



Constantine Energy Storage Kirkby 275KV Solar Project

Outline Battery Storage Safety Management Plan

Revision 9

Prepared by: Pearl Safety Solutions Ltd
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Issue Sheet

Report Prepared for: Kirkby 275 KV Battery Storage Project

Outline Battery Storage Safety Management Plan

Prepared by:

Name: Mick Carr

Title: Consultant

Reviewed by:

Name: Alex Jones

Title: Quality Director

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1 Executive Summary

- 1.1.1 This report has been prepared on behalf of Constantine Energy Storage and Pelagic Energy (the 'Applicants') in relation to an application made to Knowsley Metropolitan Borough Council (Permission Referenced: 23/02008/FUL) for the Kirkby 275 KV Battery Storage Energy Equipment Project (the 'Scheme').
- 1.1.2 The Applicants have entered into a Bilateral Connection Agreement with National Grid for the connection of up to 57MW of Battery Storage to the National transmission system. This is to be achieved by the connection of the applicant's battery site to a set of tertiary connections available on Supergrid Transformer 1A (SGT1A)
- 1.1.3 The application proposes that the BESS will be located on land to the south east of the existing National Grid Kirkby site to the west of the village of Bulphan. The wider site will accommodate the battery containers, power skids containing HV / LV transformer with dual secondary windings and twin inverters along with 33kV Substation Building containing the 33kV switchgear, protection, control and auxiliary equipment. Access to the site is via an existing National Grid access road, off Coopers Lane, which will be shared access.
- 1.1.4 The application affirms that the form of energy storage will be battery storage and as such, the Energy Storage is often referred to as a 'BESS' (Battery Energy Storage System throughout this document).
- 1.1.5 The design and layout of the BESS within the site will comply with the guidance given in NFPA 855 Standard for the Installation of Stationary Energy Storage Systems (2023). Compliance with this standard is deemed to meet the NFCC Guide: Grid-Scale Battery Energy Storage System Planning (2023).
- 1.1.6 The proposed battery storage system (Envision's 5 MWh containerised system) has key components including: battery cell, pack, DC and AC systems. The DC Container is powered by AESC's 315 Ah LFP prismatic cells, which are tailored for stationary energy storage applications. System-level reliability and performance is ensured through adoption of the enhanced liquid-cooling system, fire protection system (FPS), and embedded monitoring and control systems.
- 1.1.7 The DC output from a single inverter is connected to a pair of ESS containers each with 5MWhr capability. A single module is therefore made up of one 40ft Power skid and four 20ft battery containers. The four battery containers are arranged in two sets of pairs typically back-to-back with 3m separation between each bank of pairs. This 3m is specified by the insurance provider rather than a technical requirement by the Supplier.
- 1.1.8 Indicative arrangement/layout drawings with recommended and minimum separation for the battery modules provided by the manufacturer.
- 1.1.9 Prior to the commencement of construction of the BESS, the applicants are required to prepare a Battery Storage Safety Management Plan (BSSMP) which must in accordance with this outline BSSMP. As part of the preparation of the BSSMP, the Applicant takes 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.

- 1.1.10 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:
- Elimination;
 - Substitution;
 - Engineering Controls;
 - Administrative Controls;
 - Personal Protective Equipment (PPE).
- 1.1.12 This document details the safety systems planned for the project, along with risk reduction controls which are likely to be incorporated into the system to be installed.
- 1.1.13 A summary of the anticipated fire safety provisions are as follows:
- The BESS is 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 has been chosen to minimise impacts on receptors
 - Separation distances between components have been selected to minimise the chance of fire spread based on best practices.
 - 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 enclosures. The BESS facility will be designed with multiple layers of protection to minimise the chances of a fire or thermal runaway event.
 - All equipment will be monitored, maintained, and operated in accordance with manufacturer instructions.
 - The fire protection for the BESS is suitably integrated with the overall site fire protection system to enable the status and alarms of the BESS fire protection system to be monitored from the BEA 24/7 remote control facility. The BESS has a high level of fire protection in accordance with an internationally accepted procedure on battery fires, including the National Fire Protection Association (NFPA) Codes; NFPA 855 and FM-Global Datasheet 5-33. The battery enclosures include explosion prevention and deflagration relief systems in compliance with NFPA 855.
 - The site will operate under the Kirkby 275/132kV Substation Emergency Response Plan (ERP) in the interim period. However, a site-specific ERP will be developed for the BESS itself, post consent, based on national and international best practice measures.

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- Site containment including perimeter and security fencings and gates are based on industry best practice but generally comprising a 2.4m high palisade fence to cat3 standard with internally mounted electric pulse security fence. The perimeter fence will include two access/egress points to satisfy Fire Risk Assessment requirements, including a double-leaf entry gate.
 - The security system provides a design incorporating a lighting column-based CCTV system for the site. The CCTV camera operation and recording will be initiated by motion detectors integral to the cameras. The cameras/camera system will be equipped with a night vision facility. The system shall be enabled to switch on the external column- based lights once triggered.

2. Introduction

2.1 Scope of this Document

- 2.1.1 This outline BSSMP document, produced by the Applicant, profiles the key fire safety provisions for the BESS proposed to be installed at Kirkby 275 kV BESS project including measures to reduce fire risk and fire protection measures.
- 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 outline BSSMP is to identify how the Applicant will use good industry practice to reduce risk to life, property, and the environment from the BESS.
- 2.1.3 As the operational phase is anticipated to commence no earlier than November 2025, reference to current measures and guidelines are included here. However, this document will be updated prior to construction of the BESS to take account of prevailing guidance.

