Gate Burton Energy Park
Outline Battery Safety Management Plan

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Gate Burton Energy Park Limited

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Abbreviations and Acronyms

Term	Meaning
ADB	Approved Document B
ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
BAT	Best Available Techniques
BESS	Battery Energy Storage System
BMS	Battery Management System
BSMP	Battery Safety Management Plan
CE	European Community Declaration of Conformity
COSHH	Control of Substances Hazardous to Health
DCO	Development Consent Order
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations 2002
FAT	Factory Acceptance Testing
FMEA	Failure Mode and Effects Analysis
HAZOP/HAZID	Hazard and Operability Analysis and Hazard Identification
HGV	Heavy Goods Vehicle
HSE	Health and Safety Executive
LCRM	Land Contamination: Risk Management
LFP	Lithium Iron Phosphate (LiFePO4)
MSDS	Material Safety Data Sheets
NFPA	National Fire Protection Agency

Term	Meaning
NMC	Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2)
R&D	Research and Development
SAT	Site Acceptance Testing
SIL	Safety Integrity Level
UPS	Uninterruptible Power Supply
VESDA	Very Early Smoke Detection by Aspiration

Executive Summary

This report outlines the key fire safety provisions proposed to be included in the design of the proposed Battery Energy Storage System (BESS) facilities which are to be installed in relation to the Gate Burton Energy Park. Prior to the commencement of construction of the BESS, Gate Burton Energy Park Ltd (the Applicant) will be required to prepare a Battery Safety Management Plan (BSMP) which will be substantially in accordance with this outline BSMP. As part of preparation of the BSMP, the Applicant will take into account the latest good practices for battery fire detection and prevention, along with the emergency response plan, as guidance continues to develop in the UK and around the world.

There are several battery storage technologies available to system designers. The exact technology and system chemistry type is still to be determined, but it is likely to be a lithium ion battery cell type. The popular types of this chemistry within the lithium ion family are Lithium Nickel Manganese Cobalt Oxide ($LiNiMnCoO_2$) known as "NMC" after the three key active materials or Lithium Iron Phosphate (LiFePO4) known as "LFP". The final battery chemistry will be confirmed as part of the detailed design prior to the commencement of construction.

For the purposes of this document it is assumed that the BESS system will be based upon LFP lithium ion battery technology that is currently used on other sites being developed. This is considered to be a reasonable worst case for the purposes of the assessment in terms of safety.

The BESS will be designed in accordance with the UK and internationally recognised good practice guidance available at the time, and informed by expert assessment of the causes and consequences of past BESS fires and explosions.

The overall approach is to follow the HSE's hierarchy of controls:

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment

This document details the types of safety systems available on the market at present along with risk reduction barriers which are likely to be incorporated into the system to be installed at the site. It is possible that by the time of construction that all solid-state batteries, or other battery technology may be available. This will be reflected in the BSMP approved by the Local Planning Authorities in consultation with the Health and Safety Executive (HSE), Lincolnshire County Fire and Rescue Service and the Environment Agency.

A summary of the anticipated site-wide fire 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 specific location of the BESS will be chosen to minimise impacts on receptors.
- Separation distances between components will be selected to minimise the chance of fire spread based on Best Practice, currently represented by NFPA 855.
- Equipment will, where possible, be selected to be fire limiting, such as selection of transformer oils with low flammability and the fire resistance of the BESS enclosure.
- In the case of the BESS, it will be designed with multiple layers of protection to minimise the chances of a fire or thermal runaway.
- All equipment will be monitored, maintained and operated in accordance with manufacturer instructions.
- 24h monitoring of the BESS via a dedicated control room: the monitoring system will automatically alert Lincolnshire Fire and Rescue Service in the event of an incident.
- The BESS will include integrated fire detection with automated suppression systems to deal with electrical fires. Following Best Practice (e.g. NFPA 855 2023) and in line with our Safety Strategy, the build-up of explosive gases will be avoided by gas venting. Fires involving the batteries will be addressed in the Emergency Response Plan, again based on Best Practice.
- The Applicant will have a dedicated emergency plan (ERP) in place, with consideration of credible plant failure scenarios. The ERP will include 24/7 availability of a Subject Matter Expert (SME).
- Communication with Lincolnshire Fire and Rescue Service has already commenced and will continue across design and construction phases. This anticipates Dame Marie Miller’s Lithium-Ion Battery Storage (Fire Safety and Environmental Permits) Bill, due for its second reading in March 2023 and will ensure a robust ERP.

1. Introduction

1.1. Scope of this Document

1.1.1 This outline BSMP document produced by the Applicant, outlines the key fire safety provisions for the BESS proposed to be installed at Gate Burton Energy Park (the Scheme) including measures to reducing fire risk and fire protection measures.

