WHITESTONE
solar farm

WHITESTONE SOLAR FARM

Volume 5 - Reports and Statements

5.15: Outline Battery Safety Management Plan

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Glossary

Term	Meaning
Development Consent Order (DCO)	A statutory order made by the relevant Secretary of State pursuant to The Planning Act 2008 to authorise a Nationally Significant Infrastructure Project which provides consent for the project and means that a range of other consents, such as planning permission and listed building consent, will not be required. A DCO can also include rights of compulsory acquisition.
Long Lane 400kV Substation	The new 400 kilovolt National Grid substation proposed on land immediately east of Long Lane, Brinsworth, S60 4JJ.
National Grid Brinsworth Substation	The existing 275 kilovolt substation at Brinsworth, located on Howarth Lane, Brinsworth, S60 5LW
The Applicant	Whitestone Net Zero Ltd
The Proposed Development	The proposed Whitestone Solar Farm.
The Site	The land planned to be used for solar PV array and associated infrastructure, BESS, substations, and landscaping and habitat enhancement. The Site is split into W1, W2, and W3.
Whitestone 1 (W1)	The northern parcels of the Whitestone Solar Farm.
Whitestone 2 (W2)	The middle parcels of the Whitestone Solar Farm.
Whitestone 3 (W3)	The southern parcels of the Whitestone Solar Farm.

Acronyms

Acronym	Meaning
AC	Alternating Current
BESS	Battery Energy Storage System
BMS	Battery Management System
BS	British Standards
BS EN	British Standards European Norm
CCTV	Closed-Circuit Television
CFD	Computational Fluid Dynamics
CO2	Carbon Dioxide
COSHH	Control of Substances Hazardous to Health
DC	Direct Current
DNO	Distribution Network Operator
DNV	Det Norske Veritas
DRA	Design Risk Assessment
EA	Environment Agency
EMS	Energy Management System
EN	European Norm
ERP	Emergency Response Plan
E-Stop	Emergency Stop
ESS	Energy Storage System
FAT	Factory Acceptance Testing

Acronym	Meaning
FACP	Fire Alarm Control Panel
FRA	Fire Risk Assessment
FRS	Fire and Rescue Service
HAZID	Hazard Identification Study
HMA	Hazard Mitigation Analysis
HMI	Human Machine Interface
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
IEC	International Electrotechnical Commission
ITP	Inspection Test Plan
LFP	Lithium Iron Phosphate
Li-Ion	Lithium-Ion
LPS	Loss Prevention Standard
MSDS	Material Safety Data Sheets
MW	Mega Watt
MWh	Mega Watt hour
NFCC	National Fire Chiefs Council
NFPA	National Fire Protection Agency
NG	National Grid
ODEMP	Outline Decommissioning Environmental Management Plan
OEM	Original Equipment Manufacturer
PCS	Power Conversion System
PHAST	Process Hazards Analysis Software Tool
PPE	Personal Protective Equipment
PTW	Permit To Work
RRO	Regulatory Reform Order
SAT	Site Acceptance Testing
SoC	State of Charge
SoH	State of Health
SSRI	Site-Specific Risk Information
SuDS	Sustainable Urban Drainage System
T&D	Transmission and Distribution
TSO	Transmission System Operator
UL	Underwriters Laboratories
VESDA	Very Early Smoke Detection by Aspiration

EXECUTIVE SUMMARY

ES1 This Outline Battery Safety Management Plan (oBSMP) identifies the fire safety risks for the Battery Energy Storage System (BESS) installation, located in South Yorkshire between Rotherham and Doncaster and connecting into the National Grid at the new National Grid substation at Brinsworth (Long Lane 400 kV Substation). The BESS development is hereafter referred to as the 'BESS Site'. The extents of the BESS Site is confirmed through the associated Works Areas; however, the detailed BESS design, supplier and associated equipment will be known at a later date following the procurement process. This oBSMP has been developed to support the Development Consent Order (DCO) Application for the Proposed Development and will outline the safety objectives, BESS failure modes, relevant guidance (standards), BESS safety requirements, firefighting consultation and guidance, and preconstruction information requirements planned for the BESS Site.