2.2 Project Description

- 2.2.1 For the purposes of this document a concept design has been considered that uses a BESS based upon LFP lithium-ion battery technology that is currently used on other sites being developed by the Applicant.
- 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 Outline BSSMP) is required to be submitted to the relevant local planning authority and approved, in consultation with the HSE, Merseyside Fire and Rescue Service and the Environment Agency. The Applicant must operate the BESS in accordance with the approved plan.
- 2.2.3 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. The Concept Design Parameters and Principles contain controls over the BESS, which include that the chemistry of the BESS will be lithium-ion.
- 2.2.4 The concept design consists of the BESS containers and the associated transformers, circuit breakers and inverters. The BESS, containers, and auxiliary system, such as cooling, uninterruptible power supply (UPS), fire and gas detection systems, monitoring and control, and is designed in accordance with national and international BESS standards and best practice guidance available at the time.
- 2.2.5 Once operational, the plant will be designed to operate unmanned with access required for maintenance only, and with a minimum Operational Life of 40 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 The Lithium Iron Phosphate (LFP) cells used in this project are inherently more stable compared with Nickel Manganese Cobalt NMC cells in terms of electrochemical characteristics, providing minimal risk of thermal runaway events (*see section 4. for full details*)
- 2.3.3 BESS hazards for first responders in the unlikely event of a battery failure and thermal runaway event are typically defined as: fire hazards, explosion hazards, electrical hazards (shock or arc flash), and chemical hazards (i.e. the release of toxic gases). First responders will wear full PPE and remove all jewellery, fire management should not generally be conducted within any exclusion zones identified by the fire and rescue services.
- 2.3.4 Regardless of the type of failure or the cause, the main potential hazard is thermal runaway and ultimately, if not controlled, a significant flaming or explosive gas venting incident and therefore this report focusses on reducing fire and explosion risks associated with the BESS and managing the hazard in the unlikely event that it occurs.
- 2.3.5 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 an event. This is an overriding priority;
 - To minimise the consequences should an event occur;
 - To restrict any event to the BESS site and minimise any impact on the surrounding areas;
 - To automatically detect and begin to fight a fire as soon as possible;
 - To ensure any personnel on Site are able to escape safely away from the Site;
 - To ensure that firefighters can operate in reasonable safety where necessary;
 - BESS design and site layout will minimise the requirement for direct Fire and Rescue Service (FRS) intervention in a thermal runaway incident i.e. direct hose streams or spray directly on BESS battery systems. FRS intervention in worst case scenarios would ideally be limited to boundary cooling of adjacent BESS and ESS units to prevent the fire from spreading. This strategy will be finalised with the Merseyside Fire & Rescue (MFR) and be clearly communicated in the Emergency Response Plan (ERP).
 - To ensure that fire, smoke and any release of toxic gases do not significantly impact site operatives, first responders and the local community.
 - To ensure that firewater run-off is contained and treated.

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).
- NFPA 855: Standard for the Installation of Stationary Energy Storage Systems
- NFPA 850: Recommended Practice for Fire Protection for Electrical Generating Plants and High Voltage Direct Current Converter Stations
- BS 9999: Code of Practice for Fire Safety in the design, management and use of Buildings
- Underwriters Laboratories (UL) UL 9540A (2019) 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.
- IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- UN 38.3 international standard for the testing and transporting of lithium-ion batteries.
- UN 3535 Safe transport of dangerous goods
- EN 15004: Fixed firefighting system. Gas extinguishing systems
- EN 12845: Fixed Firefighting systems. Automatic sprinkler systems. Design, installation and maintenance
- ISO 15779: Condensed aerosol fire extinguishing systems
- Department for Energy Security and Net Zero - Health and Safety Guidance for Grid Scale Electrical Energy Storage Systems; and
- The Regulatory Reform (Fire Safety) Order (RRO) 2005.

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- BS EN IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes. Safety requirements for secondary lithium cells and batteries, for use in industrial applications.
 - IEC 62477-1 Safety requirements for power electronic converter systems and equipment - Part 1: General
 - IEC 63056 Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
 - IEC 6100-6-2 & IEC 6100-6-4 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
 - IEC 62933-5-2 Safety requirements for grid-integrated EES systems - Electrochemical-based system

3. Consultation

3.1 Merseyside Fire and Rescue

- 3.1.1 Communication with the local fire & rescue services (FRS) has already begun early in the project and will continue across design and construction phases. This will ensure a robust emergency plan and material is available in an emergency.
- 3.1.2 The local fire and rescue service, Merseyside Fire and Rescue (MFR) has been consulted during pre-application discussions and as part of the Section 42 Statutory Consultation exercise.
- 3.1.3 A formal written response is awaited at the time of writing from Merseyside Fire & Rescue Service.
- 3.1.4 Any comments made by MFR in their responses will be included within this section.

4. BESS Safety Requirements

4.1 Safe BESS Design

4.1.1 Envision Energy's fire safety strategy is rooted in the ethos of 'putting prevention first and combining prevention and containment'. This approach focuses on preventing and containing thermal runaway events through a multi-tiered safety protocol covering prevention, detection, suppression, and containment.

4.1.2 The prevention by design philosophy includes LFP cells which are inherently more stable than NCM cells in terms of electromechanical characteristics. Integration of a Battery Management System (BMS) with a three-layer control topology, actively monitoring and regulating cell parameters to prevent failures and maintain optimal performance are expanded upon in the paragraphs below.

Early Detection

4.1.3 Utilisation of AI IoT based fault detection of thermal runaway events, enabling proactive systematic intervention before safety hazards escalate.

4.1.4 Development of gas detection systems, including Hydrogen, and Carbon Monoxide sensors to identify off-gassing concentrations and facilitate rapid response and early risk mitigation.