1.1.2 This document provides a summary of the safety related information requirements which will be provided in advance of construction of the BESS. The purpose of this outline BSMP is to identify how the Applicant will use advice from experts in the field and good industry practice to reduce risk to life, property, and the environment from the BESS.

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

1.1.4 As the operational phase is anticipated to commence no earlier than 2026, references to current measures and guidelines are included here, however the BSMP will be prepared prior to construction of the BESS to take account of prevailing guidance.

1.2 Project Description

1.2.1 The Scheme includes a BESS, within the BESS compound located to the west of the Scheme's substation and to the south of Long Nursery Wood as shown as Work Number 2 in the Works Plans submitted with the Application **[EN010131/APP/5.2]**.

1.2.2 For the purposes of this document it has been assumed that the BESS will utilise LFP lithium ion battery technology that is currently used on other sites being developed in the Grteat Britain market. This is considered to be a reasonable worst case for the purposes of the assessment in terms of safety.

1.2.3 The design of the BESS and its impacts are controlled in several ways. Prior to commencement of construction of the BESS, a BSMP (substantially in accordance with the outline BSMP submitted with the Application) will be submitted to the relevant local planning authority and approved, in consultation with the HSE, the Lincolnshire County Fire and Rescue Service and the

Environment Agency. A requirement to secure this has been included The Applicant must operate the BESS in accordance with the approved plan. Further, pursuant to a requirement of the Development Consent Order (DCO), the detailed design of the BESS must be in accordance with the Outline Design Principles **[EN010131/APP/2.3]**.

1.2.4 The Outline Design Principles contain controls over the BESS, which include that an assessment will be undertaken, based on the detailed design for the BESS, to demonstrate that the risk of fire and impacts from such a fire will be no worse than as assessed in the plume assessment submitted with the Application. The Outline Design Principles have been informed by consultation with Lincolnshire Fire and Rescue Service.

1.2.5 In this way, the Applicant can confirm that if the BESS constructed is different to that assessed in the plume assessment, its impacts in the event of a fire would be no worse than those assessed in the plume assessment, and therefore the risk to the local population and environment would be very low.

1.3 Potential BESS failure

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

1.3.2 Regardless of the type of failure or the cause, the main potential hazard is thermal runaway which produces a flammable and toxic vapour cloud. If the vapour cloud ignites immediately, the lithium-ion cells eject flare-like flames. If ignition is delayed and the container becomes saturated, a vapour cloud explosion can take place, and therefore this report focusses on reducing these risks associated with the BESS and managing the hazards in the unlikely event that they occur.

1.3.3 Other electrical systems than the batteries which form part of the BESS can carry fire risks, however due to the extensive historic long-term deployment of other technology such as transformers, inverters and switchgear, these risks are better understood and regulated, through longstanding industry guidance and codes. An aerosol or gaseous suppressant system will be employed to extinguish fires quickly and effectively that do not involve the lithium-ion batteries. Therefore, only the battery component of the BESS is addressed in this report.

1.4 Safety Objectives

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

- To minimise the likelihood of an event. This is the overriding priority.
- To minimise the consequences should an event occur,
- To restrict any event to site and minimise any impact on the surrounding areas,
- To automatically detect and begin to fight an electrical fire as soon as possible, and to alert Lincolnshire Fire and Rescue Service,
- 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, and have sufficient water resources,
- To ensure that fire, smoke, and the spread of toxic/explosive gasses do not affect occupants in surrounding buildings and areas,
- To ensure that firewater run-off is contained and treated.

1.4.2 The following sections set out the design responses incorporated into the Scheme in order to achieve these objectives.

1.5 Relevant Guidance

1.5.1 Guidance documents and standards considered by the Applicant in the design and selection of these systems have been used to inform the design of the Scheme.

1.5.2 There is currently limited UK specific guidance for BESS, however BESS is deployed globally and the Applicant will look to incorporate good practice from around the world.

1.5.3 The Applicant will develop the BESS in accordance with all relevant legislation and good practice, and following advice from subject experts. This document takes into account the recommendations of the following good practice documentation used in the UK for similar sites, including:

- National Fire Protection Agency (NFPA) 855 (United States of America)
- Underwriters Laboratories (UL) 9540A Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
- United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116: Fire Protection Standard for UK Power Networks Operational Sites, 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
- The Regulatory Reform (Fire Safety) Order (RRO) 2005
- IEC 61936, Power installations exceeding 1 kV AC and 1.5 kV DC – AC

2. Consultation

2.1 Lincolnshire Fire and Rescue

2.1.1 As per all sites in which the Applicant plans to install battery systems, the local fire and rescue service, Lincolnshire Fire and Rescue Service (LFRS) has been consulted, including during statutory consultation, a meeting on 29th November 2022 and sharing the draft outline BSMP. The Applicant has shared experience and knowledge with LFRS. This has included sharing the preliminary site design and earlier drafts of this report.