ES2 The impact of a fire event can be mitigated through a range of safety measures. This report will outline the layered security approach taken in regard to fire safety.

ES3 To ensure the safety of the overall system, various levels of fire detection and suppression mechanisms have been incorporated. These mechanisms have been designed to promptly identify and mitigate any potential risk of thermal runaway and the conditions that may lead up to it. In the unlikely event that a fire does occur, the spacing and location of the units have been carefully considered to eliminate any possibility of fire spreading between units, ensuring the situation does not escalate. BESS units shall be selected that are designed to self-contain fire risks. The emphasis of fire prevention and mitigation in design underpins Whitestone Net Zero Ltd. (hereafter 'the Applicant') commitment to maintaining the highest safety standards.

ES4 Should a fire occur, the BESS Site shall incorporate appropriate and robust fire and gas detection and suppression systems validated through Design Risk Assessments (DRA) and proven by testing at component level. It shall effectively contain the fire, off gassing, and minimise the possibility of thermal runaway and reignition. Exhaust and ventilation shall purge heat, gas and smoke during an emergency. The Fire Alarm Control Panel (FACP) located at each battery unit or group of units, will be connected to the Main/Central FACP within the control room, and shall direct attending fire service personnel to the affected location should the Local Fire Service require this. Information and guidance will be provided to assist the local Fire and Rescue Service (FRS) response and minimise any potential damage.

ES5 The local FRS shall be involved and informed on the final BESS design, means of containment and BESS Site layout, and shall be notified of any changes that impact fire safety as soon as possible. BESS Site access points, internal BESS Site roads, water sources, onsite water storage for fire service use, and any other information that may assist the fire service to assess the BESS Site fire risk shall be detailed in the pre-fire plan and passed onto the fire service during the detailed design stage of the project. The current BESS Site design has 4 water storage tanks with a capacity of 120,000l of water each, total of 480,000l (capable of supplying 25 litres per second (l/s) for 2 hours or 180,000 litres). The proposed tank will have an approximate diameter of 10m.

ES6 The risk of rapid combustion and explosion of cells will be mitigated by selecting BESS units that are designed to self-contain fire risks and proven by testing at a

component level. If an alarm is raised, the alternating current (AC) power will be automatically disconnected, however emergency responders should be aware of the risk of electric shock when using water to contain the fire. Exposed cables should be treated as “live”. Appropriate personal protective equipment (PPE) must be worn to prevent exposure to any hazards present.

ES7 The BESS Site will be unmanned during normal operation except during regular inspections and maintenance procedures. The BESS Site will be remotely monitored 24/7. An emergency information pack, where material has been agreed with the local FRS, shall be accessible to fire responders at BESS Site emergency access points. The BESS Site will be easily accessible for emergency vehicles via access routes verified by a swept path analysis. There are no dead-end access routes within the BESS Site.

ES8 Should water be used for firefighting, the firefighting water shall be collected by an appropriate drainage design under the units to prevent the release of polluted water.

ES9 In addition, the oBSMP commits the applicant to prepare an Emergency Response Plan (ERP) that will provide information that supports operators and the FRS in effectively responding to an incident at the BESS Site. It shall include information such as BESS Site plans, contact information, infrastructure details and emergency procedures and is required by National Fire Chiefs Council (NFCC) guidance. The plan will be shared for construction, operation and decommissioning.

ES10 The proposed design in this document shall be based on proven battery technology and adheres to the latest available safety guidance and relevant standards. Following the award of planning permission, a competitive tendering exercise will be undertaken to select a battery technology that includes rigorous fire safety protection and standards. Once the technology has been selected, the BESS Site will undergo further refinement to accommodate the specific technology, which is referred to as the detailed design stage. The technology information will be updated as the design progresses to reflect the selected solution, including detailed safety considerations, mitigations and specifications, to ensure the fire service can undertake a meaningful review.

ES11 The oBSMP and ERP will be reviewed regularly both prior to commencement of the development and during the operational period, and the fire service shall be consulted on the detailed Battery Safety Management Plan. The FRS shall be notified of any changes that would impact their response.