Suppression and containment

4.1.5 Implementation of aerosol fire suppression systems to ensure efficient and precise suppression of fire incidents.

4.1.6 Adoption of fire-resistant enclosure designs to prevent thermal propagation

Lithium Iron Phosphate Cells

4.1.7 The cells utilised on the Kirkby project are AESC LFP (Lithium Iron Phosphate) which are inherently safer than Nickel Manganese Cobalt cells due to their intrinsic electrochemical stability owing to a stronger P-O bond, which mitigates uncontrollable exothermic reactions under elevated temperatures and other stress factors.

4.1.3 AESC's manufacturing processes prioritise cleanliness and safety, surpassing industry standards by an order of magnitude. AESC's particle contamination levels measured in parts per million significantly outperform industry norms. This attention to detail ensures that AESC's cells remain exceptionally clean and free from contaminants, ultimately contributing to the exceptional safety and performance of the Envision system's performance.

4.1.4 AESC's cells excel in stringent safety tests, including the nail puncture tests underscoring their resilience and robust design, and demonstrating exceptional stability and safety characteristics.

Battery Management System

4.1.5 The BMS plays a crucial role in detecting cell degradation or abuse and triggering the corresponding mitigation measures. The BMS will have a built-in fail-safe system with automated algorithms. The control and safety system will provide an effective and appropriate method of early detection of a fault of the batteries and consequent disconnection shall be provided when normal voltage or temperature limits are

exceeded. Such limitation or disconnect would be alerted to the control room.

- 4.1.6 The BMS system features a three-layer architecture, primarily consisting of the system-level Battery Array Management Unit (BAU), rack level Battery Cluster Management Unit (BCU), and pack-level Battery Management Unit (BMU). The BMU is responsible for collecting cell voltage and temperature data. The BCU collects data from the BMU's and manages charge and discharge processes on the rack level. The BAU oversees all the racks within the system to ensure balancing and minimise recirculating current. The operation status of the system is communicated to the Power Conversion System (PCS) and site-level EMS through BAU.

System-Level Protections:

- 4.1.7 The Fire Protection System (FPS) the supplier (Envision Energy) has fitted to their BESS, detects, alarms, and suppresses thermal runaway events at early stage. The battery container is equipped with smoke detectors, heat detectors, and CO and H₂ combustible gas detectors to swiftly identify potential risks of battery or electrical fires. Water sprinkler system is offered as an option with pre-installed dry pipes. The active exhaust ventilation and deflagration venting system are designed to NFPA 69 and 68.
- 4.1.8 A comprehensive multi-layer electrical hardware and software protection system is implemented to prevent safety hazards. These layers include:
- Fuse and circuit breaker in the battery junction box on the rack level
 - Fuse and circuit breaker on the DC side of the PCS
 - Circuit breaker on the AC side of the PCS
 - MV fuse and MV load switch within the voltage step-up system. Notably, the high voltage switch is equipped with mechanical interlocking, differential protection, and a reverse time limit overcurrent function
 - PCS AC/DC side dynamic insulation detection for high/low voltage ride-through performance.
- 4.1.9 A two-level fire alarm setting is implemented for DC container. The first level alarm is triggered by any of the smoke sensors, temperature sensors, or combustible gas sensors. The second-level alarm is activated by two of more sensors simultaneously, automatically initiating the aerosol system.

Fire protection Components

- 4.1.10 The distributed fire protection system is complemented by IP 67 rated battery packs. Key features of the fire protection system include:
- Compartment level detection and total flooding
 - Early detection and persistent suppression
 - Distributed detection and centralised locking control
- 4.1.11 Two smoke sensors are installed within the system: one in the battery compartment and one in the power distribution compartment. The heat sensor is installed in the battery compartment to detect temperature abnormalities at an early stage of thermal runaway events. Both heat and smoke sensors are securely mounted with anti-loosening

fasteners and designed with anti-interference signal transmission capabilities.

- 4.1.12 Each DC Container system is equipped with one carbon monoxide sensor and one hydrogen sensor. An alarming signal is generated once the LFL reaches greater than 10%. The normal operation of combustible gas detectors by UPS for at least 24 hours (2 hours with continuous alarming conditions)
- 4.1.13 The alarming system consists of an alarm bell and horn strobe. The alarm bell is triggered under level 1 fire alarm, where a single fire detection device is activated. The horn strobe is triggered under level 2 fire alarm, where multiple fire detection sensors are activated simultaneously.
- 4.1.14 The active ventilation system consists of electrically actuated ventilation louvers, explosion-proof fans, and a central controller. The active ventilation is linked with hydrogen and carbon monoxide detectors to receive start and stop commands.
- Once the gas concentration is detected above the pre-set thresholds, the electric louvers are opened, and the explosion-proof fans start to discharge until the combustible gas concentration falls back to the normal range.
- 4.1.15 A deflagration panel serves as a crucial safety component designed to release pressure in the event of a sudden pressure build-up, preventing potential damage to the enclosure. The deflagration panels are installed on the top of the enclosure. When the pressure within the enclosure exceeds the static opening pressure threshold (typically around 0.1 bar), the vent panel is designed to passively open to relieve the pressure. This passive deflagration mechanism minimises the risk of structural damage or catastrophic failure of the enclosure.
- 4.1.16 The sizing and design of the explosion vent panel is carried out according to NFPA 68 and EN 14797. Fire resistance test is conducted as per EN 1643-1 with a resultant fire resistance level of EI 60.
- 4.1.17 A total flooding aerosol system is adopted to cover the battery compartment with a total volume of approximately 31m³. Five aerosol dispensers are installed on the top of the container at the door opening side. To effectively suppress thermal runaway event at an early stage, the total flooding suppression is to be achieved within 25 seconds after the initial release.
- 4.1.18 Dry pipe water sprinkler system can be provided as an optional fire suppression approach. Sprinkler pipes are filled with pressurized air or nitrogen during normal operation. Pipes are filled with water upon loss of pressure from closed sprinkler operation.
- 4.1.19 Envision have developed a patented "Cell Pad Isolation" technology, utilizing high thermal resistance pads placed between battery cells. Inspired by high-class electric vehicles and the mining industry, this innovation effectively inhibits thermal runaway propagation between cells. Test results demonstrate that the cell pad isolation technology