2.1.2 During this consultation LFRS has made a few recommendations on design, as set out in Table 1 below.

Table 1 – Lincolnshire Fire and Rescue Service Design Recommendations

Topic	LFRS Recommendations	Scheme Response
Fire detection	Install a very early warning fire detection system, such as aspirating smoke detection/air sampling.	The inclusion of a VESDA is included in the design (Section 4.2.4).
Fire detection	Install carbon monoxide (CO) detection	We favour Volatile Organic Compound (VOC) sensors rather than specifically carbon monoxide as VOC sensors will respond to the droplets of organic solvent as well as carbon monoxide. The sensors will be aspirated and located to detect both heavier than air and buoyant vapour cloud. (Section 4.2.4).
Fire suppression	Including automatic fire suppression systems in the development design.	The LiBESS installation is likely to comprise cabinets which are high energy density and hence have little free volume rendering water suppression systems ineffective. As such, and in line with accepted firefighting practice, we will work with LFRS to develop a defensive firefighting strategy to ensure that fire does not propagate beyond a single cabinet (Section 4.2.4).
Firefighting water	Ensure that sufficient water is available for manual fire-fighting. An external fire hydrant should be located in close proximity of the BESS containers. − The water supply should be able to provide a minimum of 1,900 l/min for at least 120 minutes	The ability to connect into the mains water off the A156 is being designed along with onsite water storage tanks onsite if a connection in the main water supply is not viable. Appropriate connection points will be put in place. Engagement with Anglian Water has started to secure a mains water type connection.

Topic	LFRS Recommendations	Scheme Response
	(2 hours). Further hydrants should be strategically located across the development. These should be tested and serviced at regular intervals by the operator. If the site is remote from a pressure feed water supply, then an Emergency Water Supply (EWS) meeting the above standard should be incorporated into the design of the site e.g. an open water source and/or tank(s). If above ground EWS tanks are installed, these should include facilities for the FRS to discharge (140/100mm RT outlet) and refill the tank.	
Site access	The site design should include a safe access route for fire appliances to manoeuvre within the site (including turning circles). An alternative access point and approach route should be provided and maintained to enable appliances to approach from an up-wind direction.	Firefighting access will be designed in accordance with guidance of Approved Document B (ADB) and, over and above this, the road layouts will incorporate a circular road around the site with multiple access into the LiBESS containers etc and without any cul-de-sacs (Section 5.2).
Information for firefighter	As the majority of BESS are remotely monitored, consideration should include the fixing of an Information Box (IB) at the FRS access point. The purpose of the IB is to provide information for first responders e.g. Emergency Response Plan, to include water supplies for firefighting, drainage plans highlighting any Pollution Control Devices (PCDs) / Penstocks etc for the FRS.	The site will include a staging/rendezvous point at the BESS area to allow coordination of firefighting activities. Both will have the contact number for the control room and 24/7 Subject Matter Expert. In addition, a fire control monitor will be located at the staging point which will show the status of the battery containers and whether suppressant has been discharged. The effected container will be identified rapidly by a flashing red light (Section 5.2).

Topic	LFRS Recommendations	Scheme Response
Standard	Strongly recommend applying the National Fire Protection Association (NFPA) 855 Standard for the Installation of Stationary Energy Storage Systems.	This is included in the design (Executive Summary and Section 2.5).
Emergency response plan	Develop an Emergency Response Plan with LFRS	Agreed see Section 5.4.

3. BESS Safety Requirements

3.1. BESS Procurement and Testing

Procurement

3.1.1 Gate Burton Energy Park Ltd is the Applicant for the development. Gate Burton Energy Park Ltd is a subsidiary of Low Carbon, an experienced developer of electricity generation and storage projects. Low Carbon is an integrated renewables project development, investment and asset management company with active interest in developing utility scale wind, solar and storage across the UK, EU and the US. Low Carbon has been at the forefront of the storage market, having successfully deployed lithium-ion battery projects at scale in the UK and Republic of Ireland.

3.1.2 The Applicant is therefore experienced in conducting thorough tendering processes for procuring battery storage equipment and services, working with Tier 1, bankable, suppliers of battery cell manufacturers, inverters and transformers.

3.1.3 The Applicant gains access to the integrators' whole-system testing labs, which can simulate conditions at the Applicant's (as a subsidiary of Low Carbon) site locations, undergoing the full cycle of installation, commissioning, and operation under all required application modes, putting the hardware, controls, and software integration through a suite of tests.