1 INTRODUCTION

1.1 SCOPE OF DOCUMENT

1.1.1 This outline Battery Safety Management Plan (oBSMP) has been prepared on behalf of Whitestone Net Zero Ltd ('the Applicant') in relation to the Development Consent Order (DCO) Application for the construction, operation, maintenance, and decommissioning of Whitestone Solar Farm (hereafter referred to as the 'Proposed Development').

1.1.2 This document specifically examines the fire safety risks associated with the BESS Site. In particular, it considers risks which will occur during the operation and maintenance phase. It aims to consider the National Fire Chiefs Council (NFCC) guidance document on fire safety for grid-scale BESS projects and other best practice fire safety standards and recommendations[1].

1.1.3 The proposed design **ES Figure 5.1: Illustrative Masterplan [EN0110020/APP/6.19]** shall use proven battery concepts which comply with current applicable safety guidance and relevant standards. After the DCO has been granted, a competitive bidding process will be conducted to select a battery technology that ensures fire and battery safety. Subsequently, the BESS Site will undergo adjustments to accommodate the technology in what is referred to as the detailed design stage.

1.1.4 Risks during construction are considered to be standard for a construction project and will be addressed in the **Outline Construction Environmental Management Plan [EN0110020/APP/5.9]** and covered in relevant BS/IEC standards using construction industry standard techniques.

1.1.5 Risks associated with ancillary equipment required to connect the BESS to the electrical network are considered to be standard for Transmission and Distribution (T&D) equipment and shall be addressed in the Employer's Requirements and covered in relevant BS / IEC standards using standard T&D techniques and in conjunction with the Distribution Network Operator (DNO) / Transmission System Operator (TSO) requirements.

1.1.6 This document will summarise the safety considerations already accounted for in the design of the BESS Site, inviting the local Fire and Rescue Service (FRS) to review and comment. The FRSs will be invited to review this draft oBSMP. A detailed battery safety management plan (BSMP) for the BESS Site will be produced following grant of the DCO, appointment of a contractor(s), and prior to the start of construction of the BESS Site. The detailed BSMP will be prepared in accordance with this oBSMP as a requirement of the DCO. The detailed BSMP will be approved by the relevant local planning authorities following consultation with the FRS, prior to the commencement of works for the BESS.

1.2 Project Description

1.2.1 The Proposed Development involves the construction, operation and maintenance, and decommissioning of more than 100MW of solar photovoltaic (PV) array, Battery Energy Storage System (BESS), onsite substations and supporting infrastructure, and grid connection infrastructure. The grid connection infrastructure would connect the Proposed Development to the National Grid at the new National Grid substation Brinsworth (Long Lane 400kV

Substation), located east of Long Lane, Rotherham. National Grid has applied to Rotherham Metropolitan Borough Council for the development of this new substation which is intended by National Grid to be operational in time for the Proposed Development to connect in 2029. This substation is therefore not included in the Proposed Development and will be subject to a separate planning application taken forward by National Grid.

1.2.2 It is anticipated that the BESS Site will comprise the construction of battery units and MV skids to allow for the creation, storage and exportation of energy to the National Grid, with associated access, landscaping and other infrastructure works within an area of approximately 12ha. Further details will be provided in **ES Chapter 5: The Proposed Development [EN0110020/APP/6.5]**.

1.2.3 Associated equipment for the BESS Site includes electrical cables, electrical metering, substations, transformers, circuit breakers, current and voltage transformers etc. The associated equipment can be considered as mature and closely similar to equipment which has been in use for many years in the UK electrical transmission and distribution network. All such associated equipment will be installed, operated and maintained in strict accordance with established electricity industry standards and guidelines including, but not limited to, BS 61936-1[2].

1.2.4 The BESS installation itself shall use lithium-ion (Li-ion) battery technology with Lithium Iron Phosphate (LFP) chemistry or an improved technology available at the time of installation.

1.2.5 A proposed general arrangement for the BESS Site is provided in **Figure 1.1**. This could be subject to change if an alternative battery supplier is chosen when the design is finalised, and in accordance with the requirements of the DCO, the detailed design of the Proposed Development will be undertaken in accordance with the **Outline Design Parameters [EN0110020/APP/7.3]**.