Advanced liquid cooling system

- 4.1.20 Envision's liquid cooling system for the energy storage containers is composed of chillers, pipes and pack cold plates. Each battery pack has a separate cooling channel.

Coolant in the water circuit system is driven by a water pump in the chiller and goes to the cold plate of each battery pack. Heat generated during battery charging and discharging is absorbed by heat conduction and convection. The coolant that has absorbed the heat is gathered again and flows into the chiller. A patented parallel pipe flow distribution technology is used by Envision to ensure a high degree of consistency in battery temperature during operation and storage while making the system run more efficiently and achieve a longer cell life. These chillers are equipped with heaters to heat batteries in low temperature scenarios and meet operating temperature requirements under battery charging and discharging conditions.

Design standards

4.1.21 NFPA 855 (2023) currently provides the most comprehensive guidelines for BESS design and site installation specifications. BESS design structural integrity will be demonstrated through full-scale fire and explosion testing or by integrating NFPA 69 (explosion prevention) and NFPA 68 (Explosion protection through deflagration venting) features. Additionally, LFP cells exhibit lower reactivity with moisture and reduced oxygen release during overcharge conditions, which further minimises the risk of thermal runaway events. With a combined installation of >1,000,000 electric vehicle packs and grid-scale batteries, AESC cells, including both NMC and LFP variants, have maintained a track record of zero critical accidents.

4.1.22 To ensure the highest fire safety standard all BESS must be tested and certified to UL9540A Test Method for Evaluating Thermal Runway Fire Propagation in Battery Energy Storage Systems (or any future standards which supersede this). In addition, it is a requirement to meet business continuity and property protection that BESS units will have integrated fire, heat and smoke detection, alarm, and suppression systems. All BESS installed on site at Kirkby will be UL9540A tested. This globally recognised testing standard for fire safety in BESS address the following key issues:

- BESS installation requirements.
- Ventilation requirements for explosion and deflagration prevention. BESS will have appropriate deflagration venting and explosion prevention installed. The results of the ventilation and deflagration prevention studies will be included as part of the Fire Safety Study.
- Effectiveness of BESS fire protection (integral and / or external)
- Impact of the BESS design on fire service strategy and tactics.

The adoption of the test standard also influences the battery management system, which is a key part of prevention of fires by allowing early detection of a potential incident before it occurs and taking remedial measures before a fire can occur.

4.1.23 The battery system has completed unit or installation level UL 9540A testing, demonstrating that thermal runaway propagation will not spread between modules or between battery racks and the generation of explosive gases will not threaten container structural integrity. This offers a high level of protection against fire and explosion risk. This is highlighted in their UL9540A Cell Test Report issued 2024-06-21.

- 4.1.24 The fire suppression system performance will be benchmarked against free burn testing and a minimum of three suppression tests conducted. An independent Fire Protection Engineer (FPE) specialising in BESS will review all UL 9540A test results and any additional fire and explosion test data which has been provided and validate the suppression system design.
- 4.1.25 Additional Third-Party fire and explosion testing will be utilised by the BESS OEM to demonstrate that structural integrity is maintained and toxic gas emissions to the closest receptors are below Public Health England (PHE) guidelines when the battery system is fully consumed in a thermal runaway event. An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results and any additional Third-Party fire and explosion test data which has been provided and share conclusions with the MFR.
- 4.1.26 In addition to this, good practice guidance for electrical sites within the UK has been consulted with regards to Site layout and separation distances for the transformers and inverters.
- 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
 - Contactor at rack/string and bank level
 - Overcharge safety device
 - Internal passive protection products
 - Venting systems and gas channels
 - Thermal or multi-sensor monitoring devices.

4.1.27 Battery cell will be certified to UL 1973 and tested to UL 9540A unit or installation level for BESS designs.

4.1.28 Module design will be certified to UL 1973 and tested to UL 9540A unit or installation level.

System Location

4.1.29 Within the Kirkby Site 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 nearest residential properties to the Site are isolated homes off Hewitt's Lane (approx. 280m east), Perimeter Road (approx. 300m north), and Knowsley Lane (approx. 370m south). Existing vegetation surrounding the Site, along with the substation infrastructure, provide effective screening to these receptors.

System Layout

4.1.30 The layout of the system will provide separation between key components and groups of key components.

4.1.31 The BESS will be broken into discrete groups consisting of liquid cooled battery containers, PCS MV Stations, switchgear building, control room and the auxiliary transformer compound. 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.

4.1.32 National Fire Protection Agency (NFPA) 855 (2023) defines basic operation Health & Safety (H&S) protocols for all BESS site designs which should be incorporated into emergency response plans:

4.1.33 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.

4.1.34 Automatic building evacuation area is defined as 200 ft or 61 m from the affected BESS enclosure.

Separation Distances

4.1.35 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)' has been followed at the design stage.