3.1.4 The Applicant only considers and engages with suppliers and products that conform to ISO 9001, ISO 14001, OHAS 18001, CE, and local regulation, auditing both technical and financial aspects.

3.1.5 The Applicant's procurement processes look to inspect manufacturing facilities and periodically monitor production lines. The inspections evaluate production quality documentation and production line process, against pre-defined documentation to verify that the quality requirement is correctly respected and implemented. The following aspects are specifically checked:

- Material management,
- Procurement and supplier management
- Manufacturing processes
- Quality system
- Reliability program

- Training
- Corrective action and non conformance process improvements
- Corporate social responsibility, environmental, health and safety.

3.1.6 The Applicant recognises that robust quality processes are essential within the development and procurement stages in terms of safe, continuous operation.

3.1.7 Low Carbon has been at the forefront of the Battery and Energy Storage market, having successfully deployed lithium-ion battery projects at scale in the UK and Republic of Ireland. The Applicant is therefore experienced in conducting thorough tendering processes for procuring battery storage equipment and services, working with Tier 1 suppliers of battery cell manufacturers, inverters and transformers. In addition, The Applicant only works with leading battery integrators with global presence – whose expertise in system integration of battery cells and modules, inverters and transformers, in combination with intelligent software for management and optimisation of energy services from the battery – is critical for successful operation of any battery project.

3.1.8 By only working with major global battery integrators, The Applicant gains access to the integrators' whole-system testing labs, which can simulate conditions at Low Carbon's site locations, undergoing the full cycle of installation, commissioning, and operation under all required application modes, putting the hardware, controls, and software integration through a suite of tests. This helps reduce commissioning times and yield early identification of issues, allowing resolutions to be implemented prior to deployment at our sites.

3.1.9 Low Carbon's policy is to work with battery storage integrators and component manufacturers which are ISO 9001, 1SO 14001 and OHAS 18001 certified companies. We require the designs to incorporate the most advanced fire suppression systems, including adhering to the UL9450 A and NFPA 855 standards, as well as conform to local and industry standards. A non-exhaustive list of standards applied in general for the equipment we procure are set out below.

Standard	Description
IEEE 1547:2003	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
National Grid	Grid Code
IEC 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Emission standard for industrial environments
IEC 61000-6-4	EMC Part 6-4 Generic Standards- Emission Standard for Industrial Environment

Standard	Description
Directive 2006/66/EC	Directive of Batteries and accumulators and waste batteries and accumulators
2006/95/EC	Low Voltage Directive
2004/108/EC	EMC Directive
IEC 60183	Guidance for the selection of HV AC cable systems
IEC EN 62477	Safety requirements for power electronic converter systems
IEC 62116 ed1.0	Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters
IEC EN 61727	PV – Characteristics of Utility Interface
IEC 61140	Electrical low voltage installations - Part 4-41: Protection measures - Protection against electrical shock
IEC 60076	Power Transformers
IEC 62933	Electrical energy storage (EES) systems
IEC 62619	Secondary Cells and Batteries containing alkaline or other non-acid electrolytes
UL 9540 A	Test Method for Evaluating Thermal Runaway Fire Propagation in Fire battery Energy Storage System
NFPA 855	Standard for the installation of Energy Storage Systems
UN38.3	UN Manual of Tests and Criteria

Testing

3.1.10 The system selected will be tested in accordance with UL9450A or its contemporary. This will determine the propensity of the system to suffer from thermal propagation at cell, module or rack level. The results of all four tests at each level will be made available on request (note: if thermal propagation does not take place at module level, there is no need to proceed). Any actions taken, if necessary, to prevent thermal propagation will also be available as will the results of the re-testing.

3.2. Safe BESS Design

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

3.2.2 The current industry standard is NFPA 855, Standard for the Installation of Stationary Energy Storage System and the Applicant also requires any system selected to comply with UL9540, the Standard for Safety for Energy Storage Systems and Equipment, to evaluate the safety of ESS.

3.2.3 In addition to this, good practice guidance for electrical sites within the UK (see section 2.5) has been consulted with regards to site layout and separation distances for the transformers and inverters.

System location

3.2.4 Within the Scheme the selection of the location of the BESS has been based on a number of factors. The most pertinent factor being the selected site has 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 the proposed BESS is more than 750m from any residential properties.

