process areas, chemicals, piles of combustible wastes, oil and fuel tanks);
  - All permanent ignition sources within the Order limits and show they are a minimum of 6 m away from combustible and flammable waste;
  - Any areas where combustible waste is being treated or stored including non-waste material;
  - All separation distances;
  - Any areas where combustible liquid wastes are being stored;
  - Any area where depollution of end of life vehicles (ELVs) takes place;
  - Any area where crushing, shredding, baling of metals or ELVs takes place;
  - Main access routes for fire engines and any alternative access;



- Access points around the perimeter of the Order limits to assist firefighting;
- Hydrants and water supplies;
- Areas of natural and unmade ground;
- Drainage runs, pollution control features such as self-actuating valves, and fire water containment systems such as bunded or kerbed areas (this may be easier to show on a separate drainage plan);
- Storage areas with pile dimensions and fire walls (where applicable) – this includes wastes stored in a building, bunker, or containers – include indicative pile layouts and ensure it is geographically representative;
- The location of fixed plant or storage location of mobile plants when not in use;
- The location of spill kits;
- The quarantine area; and
- Anything site specific considered needing to be added.

### 5.3 Fire Water

5.3.1 The Concept Design Parameters and Principles [EN010170/APP/GH7.17] for the Scheme include the following for water storage structures for the purposes of firefighting.

5.3.2 The BESS areas shall be designed to integrate firefighting designed to integrate pressure fed (pump driven) fire hydrants fed from water tanks and / or water tanks depending on site topography and final site design layout. Water access points, whether hydrants or tank connections, would be located in consultation with NFRS to provide redundancy and safe operating distances for firefighters with 30 – 50m, which is considered an optimal safe distance. They must be clearly marked with appropriate signage. They will be easily accessible to NFRS vehicles, and their siting should be considered as part of a risk assessed approach that considers potential fire development/impacts. Outlets and connections should be agreed with NFRS. Any outlets and hard suction points should be protected from mechanical damage (e.g. through use of bollards);

- The firefighting water requirement will be fully assessed at the detailed design stage based upon BESS fire and explosion test data by an independent Fire Protection Engineer and water storage volumes will be agreed with NFRS during detailed design;
- Each BESS area will contain a minimum of two firefighting water storage units of no less than 230,000 litres in capacity, capable of delivering 1900 litres per minute for 4 hours (exceeding NFCC guidance);
- Water storage will either be in sectional steel panel tanks, or cylindrical steel tanks, above or below ground;
- Where above ground, tanks will be supported on structural concrete slab foundations to a maximum depth of 1m;



- Fire hydrants and connections to any dry pipe systems that are installed on the BESS Area will be installed in accordance with BS 9990 Non-automatic firefighting systems in buildings code of practice (Current Edition) (Ref 9) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (Current Edition) (Ref 10);
- Site and BESS design principles and ERP content will ensure that the NFRS are expected to employ a defensive strategy i.e. only boundary cooling should be employed for cooling of adjacent BESS or associated supporting equipment, this ensures that environmental pollution risks are minimised. Boundary cooling typically involves firefighters directing water fog or spray pattern discharge to ensure the incident does not spread to adjacent BESS enclosures. NFCC guidance states: *“If it can be confirmed that the recommended firefighting tactic for the BESS is to defensively fire fight and boundary cool whilst allowing the BESS to consume itself, this will reduce the water requirements, and thus the drainage/environmental protection requirements significantly.”* A BESS design which may require direct NFRS firefighting engagement tactics will not be selected for this facility;
- The BESS scheme will integrate an external firefighting water capture drainage system. In the event of a fire a system of automatically self-actuating valves at the outfalls from the BESS areas will be closed, isolating the BESS areas drainage from the wider environment. Fire water runoff may contain particles from a fire, the runoff must be contained and tested before being allowed to discharge to the local watercourses. The water contained by the valves will be tested and released or, if necessary, removed by tanker and treated offsite (in consultation with the relevant consultees at the time). Pollution analysis will always be conducted before removing from site (if polluted) or releasing into drainage systems, if safe to do so; and
- If an internal BESS water based fixed suppression system (automatic or dry pipe) is integrated in the BESS enclosures a separate water supply and water containment system will be integrated, water runoff is likely to contain higher levels of pollutants compared to water used for external boundary cooling of BESS and ESS equipment. All process water used in the system shall be prevented from contaminating potable water sources in accordance with local regulations through the use of check valves or other means as part of the system design. Pollution analysis will be conducted before removing and treating offsite.