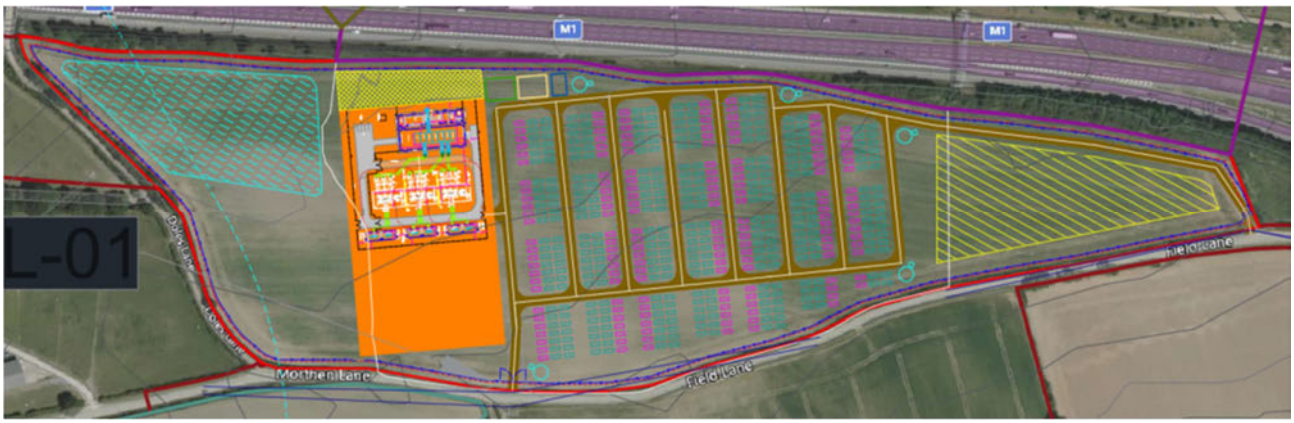

Figure 1.1: Proposed Concept BESS and Substation Layout

2 BESS SAFETY

2.1.1 Safety considerations underpin the site design and equipment procurement in order to minimise the fire risk and reduce propagation pathways as far as reasonably practicable. Reviewing a range of best practice, stringent Applicant requirements and lessons learnt from previous projects, the design methodology has made every effort to reduce the risk of fire spread.

2.1.2 Firstly, equipment selection reduces the likelihood of fire propagation and equipment separation further reduces the risk of fire spread within the BESS Site. If fire does propagate, at least two BESS Site access points allow for unimpeded access to the BESS Site and firewater tanks / hydrants to ensure that the FRS are within a suitable distance of water. The BESS Site satisfies the NFCC guidance and industry leading standards, as detailed later in Section 4.3.

2.1.3 As per Applicant requirements, a Fire Risk Assessment (FRA) will be developed at a later design stage, this will be underpinned by a Hazard Mitigation Analysis. This report shall be approved by the local planning authority, following consultation with local FRS and agreement with the Applicant prior to the manufacture of the BESS. A clear fire response strategy will be developed with the local FRS and a copy kept on the BESS Site at suitable locations including all access points.

2.1 BESS Selection

2.1.1 The section describes the BESS technologies and specific components which make up the BESS, **Table 2.1** outlines the description of each.

Table 2.1: Definitions

Term	Description
Battery Cells	Contains the electrodes, electrolyte and separator / membrane which allow the battery to store energy when submitted to an electrical current. Can have a range of battery chemistries such as lithium-ion.
Battery Module	Battery module which consists of several cells connected in series or parallel.
Battery Rack	A collection of battery modules which are combined to create a rack. These racks tend to be modular so one could be used on its own or multiple racks could be combined to create a larger capacity battery.
Battery Unit	Containerised unit comprising of multiple battery cells, modules, racks, battery management system (BMS) combining to produce a MWh storage capacity. All Battery Units considered for this BESS Site will be liquid cooled.
Power Conversion System (PCS)	PCS converts DC battery power to AC power and vice versa, for connection to the surrounding electrical network. It consists of inverter and associated control systems. Depending on the manufacturer, some PCS units include the inverter transformers within their enclosures, while others are external, located nearby.