System layout

3.2.5 The layout of the system will provide separation between key components or groups of key components.

- The BESS will be broken into discrete groups consisting of battery enclosures and inverters and transformers.
- The separation distance between the BESS and transformers will be a minimum of 5m
- Each group will be separated from the next by a minimum of 3m. This separation will limit any fire that is not able to be contained to the effected group or part of the battery system and also allow emergency access in case of an intervention.
- BESS enclosures will be separated from each other by a dedicated separation distance, which is currently assumed to be a minimum of 3m. Noting that the cube system would consist of multiple small enclosures, but these groups would have a dedicated separation distance.
- The separation distance between the battery enclosures and Order limits boundary will be in accordance with NFPA 855 which is currently assumed to be a minimum of 20m. This far exceeds the current NFPA guidance of 3m.
- The separation distance between the battery enclosures and the perimter fence will be a minimum of 5m
- 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.
- Note that a skid mounted inverter & transformer could be utilised, in which case the separation of the group from the BESS would be considered.
- The areas between and around equipment will be finished with gravel and kept free of vegetation or other material that could act to spread a fire.

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

- BESS should be separated by a minimum 3m (10 ft) from the following exposures:
  - Site boundaries
  - Public ways
  - Buildings
  - Stored combustible materials
  - Hazardous materials
  - High-piled stock

- BRE BR187 External fire spread: building separation and boundary distances (BR 187 2nd edition)
  - Separation distances in England are generally calculated based on the recommendations of BR 187 External Fire Spread: Building Separation and Boundary Distances. Although the BESS enclosures are not classified as buildings the separation requirements of BR 187 is easily satisfied by the construction of the enclosures when they achieve 60 minutes fire resistance for integrity and insulation.

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

Battery System Enclosures

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

3.2.9 The battery enclosures will be designed and constructed by the manufacturer in accordance with the good practice available at the time, such as the current guidance outlined in the NFPA 855, Standard for the Installation of Stationary Energy Storage Systems. This will ensure the enclosures will be of robust construction and have suitably high Ingress Protection (IP) ratings.

3.2.10 At the present time, the BESS industry is moving away from the relatively low energy density container + rack systems to significantly higher energy density cabinet-based systems.

Fire Detection and Suppression

3.2.11 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.

3.2.12 Water remains the best selection of suppression systems for Lithium Battery fires. It is generally recognised that, in a container and rack-based BESS, water mist or sprinkler systems can extinguish LFP fires and protect adjacent racks (depending upon spacing). This is not the case with NMC cells: water suppression will not protect the effected rack but with large (and uneconomic) rack spacings can protect adjacent racks. However, the vapour cloud and fumes evolved by cells in thermal runaway without or with ignition, respectively, generate hydrofluoric and hydrochloric acid gases which will render any undamaged cells unusable or at least uninsurable. Further, the increasing trend towards higher energy density configurations, e.g. cabinet systems, which have very little free space between densely-packed modules, renders any water suppression invalid. This is reflected in the guidelines for fire services produced by Tesla: the company recommends allowing the effected container to burn whilst cooling surrounding containers. Tesla also incorporate an igniter in their Megapacks to avoid explosion. Thus the Applicant will liaise with LFRS to develop a defensive firefighting strategy, allowing a cabinet to burn but ensuring separation between cabinets is more than sufficient to facilitate cooling of the surrounding cabinets and hence prevent fire spread.

3.2.13 Taking the above into consideration and in line with our strategy of avoiding fires and explosions, Data Analytics (DA) will be employed to help minimise risks: the battery management system (BMS) routinely records a wide variety of data (including current, voltage and temperature) which can be exploited by DA. DA will automatically detect anomalous changes in temperature, cell resistance and capacity at rack level (which could indicate lithium metal plating, corrosion, failure of components and cables) and can monitor an essentially unlimited number of sensors such as smoke and gas sensors and ground fault detectors. Further, DA will routinely monitor the ageing of the cells in the LiBESS, and can be used to predict End-of-Life, and as well as alerting the operator when modules need preventative maintenance.

3.2.14 Other measures include:

- Thermal monitoring of the battery enclosures and automated cut-out beyond safe parameters.

- Battery liquid cooling systems with automated fail safe operation. The cabinet design likely to be employed has very limited free volume rendering Heating, Ventilation and Air Cooling (HVAC) systems relatively ineffective.
- Emergency Stop – both remote and local.
- Fire and vapour cloud (immediate and delayed ignition) detection suitable to the architecture such as:
  - Aspirated very early smoke detection apparatus (VESDA).
  - Detection of volatile organic compounds (VOC) and carbon monoxide, which can be released prior to thermal runaway and hence give some warning of cell failure. The vapour cloud released in this way generally has both heavier than air and buoyant components, and the positioning of VOC sensors will reflect this. This will trigger gas venting in accord with NFPA 855 (2023) and so avoid explosion.
  - Standard heat detection system.
- Electrical fire suppression equipment such as NOVEC 1230, StatX powder fire suppression, or other contemporary system.

3.3. Safe BESS Construction

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

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

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

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

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

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

3.3.5 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.