5.3.3 The Illustrative Site Layout Plans (Green Hill BESS and Green Hill C) [EN010170/APP/GH6.4.4.4.3, EN010170/APP/GH6.4.4.9.3 and EN010170/APP/GH6.4.4.9.4] show the potential location of the water storage tanks.

## 5.4 Emergency Planning

5.4.1 The BESS scheme will have a robust and validated emergency plan, developed in consultation with NFRS.

5.4.2 Some example BESS and site design information which is anticipated to be shared with NFRS to establish a risk profile for first responders, are listed below:



- Battery chemistry integrated into BESS – can provide fire and explosive risk profile;
- Battery form factor (cylindrical, pouch, prismatic);
- Battery energy Wh / kWh – confirmation of new battery cell (second life cells will not be accepted);
- Battery module cooling system details (e.g., liquid cooling design, air cooling design) – cooling system capability assessment to stop or reduce battery cell thermal runaway propagation. Air cooled designs will not be accepted;
- Battery module vent or gas exhaust specifications;
- Battery module kWh energy + number of cells contained in the module + battery circuitry details (number of cells in series vs number of cells in parallel);
- Direct suppression system details – direct module TRPP or rack level FSS integration;
- Rack design – number of modules and kWh energy, spacing between modules, passive protection features, gas exhaust features, electrical isolation functions, heat or thermal runaway sensor integration, etc;
- Rack configuration – spacing to adjacent racks, number of racks in BESS, spacing to walls, doors, gas vents and roof;
- Type of BESS enclosure design e.g., container or cabinet, gas exhaust / ventilation features, deflagration vent design features, BESS enclosure level fire protection and suppression system details (proof of testing with BESS design and test data), additional fire or explosion protection features i.e., thermal barriers;
- EMS / BMS data monitoring capabilities and incident response integration capacity;
- Number of BESS enclosures on site;
- Size and MWh capacity of each BESS enclosure;
- BESS and ESS equipment spacing; spacing to other equipment, boundaries, vegetation, roads or access routes, fire hydrants / water tanks, site building structures, etc;
- Access routes, observation points, turning areas, FRS equipment and assets, water supply locations and capacity, drainage, and water capture design; and
- Definition and frequency of BESS equipment testing and maintenance requirements.

5.4.3 Digital provision of safety information and procedures must be provided to site operatives, first responders and SMEs during BESS incident response – hard copy printed materials must be available onsite (location agreed with NFRS). As a minimum content should include:



- Digital emergency response plans;
- Remote emergency shutoff procedures;
- SDS / Hazardous material documentation;
- Maps or design drawings;
- Gas detection capabilities; could include multi-sensor data metrics e.g., Carbon Dioxide (CO<sub>2</sub>), Carbon Monoxide (CO), Hydrogen (H<sub>2</sub>), VOC off gas + overpressure + local temperatures;
- Fire protection system data e.g., temperature, alarming, suppression status, etc. – establish discharge warrantee clauses, emergency BESS venting procedures, discharge times, impact on ventilation and detection systems, etc;
- ERP training drills for site operatives + FRS engagement (site familiarisation + training drills) + SME engagement (fire protection experts or battery experts); and
- Other documentation as required by specific BESS project i.e., local response stipulations, contact information for nominated response personnel, community contacts, etc.