Battery Management System (BMS)	The BMS provides the control, monitoring and communications for the batteries as well as controlling any individual module cooling systems.
Energy Management System (EMS)	EMS monitors and controls the flow of energy within the BESS for efficient operation.
Battery Energy Storage System (BESS)	BESS is the overall system, consisting of several Battery Units and PCS, with the BMS and EMS to monitor and control them.
MV Station	Containerised unit comprising of PCS, transformers and ring main units.

2.1.2 The BESS will use Li-ion battery cells. There are multiple variants of Li-ion batteries differentiated by the additives to the material of the cathode. The preferred chemistry for this BESS installation is Lithium Iron Phosphate (LFP). LFP is currently one of the most common chemistries used in grid scale BESS installations. While it has a lower energy density compared to Nickel Manganese Cobalt (NMC), it offers a higher energy density compared to other technologies such as lead-acid and sodium-sulphur and is considered to be safer compared to other chemistries. LFP is a more stable chemistry that is less prone to thermal runaway and overheating issues[3,4].

2.1.3 If a demonstrably similar stable chemistry or a more stable chemistry is commercially available, then this will be considered during procurement, but LFP will constitute the minimum standard for performance. The final chemistry will be confirmed as part of the detailed design prior to the commencement of construction.

Figure 2.1: Example of a Battery Unit

Figure 2.2: Example of an MV Station

2.2 BESS Failure Modes

2.2.1 The main failure modes of Li-ion batteries and the methods of mitigation to reduce the risk are detailed in **Table 2.2**.

Table 2.2: Failure modes and mitigation

Failure Mode	Description	Mitigation
Electrical Failure	An electrical failure can occur if the battery is overcharged, over-discharged, undercharged or charged too rapidly. Insulation faults, short circuit or power surge can also cause damage to the battery. These conditions can cause internal overheating and lead to thermal runaway and eventually fire.	Control systems will continuously monitor battery conditions and utilise automatic circuit breakers to protect equipment during a fault condition.

Mechanical Failure	Mechanical abuse of the battery can be caused by compression and deformation of the battery container, including collision or vibration during transportation or movements around the battery enclosures.	Quality checks on equipment at point of manufacture ensure that components and systems are not damaged prior to shipping. Damage to the battery can be prevented by protecting the internal systems through the robust design of the enclosures. Care must be taken when transporting and installing battery units. Packing and handling shall be in accordance with the manufacturer's guidance. Upon arrival to the BESS Site, units will be inspected to ensure there is no damage prior to further handling and installation. Impact protection barriers might be considered on the BESS Site in key locations. Permit to Work (PTW) procedures, which will mitigate the risk of accidental damage during installation and maintenance, shall be established at the BESS Site. A regular maintenance schedule in accordance with manufacturer / supplier requirements will be developed to identify any damage or defect at the BESS Site and will be performed by experienced personnel.
Thermal Failure	Thermal failure occurs when the BESS is subjected to or is operating at temperatures outside its specified operating range. This can lead to premature ageing of the battery, thermal runaway or even complete failure and result in a fire event. This issue can occur if exposed to external heat sources, overheated adjacent cells and high environmental temperatures.	Chemistry selected shall be LFP technology, with a higher thermal stability which means thermal failure is less likely. Thermal safety measures such as ventilation and cooling of the batteries will be in place to ensure efficient heat dissipation to manage the temperature of the system. Redundant systems ensure cooling system availability is protected in the event of cooling system primary power failure.
Environmental Impacts	Seismic events, extreme ambient temperatures, high wind speeds and high levels of solid or water ingress and damage caused by debris.	The Applicant's approved suppliers list is rigorous in this regard and only adopts robust technologies well within their safety limits. The units will be ingress protection rated to IP55. They shall withstand