4.1.36 The property protection and business continuity requirements of the client require the prevention of fire spread to adjoining BESS cabinets, and in the event of a catastrophic level event (including external fire scenarios) of fire spread from a series of cabinets to

any other adjoining cabinets. This is undertaken using suppression systems, fire resistance to the cabinets and separating the BESS by pathways and roads.

- 4.1.37 While guidance on spacings is provided by the manufacturer based on their fire tests, as a minimum the fire spacings will also be required to meet the guidance given in NFPA 855, to meet insurance requirements. The required separation distances are detailed below:
- 4.1.38 BESS 'Units' are required to be provided with a minimum separation distance of 1m *. However, typically to allow the units to be safely maintained and operated, the actual distance is increased to a minimum of 2.2 m. In this case, a provisional separation distance of 3 m is proposed subject to confirmation of operational and maintenance requirements of the manufacturer. Under no circumstance is the distance permitted to decrease to less than 1m. *(Note: * This is based on the NFPA 855 recommendation for a separation distance between units of 3ft or 914mm).*
- 4.1.39 BESS to Site Boundaries: As per the guidance in NFPA 855 section 9.5.2.6.1, the BESS should be separated by a minimum of 10 ft (3 m) from fences, buildings and other exposure hazards not associated with electrical grid infrastructure. This distance is permitted to be reduced to 1.5 m (5ft) from site boundary to BESS enclosure where a 1-hour free-standing fire wall is provided. This fire wall should be a minimum height of 1.5 m greater than the height of the adjacent BESS enclosure (e.g. 3.9 m) and located no closer than 0.9 m to the wall of BESS unit.
- 4.1.40 Impact of Vegetation: NFPA 855 recommends at least 3m between the BESS enclosure and vegetation and other combustible growth. Internally this is satisfied at Kirkby and the ground on site is predominantly gravel and no vegetation is proposed. The site is surrounded on three sides by scrubland, and it is proposed that the provision of a - hour fire rated wall will mitigate against the threat posed by wildfire.
- 4.1.41 Power Conversion Subsystems (PCS): The PCS comprises of an inverter, distribution equipment and transformer. NFPA 855 has no guidance for separation distances between the PCS and the BESS and separation distance are subject to the manufacturer's recommendations. Typically, this is based on the guidance given in IEC 61936- 1, Power Installations Exceeding 1kV AC and 1,5 kV DC. Similarly, the separation distance between the PCS and the site boundary will be dependent on the type of transformer associated with the PCS. Siting of the PCS from the boundary will be in accordance with the manufacturer's recommendations.
- 4.1.42 Auxiliary Transformer Separation distances for the ancillary transformers will be as per the manufacturers recommendations and will be developed in full accordance with their requirements. Typically, this is as per the guidance in IEC 61936-1, Power Installations Exceeding 1kV AC and 1,5 kV DC and / or NFPA 850 as appropriate.
- 4.1.43 Switchgear Building and Control Room The distance between BESS and the Switchgear Building and the Control Room shall be a minimum of 3 metres as per the recommendations given in NFPA 855, where the wall of the building is not a minimum of 60 minutes fire rated.
- 4.1.44 Separation distances between the buildings and the adjoining notional boundary will be designed in accordance with the guidance given in BS 9999. 6. Battery Control Systems

- 4.1.45 Additional consideration has been given to the UK National Fire Chiefs Council (NFCC) 'Grid Scale Battery Energy Storage System planning – Guidance for FRS (2023)' by also allowing for the following:
- 4.1.46 To protect BESS enclosures from exterior risks, they are provided with impact protection to prevent damage to battery enclosures by vehicles or construction equipment and use Damage Limiting Construction (DLC) techniques.
- 4.1.47 The BESS enclosure has an internal fire resistance rating of at least one hour (according to NFPA 855, BR 187 and FM Global Datasheet 5-33).
- 4.1.48 It is proposed that the site will be connected to the water main, serving the statutory hydrant located on Coopers Lane, via a spur, subject to approval from the Water Authority. The existing flow rates are to be confirmed, as part of the Water Authority application process, but as the existing hydrant system also serves the adjoining Knowsley Industrial Park, it should be sufficient in flow rate and pressure for the BESS site. The new site hydrant will be designed in accordance with BS 9990 Non automatic fire-fighting systems in buildings. Code of practice. The location of the hydrant will be in such a manner that all BESS and ancillary facilities will be within 90m of the hydrant.
- 4.1.49 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

- 4.1.50 Battery enclosures will house the battery systems, electrochemical components and associated equipment. They will be mounted on a concrete foundation.
- 4.1.51 The BESS enclosure will be installed by a certified and qualified installer. The BESS enclosure will be UL9540 certificated. Ingress protection testing of BESS enclosures is conducted under UL9540 and/or IEC62933-5-2 certification of any BESS system. Typical BESS enclosure ingress protection levels are IP55 / NEMA 3R or IP66 / NEMA4. 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.
- 4.1.52 Ingress Protection (IP) ratings of BESS containers will be shared with MFR 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.
- 4.1.53 The BESS enclosures will be locked to prevent unauthorised access and, will have an internal fire resistance rating of at least one hour (according to NFPA 855, BR 187 and FM Global Datasheet 5-33).
- 4.1.54 The BESS enclosure walls will have a minimum one-hour fire resistance rating to BS EN 13501-2 and BS EN 1364-1 standards.