5.4.4 An ERP will be developed post planning consent to facilitate effective and safe emergency response. It will follow UK National Fire Chiefs Council (NFCC) (Ref 1) and NFPA 855 (Ref 3) guidelines and will include as a minimum:

- How the fire service will be alerted and incident communications and monitoring capabilities;
- Facility description, including infrastructure details, operations, number of personnel, and operating hours;
- Site plan depicting key infrastructure;
  - i. Site access points, internal roads, agreed access routes, observation points, turning areas, etc;
  - ii. Firefighting facilities (water tanks, pumps, booster systems, fire hydrants, fire hose reels etc);
  - iii. Water supply locations and capacity; and
  - iv. Drainage and water capture design and locations.
- Up-to-date contact details of the emergency response co-ordinator including the subject matter expert (SME) for the Order limits;
- Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems;
- Details and explanation of warning systems and alarms on site and locations of alarm annunciators with alarm details (smoke, gas, temperature);



- Hazards and potential risks at the facility and details of their proposed management;
- The role of the FRS at incidents involving a fire, thermal event or fire spreading to the Order limits;
- Emergency shutoff or isolator locations;
- A list of dangerous goods stored on site;
- Site evacuation procedures;
- Site operation Emergency Management protocols - 4 phases: discovery, initial response / notification, incident actions, resolution and post incident actions / responses;
- Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire, wildfires, impacts on local respondents, impacts on transport infrastructure; and
- The operator will develop a post-incident recovery plan that addresses the potential for reignition of the BESS and de-energizing the system, as well as removal and disposal of damaged equipment.

5.4.5 The site owner during design development, as well as the operator once appointed, will work closely with NFRS to provide all relevant information on BESS and site design features to inform all necessary hazard and risk analysis studies and assist in the development of comprehensive Risk Management Plan and Emergency Response Plan.

5.4.6 Information will be supplied as early as possible in the detailed design stage to allow an initial appraisal of the BESS to be made. This information will be provided to NFRS with appropriate evidence provided to support any claims made on performance, and with appropriate standards cited for installation. Such information should also be made available to NFRS for inclusion in Site Specific Risk Information (SSRI) records.

5.4.7 A Risk Management Plan shall be developed with NFRS post consent at the detailed design stage which, as a minimum, will provide advice in relation to potential emergency response implications including:

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





## 5.5 Firefighting Consequences

- 5.5.1 As the BESS will not have personnel access into the battery enclosures, there is unlikely to be any immediate threat to life, only property which forms part of the Scheme.
- 5.5.2 NFRS in foreseeable and credible emergency response scenarios would most likely adopt a defensive firefighting strategy by using water on neighbouring areas such as battery enclosures and structures to cool down and prevent further fire spread. The Scheme will select a BESS design that has undertaken full scale free burn testing to demonstrate thermal insulation protection capabilities of the BESS enclosure design, validate equipment spacing distances, and demonstrate that deflagrations do not occur and/or can be safely constrained. In accordance with NFCC guidance (Ref 1), the Order limits will be maintained to prevent a fire spreading to the BESS or inadvertently fire loading, by providing a 'bridge' or path between BESS enclosures to transmit flaming or radiant heat.
- 5.5.3 As recommended in NFCC revised guidance (Draft 2024 expected in 2025) (Ref 1) it is not anticipated that firefighting techniques will require direct hose streams or spray directly on battery systems and will be limited to boundary cooling of adjacent BESS enclosures and supporting equipment to prevent the fire from spreading. IP ratings of BESS enclosures will be shared with NFRS so that risks associated with boundary cooling can be understood. This strategy will be finalised with the NFRS at the detailed design stage and be clearly communicated in the ERP.
- 5.5.4 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.
- 5.5.5 A fire affecting the BESS has the potential to mobilise pollutants in surface water runoff. As set out in Chapter 10: Hydrology, Flood Risk and Drainage [EN010170/APP/GH6.2.10] of the Environmental Statement, the BESS drainage system will be designed to isolate and contain such flows to prevent pollution of the surrounding environment. This is anticipated to be achieved using a lined, permeable gravel subbase beneath proposed hardstanding, or a functionally equivalent alternative. Outfalls from the BESS drainage system will be fitted with automatically actuated valves, which are connected to the BESS fire alarm system. In the event of a fire, these self-actuating valves will close, isolating the BESS drainage system and containing firewater runoff locally.
- 5.5.6 The surface water drainage system will be designed to attenuate runoff from the 1 in 200 year storm event plus a 40% climate change allowance. This capacity is expected to accommodate a reasonable worst-case scenario involving firewater runoff combined with a 1 in 10 year storm event. In line with guidance from the National Fire Chiefs Council (NFCC), firefighting water systems are expected to deliver a flow rate of 1,900 litres per minute for a minimum of two hours. This equates to a total volume of 228 cubic metres ( $1,900 \text{ l/min} \times 120 \text{ min} = 228,000 \text{ litres}$ ) per BESS compound. Accordingly, the drainage design will provide sufficient capacity to contain either the full firefighting volume in combination with the 1 in 1 year storm event, or the 1 in 200 year plus climate change event on its own, whichever scenario is more onerous. Additional attenuation features can be