3.4. Safe BESS Operation

Control Room

3.4.1 The BESS will be monitored by the onsite control systems as well as 24/7 monitoring by a remote control room.

- The control room will also monitor a number of other sites across the UK, staff will be fully trained and familiar with the technology.
- The control room will alert the Lincolnshire FRS and be the first point of contact with respect to linking the fire service with a Subject Matter Expert, who will be available 24/7.
- The control room will also be responsible for the security of the site with contempory detection and monitoring systems. These can be repurposed in an emergency to support first responders.
- The control room will have the ability and authority to immediately shut the system down should the need arise.
- The control room will be responsible for the implementation of the emergency plan acting as a point of contact to emergency services.

- The BESS Compound will have signage in accordance with the relevant Electrical Regulations but will also have the control room emergency telephone number should a member of the public or Emergency Services need to make contact.

Control architecture

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

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

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

3.4.4 The BMS monitors a very significant range and depth of data, and data analytics (DA) will be employed to exploit this rich source of information to predict ageing of the cells in the LiBESS and alert the operator when modules need maintenance or replacing. DA will also facilitate accurate determination of State-of-Charge (SoC) and hence State-of-Health (SoH): determination of these parameters (which are essential to safe operation) is rendered challenging by the flat regions of the voltage vs capacity curves of lithium-ion batteries, and especially LFP LiBs. Data Analytics will automatically detect anomalous changes in temperature, cell resistance and capacity at rack level (which could indicate lithium metal plating, corrosion, failure of components and cables) and can monitor an essentially unlimited number of sensors including smoke & gas sensors and ground fault detectors: a single ground fault may not be dangerous, but a second one will result in a short circuit, creating hazardous conditions that could result in a fire.

Security

3.4.5 The site security profile will be assessed by the Applicant's dedicated security team and the output form this assessment will inform the level of security measures used.

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

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

Cybersecurity

3.4.8 In contrast, cybersecurity will form a fundamental part of the system design and architecture, which is significantly in advance of current practice as it is all to often ignored by operators1. Standards such IEC 62443 and guidance from sources such as National Cybersecurity Centre will inform the implementation and protection measures, reference shall be made to the HSE Operational Guidance document OG86.

Maintenance

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

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

3.4.11 All maintenance will be undertaken in a carefully controlled manner following the site safety rules and in accordance with the Operational Environmental Management Plan (OEMP) that will be secured by a requirements on the DCO (see Schedule 2 of the draft DCO **[EN010131/APP/6.1].** The OEMP will be developed substantially in accordance with the Framework Operational Environmental Management Plan submitted with the Application **[EN010131/APP/7.4].**

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

3.4.13 The operation of the BESS will be managed in accordance with the OEMP.

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[1] See for example [redacted]

Battery Phasing or Augmentation

3.4.14 The BESS may be constructed in phases

3.4.15 During the operational phase, from time to time there may be a requirement to replace or augment the battery system due to equipment failure or degradation of the system capacity. Note the planned design life may require replacement or augmentation of the battery systems on more than one occasion depending on use case.

3.4.16 The risks associated with any wholesale replacement with similar or any new technological developments will also be considered before any works commence. It is also possible that any replacement or augmentation of the system may use a contemporary equivalent of the original BESS system.

3.5. End of life / disposal

3.5.1 With regards 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 (as amended) and pursuant to the Waste Batteries and Accumulators Regulations 2009 (or such equivalent regulations in force at the time of decommissioning) it has certain obligations in respect of battery disposal.

3.5.2 It is assumed that all components replaced during the defects notification and warranty period will be taken back and recycled.

3.5.3 The Applicant will follow the hierarchy of waste management throughout the life of the Scheme as follows:

- Reduce – lithium ion batteries have a 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.

- 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.

4. Firefighting

4.1. Fire Service Guidance

4.1.1 Guidance for the Fire Service for dealing with sites such as powerplants, substations etc is contained in the Fire Service Manual Volume 2 Fire Service Operations – Electricity.

4.1.2 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.

4.1.3 In the event of a fire, the battery system and the transformers serving the BESS will be automatically electrically isolated when a fire is detected within a container. However, the batteries within the 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 container, and this will inform the strategy for firefighting in the emergency plan.

4.1.4 The Applicant has commenced engagement with Lincolnshire FRS and will continue to do so throughout the design, construction and commissioning phases of the project.

4.1.5 As stated above, it is expected that the fire service will exploit a defensive strategy in dealing with fire involving the LiBs. This will include “fogging out” any gases or fumes.

4.2. Fire Service Access

4.2.1 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:

4.2.2 Firefighting access will be designed in accordance with guidance of Approved Document B (ADB). Although ADB is not applicable as this site is not covered under the building regulations it provides useful access road specifications which are outlined in the table below. It should be noted that vehicles differ across the UK for different fire and rescue services and access route specifications should be considered on a site by site basis.