Fire Detection and Suppression

- 4.1.55 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:

- 4.1.56 Thermal monitoring of the battery containers and automated cut-out beyond safe parameters
- 4.1.57 Battery cooling systems with automated fail-safe operation
- 4.1.58 Emergency Stop – both remote and local
- 4.1.59 The fire and gas detection system for the Scheme will comply with NFPA 855 (2023) and NFPA 69. This means that smoke, fire and gas detection equipment will be installed on site. The gas detection systems will have external BESS beacon and audible alert facility. The final fire 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 MFR.
- 4.1.60 The BESS fire suppression system will conform to NFPA 855 (2023) guidelines, and the suppression system will be tested to UL 9540A latest standard or significant scale third party fire and explosion testing. Fire suppression system performance will be benchmarked against free burn testing. An independent Fire Protection Engineer specialising in BESS will be contracted by the Operations, Engineering and Maintenance Contractor to review all UL 9540A test results and any additional fire and explosion test data which has been provided and validate the suppression system design.
- 4.1.61 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.
- 4.1.62 Energy Storage Management Systems / Battery Management Systems (ESMS / Battery Management System (BMS) controls will follow NFPA 855 (2023) recommendations (new IEC and IEEE standards are being drafted). Battery system data analytics will be integrated into ESMS / BMS systems and controls which reduces Thermal Runaway risks. Data Analytics can also be used to predict accurate End-of-Life timeframes and provide operator maintenance alerts.
- 4.1.63 Other measures to minimise the risk of a fire event that could be implemented include:
 - As a minimum, a BESS ventilation system will comply with NFPA 855 (2023) / NFPA 69 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. 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.

- 4.1.64 The BESS enclosure is designed to withstand overpressures generated by the battery system during thermal runaway. An explosion prevention system to NFPA 69 standards and / or explosion protection system to NFPA 68 and BS EN 14797 standards will be integrated. The BESS design will integrate explosion protection systems i.e. deflagration panels. At the time of writing manufacturers information has been requested for review against performance validated through BESS free burn testing and requisite pressure testing required by NFPA and EN standards. Further, the BESS enclosure will have completed UL 9540A unit and / or installation 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 will review all UL 9540A test results and any additional fire and explosion test data which has been provided.

4.2 Safe BESS Construction

- 4.2.3 The BESS will be constructed in 2 distinct phases. Firstly, the civil works and balance of plant equipment would be started. Then at a suitable point the BESS equipment would be delivered to be installed on the foundations and connected to the balance of plant.
- 4.2.4 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.
- 4.2.5 The transportation of the system from the factory will be a combination of sea and land freight. The system is certified for transportation in all potential environmental conditions. The equipment will be certified for transport to UN 38.3. Transportation will be managed in accordance with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2019 and the UK guidance on the transport of dangerous goods "Moving dangerous goods, Guidance" Government webpage (Ref 1- 4).
- 4.2.6 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 standards. Site Acceptance Tests (SAT) will follow IEC 62933-5-2 and IEEE 2962 (in development) standards and protocols.
- 4.2.7 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

- 4.3.3 The BEA 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) defines the minimum monitoring and control standards.

- 4.3.4 Staff will be fully trained and familiar with the BESS technologies and will be responsible for alerting MFR and for connecting MFR with BESS incident Subject Matter Experts (SMEs).
- 4.3.5 The 24/7 control facilities will have the capability to immediately shut the system down should an incident occur, and the need arise. It will also implement the ERP, acting as a point of contact to the emergency services.
- 4.3.6 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 remote facility (24/7). 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 MFR and is secured through this document.
- 4.3.7 The control room will also be responsible for the security of the Site with state- of-the-art detection and monitoring systems. These can be repurposed in an emergency to support first responders.
- 4.3.8 Signage will be installed in a suitable and visible location on the outside of the BESS units, identifying the presence of a BESS system. Signage will be as per NFCC guidelines and will also include details of:
- 4.3.8.1.1 Relevant hazards posed i.e., the presence of High Voltage DC Electrical Systems is a risk, therefore their location should be identified.
 - 4.3.8.1.2 The type of technology associated with the BESS.
 - 4.3.8.1.3 Any suppression system fitted.
 - 4.3.8.1.4 24/7 Emergency Contact Information.
 - 4.3.8.1.5 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

- 4.3.9 The control and safety system will provide an effective and appropriate method of early detection of a fault of the batteries and consequent disconnection shall be provided when normal voltage or temperature limits are exceeded. Such limitation or disconnect would be alerted to the control room.
- 4.3.10 NFPA 855 (2023) 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.
 - 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.

- 4.3.11 The BMS should, at minimum, incorporate NFPA 855 (2023) monitoring and control features. Three new IEEE standards are in development (IEEE P2686, IEEE P2688 and IEEE P2962) which cover BESS data analytics, electrical controls and maintenance/replacement of battery components/systems. These standards should be adopted by the BESS system provider once the standards are published. (at draft stage at time of writing)
- 4.3.12 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, UL 1741, IEEE 1815, and IEEE 1547.3 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.
- 4.3.13 UL published 'UL 2941 (2023) Outline of Investigation for Cybersecurity of Distributed Energy and Inverter-Based Resources'. 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

- 4.3.14 The BESS will be monitored by the on-site control systems as well as being monitored 24/7 by a remote - control room. The control room will have the ability and authority to immediately shut BESS down should the need to do so arise. It will also be responsible for contacting the emergency services and relaying information to attending first responders.
- 4.3.15 The Scheme 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.
- 4.3.16 The site security profile will be assessed by an on-call team with dedicated service level agreement in place with input from all local key safety stakeholders. The package of security measures will be agreed with this stakeholder group.
- 4.3.17 The exact operations will be developed as part of the Emergency Response Plan and the Battery Storage Safety (Operational) Management Plan.