incorporated within the Order Limits where required, and final storage requirements will be agreed with the Fire and Rescue Service.

- 5.5.7 Following a fire event, retained water will be sampled and analysed to confirm whether pollution has occurred. If contaminated (polluted), the water will be removed from site by tanker for treatment at an appropriate offsite facility. If testing confirms that the water is suitable for discharge, it will be released to the local drainage network under controlled conditions, in consultation with the relevant regulators. This approach ensures that environmental protection is maintained under both normal and emergency conditions.
- 5.5.8 Chapter 16: Air Quality **[EN010170/APP/GH6.2.16]** of the ES (and associated Appendices) assesses the battery fire emission impact in ten worst case fire locations (using the concept BESS design) on sensitive receptors within a 1 km radius of the BESS area. Typically, a BESS fire would be a relatively short-term incident, the plume study therefore compared predicted concentrations against Acute Exposure Guidance Levels (AEGs), which have higher threshold concentrations than the national air quality objectives and are relevant to short term releases. AEGs are expressed as concentrations of a substance above which it is predicted that the general population could experience, including susceptible individuals:
- Level 1 - Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure;
  - Level 2 - Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape; and
  - Level 3 - Life-threatening health effects or death
- 5.5.9 Based on the factors of distance to the nearest property and the anticipated short-term nature of a fire incident, the assessment concludes that there will not be adverse effects at the closest receptor locations because of a BESS fire incident. Notwithstanding, at the detailed design stage a BESS system and site specific Plume Analysis study will be conducted to assess the environmental impact of a site incident to sensitive receptors within a 1 km radius. Toxic gas emissions to sensitive receptors must be below relevant public health exposure limit guidelines when the battery system of a BESS is fully consumed (burnt out), production of Particulate Matter (PM) and a visibility impact assessment on any transport links within a 1 km radius of the BESS area will also be included. The emergency response plan (ERP) produced at the detailed design stage (template outlined in section 5.4.4) will incorporate all necessary emergency response procedures and actions based upon thermal runaway test data supplied by the BESS system provider.
- 5.5.10 The ERP could contain the following measures or protocols relating to air quality for sensitive receptors located downwind from a fire plume:
- 5.5.11 Notification of potentially affected residents including advice on the health effects of smoke and ways to reduce exposure (e.g. close windows and stay indoors); Notification of potentially affected members of the public to move to a cleaner air location;



- 5.5.12 Cancellation of outdoor events and potentially moving affected residents to a cleaner air location; and
- 5.5.13 Should there be a BESS fire in close proximity to the road, the site operator to determine wind direction and seek to close the road if deemed necessary i.e. any significant fire plume impact on traffic visibility.