		high wind speeds and seismic forces however seismic events are very unlikely in the BESS Site area. The ambient temperatures at the BESS Site are expected to be within the design operating temperature range. The BESS and Whitestone project substations are sited outside of flood zones.
System Faults	Manufacturing defects or failure of the control and instrumentation systems can lead to failure in monitoring the operating environment of the BESS.	Manufacturing faults will be protected by quality processes (Factory Acceptance Tests (FAT), BESS Site Acceptance Tests (SAT) and Inspection and Test Plans (ITP)) as the first line of defence. Faults shall be detected and managed by the Battery Management System (BMS) and the Energy Management System (EMS). The BMS continuously monitors the individual cell condition, measuring its operating parameters and states, such as such as state-of-charge (SoC) and state-of-health (SoH), it also regulates the charge and discharge of batteries and ensures that the battery is within safe operational limits. EMS provides stability, resilience and reliability by communicating with the Power Conversion System (PCS) and BMS to monitor and control the flow of energy within the BESS. It optimises the charge-discharge cycles to guarantee safe operation while highlighting any issues to the operators.

2.3 BESS Safety / Hazards

2.3.1 Should the event of BESS failure occur, hazards associated with the installation are outlined below. Hazard mitigation analysis shall be conducted to provide a record of the decision-making process for fire prevention as required by the Applicant.

2.3.2 **Figure 2.3** shows the bow-tie diagram of the potential conditions and control measures and the potential outcomes and their defence mechanisms.