Maintenance

- 4.3.18 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.
- 4.3.19 Routine maintenance will be undertaken on the BESS equipment under the guidance of the OEM Maintenance Manual.
- 4.3.20 All maintenance and operations will be undertaken in a carefully controlled manner following the Site safety rules and in accordance with the Operational Environmental Management Plan (OEMP) document which will be produced prior to operations.
- 4.3.21 During operation of the BESS facility, 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 or battery monitoring systems will not be stopped or taken out of service without appropriate mitigation, following the system being made safe so far as reasonably practicable, and only for the minimum time required to undertake any specific maintenance tasks.
- 4.3.22 The operation of the BESS will be managed in accordance with the OEMP.

End of life/Disposal

- 4.3.23 With regards to the decommissioning of the BESS, it will be confirmed with the manufacturer and site operator within the Emergency Response Plan that they will comply with all the requirements of the Waste Batteries and Accumulators Regulations 2009 (as amended) and pursuant to the Waste Batteries and Accumulators Regulations 2009 (or such equivalent regulations in force at the time of decommissioning) (Ref 1-5) it has certain obligations in respect of battery disposal.
- 4.3.24 All components replaced during the defects notification and warranty period will be taken back and recycled.
- 4.3.25 The Applicant will follow the hierarchy of waste management through the life of the Scheme as follows:
- Reduce – the 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.
- 4.3.26 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 1-6).
- 5.1.2 The Fire Service Manual stipulates that in all cases involving electrical apparatus, it is essential to ensure, on arrival, that the apparatus is electrically isolated and safe to approach. This should be carried out by the operator at the premises concerned. It is strongly advised that electrical or associated equipment should not be touched or even approached unless it is confirmed to be isolated and safe.
- 5.1.3 In the event of a fire, the battery system and the transformers serving the BESS will be automatically electrically isolated when a fire is detected within a container. However, the batteries within the containers will still hold charge in the event of a fire, even after the electrical system is isolated. It will not be possible to confirm that there is no residual risk from the energised batteries within the container, and this will inform the strategy for firefighting in the emergency plan.
- 5.1.4 A dedicated fire detection and suppression system is provided within each BESS container this will be designed to control or fully suppress a fire, without the direct intervention of MFR.
- 5.1.5 The Applicant has engaged with Merseyside Fire and Rescue (MFR), and awaits any design recommendations they may deem appropriate. However, in the meantime, it can be confirmed that all phases to date and those planned for the future have been based upon the NFCC (National Fire Chiefs Council) guidance for grid-scale battery energy storage systems.

5.2 Fire Service Access

- 5.2.1 Roadways will be sized for fire and rescue pumping appliances and will exceed the guidance given in Table 20 of *BS 9999 Fire safety in the design, management and use of buildings - code of practice*.
- 5.2.2 With the site being land locked by adjoining National Grid land, a second access route is not possible, as all access routes would need to be via the Coopers Lane entrance. Given the very small area of the BESS site of 4,451 m², the provision of two entrances is not considered necessary to allow effective firefighting operations. It is noted that no recommendations to provide a second entrance are given in the guidance of NFPA 855 or BS 9999.
- 5.2.3 The roads on site are to be tarmac or other hard-wearing surfaces that will be capable of accommodating vehicles, including fire and rescue service vehicles, in all weather conditions. The internal roadway will include the provision of a hammerhead meeting the guidance given in BS 9999 for the use of fire and rescue vehicles
- 5.2.4 Road networks on sites will enable unobstructed access to all areas of the BESS facility.
- 5.2.5 The Fire Service Vehicle access is provided to all parts of the site within 25m hose distance of parking positions on the site.

- 5.2.6 A hammerhead is included in the roads on site to provide suitable Fire and Rescue Service vehicle access.

5.3 Fire Water

- 5.3.1 The BESS scheme will integrate both internal Fire Suppression System (primary containment) and external firefighting water capture drainage (secondary containment). Pollution analysis will be conducted before removing from site (if polluted) or releasing into drainage systems, if safe to do so. Internal Fire Suppression System will be gaseous thus eliminating water run-off from this source.
- 5.3.2 Endeavours are being made to determine if a hydrant can be provided to the site, spurred off the existing main located on Coopers Lane. Access to all parts of the site would be possible within 90 m of the hydrant. The existing flow rates are to be confirmed, as part of the Water Authority application process, but as the existing hydrant system also serves the adjoining Knowsley Industrial Park, it should be sufficient in flow rate and pressure for the BESS site
- 5.3.3 The new site hydrant will be designed in accordance with BS 9990 Non automatic fire-fighting systems in buildings. Code of practice. The location of the hydrant will be in such a manner that all BESS and ancillary facilities will be within 90m of the hydrant.
- 5.3.4 In addition to the hydrant, it was also proposed to provide a circa 51m³ water attenuation storage tank, located underground beneath the access road, with a fire-fighting connection; however Pearl was advised on the 12th of March in writing that this had been removed from the design.
- 5.3.5 Signage of hydrants and inlets will be provided onsite and detailed in the Emergency Response Plan to allow rapid identification
- 5.3.6 The Illustrative Site Layout Plans for the site show the locations of firefighting water
- 5.3.7 The following requirements from the NFCC guidance will also be taken into account:
- Site and BESS design principles and ERP content will ensure that the FRS are expected to employ a defensive strategy i.e., only boundary cooling should be employed for cooling of adjacent BESS or associated supporting equipment.
 - A 60-minute firewall is proposed along the site boundary.

5.4 Emergency Planning

- 5.4.1 A Risk Management Plan shall be developed with MFR 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. Establish response times and site arrival protocols.

- The adequacy of proposed fire detection and suppression systems e.g., water supply on-site.
- Natural and built infrastructure and on-site processes that may impact or delay effective emergency response i.e., firefighting water runoff capture.