## 6 Pre-Construction Information Requirements

### 6.1 Summary

- 6.1.1 The detailed design phase of the Scheme will consider the lifecycle of the battery system from installation to decommissioning. At the detailed design stage, risk assessment tools will be utilised together with detailed consequence modelling to provide a comprehensive site operations and emergency response safety audit.
- 6.1.2 The battery system mitigation measures adopted in a final BSSMP, will reflect the latest BESS safety codes and standards applicable at that stage. Mitigation measures will be discussed and coordinated with NFRS.
- 6.1.3 As stipulated in NFPA 855 (2023) (Ref 3), a Failure Modes and Effects Analysis (FMEA) of the BESS (BS EN IEC 60812 (Ref 37)) or Layer of Protection Analysis (LOPA) of the BESS will be conducted to lay the foundation for predictive maintenance requirements and complement the fault indicator capabilities of the BMS data analytics system. This key analysis minimises the probability of a BESS failure in relation to the specific BESS system and site design and analyses key mitigation solutions to minimise the impact of a BESS failure in the unlikely event that this would occur. These types of risk analysis provide confidence to demonstrate that under day-to-day operation there is a low risk of a BESS failure incident, and in the event of an incident the credible hazards are understood and have been evaluated both at the illustrative and detailed design stages to demonstrate that the risk to site operatives, first responders, and the local population remains very low.
- 6.1.4 Comprehensive Hazard Mitigation Analysis (HMA) will be conducted by a BESS specialist independent Fire Protection Engineer following NFPA 855 (2023) (Ref 3) guidelines and recommendations to cover BESS system and site-specific safety issues. Typically, the main components of an HMA are:
- BESS Information (design and site layout);
  - Code Analysis (BESS safety and fire standards);
  - UL 9540A testing (Ref 6), 3<sup>rd</sup> party fire and explosion test results, consequence modelling (heat flux analysis, NFPA 68 (Ref 8) deflagration analysis, etc.) reports; and
  - Failure Modes and Effects Analysis (FMEA).
- 6.1.5 A range of studies will be undertaken, with a primary focus on fire and explosion risk including (but not limited to) risk analysis and management tools to inform the overall design solution include:
- Hazard and Operability Analysis ('HAZOP');
  - Hazard Identification ('HAZID');
  - Fire Risk Analysis (FRA);
  - Explosion Risk Analysis (ERA); and



- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (Ref 38).

6.1.6 Additional BESS system risk analysis reports frequently provided by Tier 1 BESS manufacturers or BESS integrators, which can inform a key risk analysis studies (listed in 6.1.5 and 6.1.6) and provide NFRS with detailed insights into capability of BESS system hazard mitigation systems (burning and venting thermal runaway scenarios) and provide guidance for evaluating site-specific equipment spacing templates. A non-exhaustive list of reports are listed below:

- NFPA 69 Explosion Prevention Compliance report;
- Deflagration analysis report;
- FDS gas ventilation analysis report;
- Heat Flux and flame tilt analysis report;
- Full scale fire test report;
- Firefighting water analysis report;
- UL 9540A test interpretation reports;
- Emergency Response Plan (ERP) templates; and
- Decommissioning Plan templates.

6.1.7 If the BESS system supplied differs from the specification considered for risk assessments and consequence modelling, then a full safety audit will be repeated for the new BESS system specification. These studies will be completed and signed off before construction commences.

6.1.8 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 final BSSMP prior to the commencement of construction. The 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; and
- Emergency Response Plan(s) covering construction, operation and decommissioning phases will be developed once a construction team, and an operator have been appointed. These plans will be developed in consultation NFRS and other local emergency services to include the adequate provision of firefighting equipment onsite and ensure that fire,



smoke, and any release of toxic gases from a thermal runaway incident does not significantly affect site operatives, first responders, and the local community.

- 6.1.9 Provision of the above information will demonstrate prior to construction that all the considerations and requirements in this document have been addressed, and the BESS installation is safe.
- 6.1.10 Safe decommissioning of the BESS will be addressed prior to decommissioning of the Scheme in a Decommissioning Environmental Management Plan, and in accordance with the Outline Decommissioning Statement **[EN010170/APP/GH7.3]** submitted as part of the DCO Application.





## **7 Conclusion**

### **7.1 Summary**

- 7.1.1 This OBSSMP has demonstrated in a systematic way the mitigation of the safety risks posed by the BESS in the Scheme.
- 7.1.2 The Applicant is committed to developing a BESS project incorporating equipment which provides optimal levels of performance and safety during its lifecycle.
- 7.1.3 This OBSSMP demonstrates that the Applicant has relevant experience of BESS systems; that the relevant stakeholders have been consulted, and therefore safety will be inherent in the overall design, minimising the risk of a BESS failure event occurring, and reducing the impact of such an event should it occur.
- 7.1.4 The implementation of the OBSSMP is secured through a Requirement in Schedule 2 of the DCO. This will stipulate that a detailed Battery Safety Management Plan will be submitted to and approved in consultation with NFRS by the relevant planning authorities prior to the commencement of the works for the BESS. This plan will be substantially in accordance with the OBSSMP.