4.2.3 Turning facilities will be provided in any dead-end access route that is longer than 20m.

Table 4 -1: Typical Fire and Rescue Service Vehicle Access Route Specification

Appliance Type	Minimum width of road between kerbs (m)	Minimum width of gateways (m)	Minimum turning circle between kerbs (m)	Minimum turning circle between walls (m)	Minimum clearance height (m)	Minimum carrying capacity (tonnes)
Pump	3.7	3.1	16.8	19.2	3.7	14.0
High reach	3.1	26.0	29.0	4.0	23.0	

4.2.4 The minimum proposed access-road width to reach the BESS will be 4m. In order to assess a worst case scenario and to allow for a wider access for vehicles during construction and Abnormal Indivisible Load vehicles the Environmental Impact Assessment has assessed a road to the BESS with a width of up to 8m. This means the road can be delivered at greater width if necessary without any additional environmental effects. In addition, and going above and beyond the minimum requirements stated above, the BESS area will be surrounded by a ring-road with multiple access roads into the BESS without any cul-de-sacs to allow free access.

4.2.5 A swept path analysis for a series of oversized vehicles and loads has been undertaken and the roads have been confirmed as suitable for vehicle access, therefore it is anticipated that all emergency vehicles can also be accomodated. A hard top road will be installed from the public highway to the BESS site from the west. Alternative access to the BESS can be made via Clay Lane to the south.

4.2.6 The site will include a staging/rendezvous point at the BESS area to allow coordination of firefighting activities. Both will have the contact number for the control room and 24/7 Subject Matter Expert. In addition, a fire control monitor will be located at the staging point which will show the status of the battery containers and whether suppressant has been discharged. The effected container will be identified rapidly by a flashing red light.

4.3. Fire equipment

4.3.1 Additional firefighting equipment will also be provided on the site for use by Lincolnshire FRS. Weather stations will be installed to identify the weather conditions in an emergency situation. This will allow the fire service to approach from a safe direction. Other firefighting or emergency equipment such as additional fire hose to be stored onsite for use by the fire service will be agreed with Lincolnshire FRS prior to the commencement of construction.

4.4. Emergency Planning

4.4.1 The BESS will have a robust and validated ERP, developed in consultation with Lincolnshire FRS. This emergency plan will include:

- Full description and site plans identifying all of the relevant features required in an emergency such as layout, rendevous point and staging area, e-stop locations and firefighting equipment.
- Design drawings and schematics of the system for reference.
- Procedures for the isolation of enclosures in the case of failure. Location of electrical isolation switchgear.
- Battery data including:
  - MSDS (Material Safety Data Sheets)
  - COSHH (Control of Substances Hazardous to Health) Assessment
  - Number of cells
  - Details of the fire detection and suppression systems.
- Fire-fighting strategy.
  - Conservative plume and explosion impact assessments.
  - Review of local risk points e.g. adjacent trees or infrastructure requiring possible protection from fire propagation;
  - Review of fire water provisions
- Location of alarm panels, details and location of signage
- Chain of command and phone numbers of control room & 24/7 SME
- Details of the explosion prevention venting system including discharge locations and orientation
- Evacuation routes
- Medical emergency procedures
- Maintenance records
- Decommissioning procedure for damaged BESS batteries and equipment
- Protocols and schedules for conducting safety and emergency response drills

4.4.2 In the unlikely event of an incident, the company will fully engage with the local community. In addition, an executive stakeholder steering committee comprising key organisations will be set up within 24 hours of the incident: in this way, with multiple parties involved in the emergency response to the fire event actively participating in the steering committee, communication will be effective and accurate. Finally, the company will be open and free with information to industries, first responders and local authorities where possible.

4.5. Firefighting consequences

4.5.1 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.

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

4.5.3 As set out in the Surface Water Drainage Strategy for the Solar Site (see Appendix 9-C of the Environmental Statement **[EN010131/APP/7.4]**) the Scheme's drainage strategy includes a separate system around the BESS with a combination of positive drainage and swales/infiltration basins around the perimeter of the battery system to act as a natural barrier to runoff or collecting runoff into an attenuation / storage lagoon. This will have automatic and manual isolation systems to ensure that any firewater runoff is captured for analysis prior to disposal. This trapped water may then be reused as a potential source of firefighting water. This follows the management plan process as detailed in "Protocol for the disposal of contaminated water and associated wastes at incidents 2018" jointly issued by the Environment Agency, Northern Ireland Environment Agency, Water UK and Chief Fire Officers Association.