5.4.2

Further information which is anticipated to be shared with MFR to establish a risk profile for first responders, is listed below:

- Battery chemistry integrated into BESS – can provide fire and explosive risk profile.
- Battery form factor (prismatic in this case).
- Battery energy Wh / kWh – confirmation of new vs second life cells.
- 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.
- 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 – module or rack level 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 design e.g., container or cabinet, gas exhaust / ventilation features, deflagration vent design features, BESS enclosure level fire protection & suppression system details (proof of testing with BESS design + 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 containers/cabinets on site.
- Size and MWh capacity of each BESS unit.
- 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, LFR equipment & assets, water supply locations and capacity, drainage, and water capture design.
- Definition and frequency of BESS equipment testing and maintenance requirements.
- 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 LFR).
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 (CO₂), Carbon Monoxide (CO), Hydrogen (H₂), VOC off gas and overpressure and 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 + MFR engagement (site familiarisation + training drills) and SME engagement (fire protection experts or battery experts)
- Other documentation as required by specific BESS project i.e., local response stipulations, contact information for nominated response personnel, community contacts, etc.

5.4.3 An ERP will be developed post planning consent to facilitate effective and safe emergency response. It will follow UK National Fire Chiefs Council (NFCC) and NFPA 855 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:
 - Site access points, internal roads, agreed access routes, observation points, turning areas, etc.
 - Firefighting facilities (water, pumps, booster systems, fire hydrants, fire hose reels etc.).
 - Water supply locations and capacity.
 - Drainage and water capture design and locations.
- Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eyewash and shower facilities; spill containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid.
- Up-to-date contact details for facility personnel, and any relevant off-site personnel that could provide technical support during an emergency.
- A list of dangerous goods stored on site.

- Site evacuation procedures.
- Site operation Emergency Management protocols - four 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.
- 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.

Operational Management

5.4.4 Battery Storage Safety (Operational) Management Plan Kirkby BESS site will have a detailed Battery Storage Safety (Operational) Management Plan that includes:

- The site hazards and risks and their proposed management.
- Any infrastructure that may impact or delay the emergency response.
- Access to the facilities on site for emergency vehicles and responders.
- The proposed fire detection and suppression systems on site.
- Proposed maintenance requirements and responsible persons / entities.
- Decommissioning and safe transport / storage of decommissioned batteries.
- Security requirements and response plans

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

5.5.3 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 units and supporting equipment to prevent the fire from spreading. This strategy will be finalised with the MFR and be clearly communicated in the ERP.

5.5.4 Based on the factors of distance to the nearest property and the short-term nature of a fire incident, the assessment concludes that there will not be adverse effects at the closest receptor locations as a result of a BESS thermal runaway incident.

5.5.5 Notwithstanding, whilst there is low risk of adverse effects at the closest receptors, the emergency response plan (ERP) produced at the detailed design stage will incorporate all necessary emergency response procedures and actions based upon thermal runaway test data supplied by the BESS system provider.

Firewater Run-off

- 5.5.6 The client, as the site operator, understands their legal obligations to ensure measures are in place to prevent contaminated fire water run-off from entering the watercourse under legislation such as Environmental Damage (Prevention and Remediation) Regulations 2009.
- 5.5.7 The site is designed to minimise the risk of fire water runoff entering the water table. Water on site is collected in concrete apron bunds below the BESS units with a gravel layer and the water then runs into the water attenuation storage tank. Excess water can then be removed safely or if tested and uncontaminated released to the drainage system. This is subject to development as part of the Emergency Response Plan.
- 5.5.8 The drainage design has been risk assessed by a specialist for its suitability.

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 Battery Safety Management Plan, will reflect the latest BESS safety codes and standards applicable at that stage. Mitigation measures will be discussed and coordinated with MFR.
- 6.1.3 A Failure Modes and Effects Analysis (FMEA) 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.
- 6.1.4 Comprehensive Hazard Mitigation Analysis (HMA) will be conducted by a BESS specialist independent Fire Protection Engineer following NFPA 855 (2023) guidelines and recommendations, and form part of the Fire Risk Management Plan.
- 6.1.5 Additional risk assessments conducted at the detailed design stage are Fire Risk Analysis (FRA), Explosion Risk Analysis (ERA), Hazard and Operability Analysis (HAZOP) forming part of the overall fire strategy.
- 6.1.6 The detailed design phase will determine the approach to addressing the following specific requirements, which will be updated prior to construction of the BESS and submitted to the local planning authority as a detailed BSSMP prior to the commencement of construction. The detailed BSSMP must include:
- The detailed design, including drawings of the BESS;
 - A statement on the battery system specifications, including fire detection and suppression systems;
 - A statement on operational procedures and training requirements, including emergency operations;
 - A statement on the overall compliance of the system with applicable legislation;

- An emergency response plan (ERP) covering construction, operation and decommissioning phases developed in consultation with Merseyside Fire and Rescue (MFR), to include the adequate provision of firefighting equipment on- Site.

6.1.7 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.

6.1.8 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 document provided by the manufacturer or site operator and form part of the ERP.

7. Conclusion

7.1 Summary

- 7.1.1 The Applicant is committed to developing a safe BESS that will provide long dependable operation. It is in everyone's interest that the selected BESS technology is robust, in particular with regards to safe operation.
- 7.1.2 This report demonstrates that, the Applicant has relevant experience of BESS systems; that the relevant stakeholders have been consulted (and their responses have informed the design of the Scheme), and therefore safety will be inherent in the overall design, minimising the risk of a fire event occurring, and reducing the impact of such an event should it occur.