## References

- Ref 1 National Fire Chiefs Council (NFCC) Grid-Scale Battery Energy Storage System planning – Guidance for FRS (2023 and draft revision 2024).
- Ref 2 <https://www.hse.gov.uk/ppe/managing-risk-using-ppe.htm>
- Ref 3 NFPA 855 (2023): Standard for the Installation of Stationary Energy Storage Systems.
- Ref 4 UL 9540 3rd Edition (2023): Standard for Energy Storage Systems and Equipment.
- Ref 5 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
- Ref 6 Underwriters Laboratories, UL 9540A (2025) Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
- Ref 7 NFPA 69 (2024): Standard on Explosion Prevention Systems.
- Ref 8 NFPA 68 (2023): Standard on Explosion Protection by Deflagration Venting.
- Ref 9 BS 9990: 2015: Non-automatic firefighting systems in buildings - Code of practice
- Ref 10 [REDACTED]  
[REDACTED]  
[REDACTED]
- Ref 11 UL 1973 (2022): Batteries for Use in Stationary and Motive Auxiliary Power Applications.
- Ref 12 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.
- Ref 13 BS EN 14797 (2006): Explosion venting devices.
- Ref 14 Richard Chitty (2014) External fire spread: building separation and boundary distances (BR 187 2nd edition).
- Ref 15 FM DS 5-33 (2023) FM Global Datasheet. Lithium-Ion Battery Energy Storage Systems.
- Ref 16 BS EN 13501-2:2023 – TC: Fire classification of construction products and building elements - Classification using data from fire resistance and/or smoke control tests, excluding ventilation services
- Ref 17 BS EN 1364- 1: Fire resistance tests for non-loadbearing elements (walls)
- Ref 18 BS EN 54: fire detection & alarm systems
- Ref 19 BS 9999:2017 – TC: Fire safety in the design, management and use of buildings.
- Ref 20 NFPA 850 (2020): Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
- Ref 21 NFPA 72 (2025): National Fire Alarm and Signaling Code®



- Ref 22 UN 38.3: Recommendations on the Transport of Dangerous Goods – Manual of Tests and Criteria – (Lithium Metal and Lithium-Ion Batteries).
- Ref 23 <https://unece.org/transport/publications/european-agreement-concerning-international-carriage-dangerous-goods-road>
- Ref 24 <https://www.gov.uk/guidance/moving-dangerous-goods>
- Ref 25 [REDACTED]
- Ref 26 IEEE 2686 (2025) standard: Recommended Practice for Battery Management Systems in Stationary Energy Storage Applications.
- Ref 27 [REDACTED]
- Ref 28 BS EN IEC 62061:2021+A1:2024: Safety of machinery. Functional safety of safety-related control systems
- Ref 29 UL 1741 (2021): Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
- Ref 30 IEEE 1815 (2012): IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3)
- Ref 31 IEEE 1547.3 (2023): IEEE Guide for Cybersecurity of Distributed Energy Resources Interconnected with Electric Power Systems
- Ref 32 <https://www.hse.gov.uk/foi/internalops/og/og-0086.pdf>
- Ref 33 UL 2941 (2023): Outline of Investigation for Cybersecurity of Distributed Energy and Inverter-Based Resources.
- Ref 34 UK Statutory Instruments (2009) The Waste Batteries and Accumulators Regulations 2009.
- Ref 35 Fire and Emergency Planning Directorate (1998) Fire Service Manual Volume 2: Fire Service Operations, Electricity.
- Ref 36 <https://www.hse.gov.uk/pubns/books/l64.htm>
- Ref 37 BS EN IEC 60812:2018 – TC: Failure modes and effects analysis (FMEA and FMECA)
- Ref 38 The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) Assessment