4.5.4 A post event action plan will be drawn up that will determine any immediate and follow up actions required to an event including an assessment in general accordance with LCRM (Land Contamination: Risk Management) and BS 10175:2011+A2:2017 (Investigation of potentially contaminated sites – Code of practice).

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

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

5. Pre-Construction Information Requirements

5.1.1 The detailed design phase will consider the lifecycle of the battery from cradle to grave. A large number of studies will be undertaken, with a focus on fire risk including, but not limited to, studies in line with risk analysis and management tools such as Hazard and Operability Analysis and Hazard Identification (HAZOP/HAZID), failure Mode and Effects Analysis (FMEA), Bowtie risk assessments and Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) to inform the overall design solution. An agile method is applied during the engineering design phase for fire safety analysis. The analyses are updated based on any changes of the project context and during the design process from the selected contractors in case of any deviation from the initial set of technical requirements. These will be finalised before construction commences.

5.1.2 The detailed design phase will determine the approach to addressing the following specific requirements, which will be updated prior to construction of the BESS and submitted to the local planning authority as a detailed BSMP prior to the commencement of construction. The detailed BSMP 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 using methods consistent with Best Available Techniques (BAT) in relation to the specific battery chemistry selected.
- An emergency plan covering construction, operation and decommissioning phases developed in consultation with Lincolnshire FRS, to include the adequate provision of firefighting equipment onsite.

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

5.1.4 Safe decommissioning of the BESS will be addressed prior to decommissioning of the Scheme in the final version of the Decommissioning Environmental Management Plan (DEMP) that will be developed prior to decommissioning the Scheme in accordance with the Decommissioning and Restoration requirement proposed in the draft DCO **[EN010131/APP/6.1].** The DEMP will be developed substantially in accordance with the Framework Decommisioning Management Plan submitted as part of the Application **[EN010131/APP/7.5].**

6. Conclusion

6.1.1 The Applicant is committed to developing a safe BESS that will provide long dependable operation. It is in all stakeholder's interest that the selected BESS technology is robust, in particular with regards to safe operation.

6.1.2 This report demonstrates that, as well as the Applicant having significant internal expertise and robust processes in BESS development, the LFRS have been consulted and their responses have informed the Outline Design Principles **[EN010131/APP/2.3]** for the Scheme. Safety will therefore be inherent in the overall design, minimising the risk of a fire or explosion event occurring, and reducing the impact of such an event should it occur.

References

1. DNV (2017) GL-Recommended Practice-0043: Safety, Operation and Performance of GridConnected Energy Storage Systems.
2. Lithium-ion Battery Storage (Fire Safety and Environmental Permits) Bill 2022-23; First Reading (2022) Hansard.
3. Scottish and Southern Energy (2019) TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide.
4. Water UK (2018) Protocol for the disposal of contaminated water and associated wastes at incidents (Jointly issued by Water UK, Environment Agency, NIEA, Natural Resources Wales, DWI, Fera, Defra's CBRN Recovery Team, NFCC National Resilience).
5. British Standard (2017) BS 5839-1:2017 Fire Detection and Fire Alarm Systems for Buildings.
6. Regulatory Reform (2005) The Regulatory Reform (Fire Safety) Order 2005.
7. BSI Standards Publication (2021) BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC – AC.
8. UL Standard (2020) UL9540A Energy Storage Systems and Equipment.
9. NFPA (2023) NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.
10. UK Statutory Instrument (2002) The Dangerous Substances and Explosive Atmospheres Regulations 2002
11. International Standards Organisation (2015) ISO9001:2015 Quality Management Systems – Requirements.
12. United Nations (2015), Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (UN 38.3).
13. Fire and Emergency Planning Directorate (1998) Fire Service Manual Volume 2: Fire Service Operations, Electricity.
14. United Kingdom Power Networks (UKPN) (2016) Engineering Design Standard 07-0116: Fire Protection Standard for UK Power Networks Operational Sites.
15. HM Government (2019) The Building Regulations 2010, Fire Safety - Approved Document Volume 2: Buildings other than dwellings. (Incorporating 2020 amendments).
16. United Nations (2021) Agreement Concerning the International Carriage of Dangerous Goods by Road.
17. Richard Chitty (2014) External fire spread: building separation and boundary distances (BR 187 2nd edition).
18. HSE (2002) The Dangerous Substances and Explosive Atmospheres Regulations 2002.
19. Environment Agency (2021) Land contamination risk management (LCRM) Stage 1-3.
20. BSO British Standard (2017) BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice.

21. International Society of Automation (2018) ISA62443 Security of Industrial Automation and Control Systems.
22. UK Statutory Instruments (2009) The Waste Batteries and Accumulators Regulations 2009.
23. HSE (2017) Operation Guidance document OG86 Cyber Security for Industrial Automation and Control Systems (IACS).