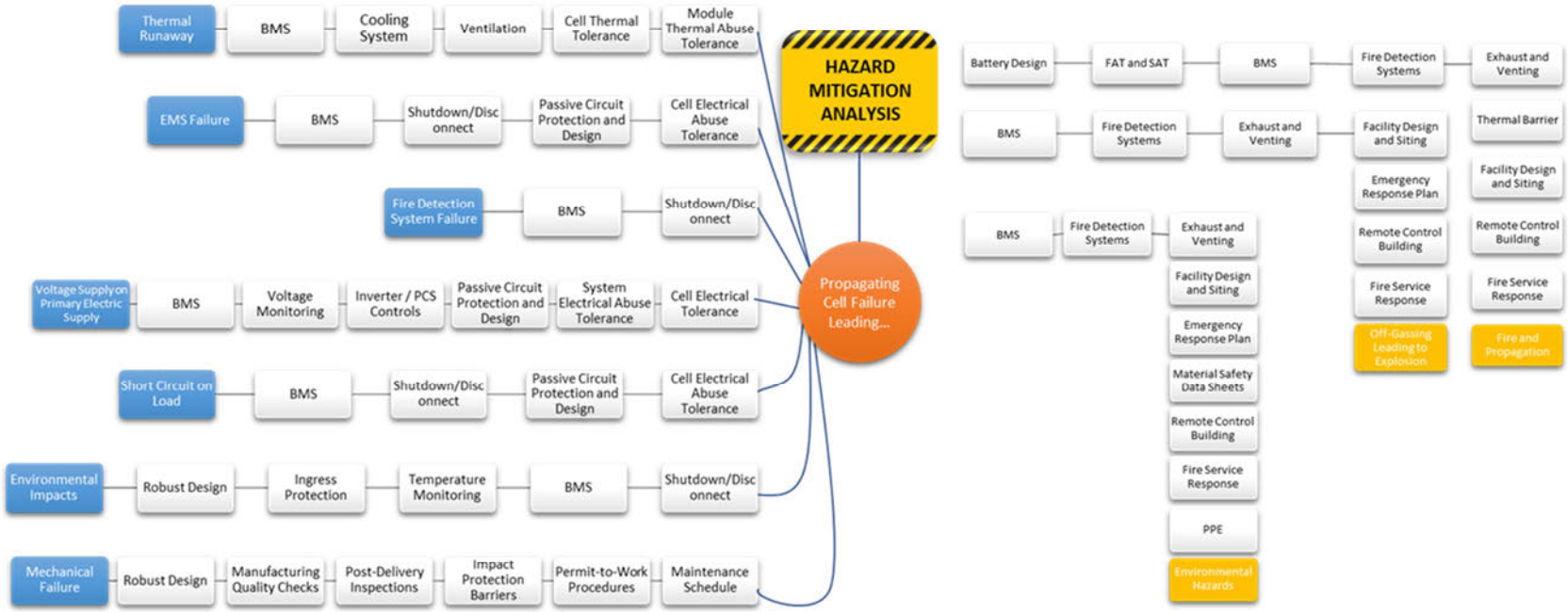

Figure 2.3: Bow-tie diagram for BESS

2.4 Thermal Runaway

2.4.1.1 Lithium-ion batteries have the risk of catching on fire if they overheat or are subject to physical damage or any of the issues highlighted in Section 2.2. If damage occurs, it can result in a short circuit, the battery will heat up to very high temperatures in a process called thermal runaway. As the battery cells rapidly degrade, they can produce significant amounts of heat, off-gassing, smoke and eventually cause it to ignite. If not detected and controlled, it can lead to a fire. If the cell explodes it may affect adjacent cells, damaging them and in turn causing the fire to spread between cells. The rapid overheating occurring during thermal runaway may not be visible compared to conventional fires however it is still detectable by robust temperature and gas detection systems and BMS. The rapid overheating can be detected by temperature detection systems and consequently the affected cell can be shut down before thermal runaway actually occurs to the extent that it would lead to ignition.

2.4.1.2 LFP batteries are less prone to thermal runaway due to being more chemically stable compared to other lithium-ion chemistries. The risk of thermal runaway spreading between batteries can be mitigated by good battery design and ensuring there is adequate spacing between units. UL 9540A details the test method for evaluating thermal runaway fire propagation in BESS. All BESS installed on site shall be tested to this standard and demonstrate that unit level performance criteria are met[5].

2.4.1.3 In the event of a fire, toxic and flammable gases such as carbon monoxide and hydrogen may be released. While smoke and temperature sensors are standard in battery units, it is considered industry best practice to include a gas detection system that can shut down the units upon detection of combustible gas. The potential for the release of dangerous gases is low; however, the risk must be properly mitigated by design and operational controls.

2.5 Combustion Products

2.5.1 Solids

2.5.1.1 Solid, corrosive and toxic post-combustion products may be present on the BESS Site following a fire event. To minimise the likelihood of firefighters encountering these harmful substances, appropriate personal protective equipment (PPE) should be worn. Details on hazardous battery compounds, decomposition by-products and material safety data sheets (MSDS) shall be provided by cell manufacturers.

2.5.2 Gases and Smoke

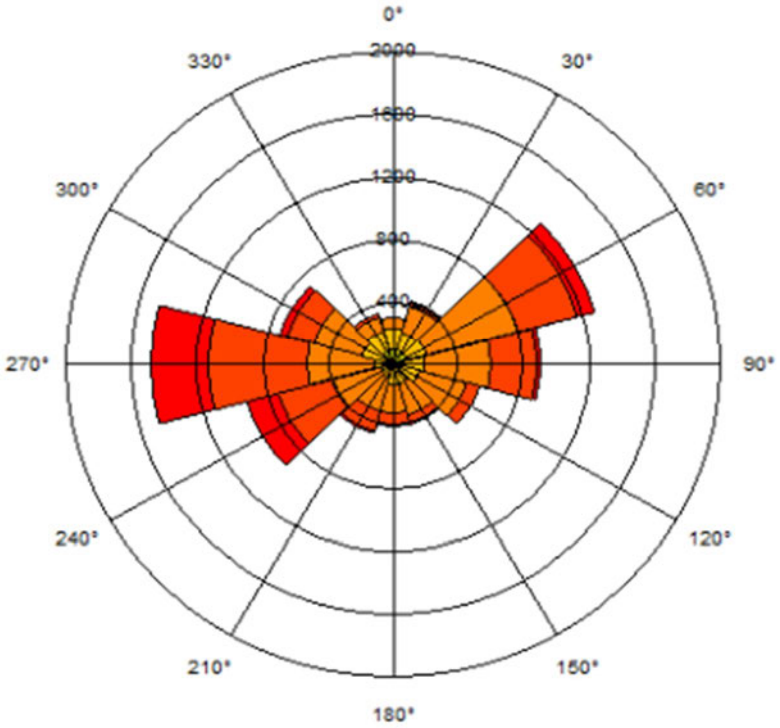

Figure 2.4: Wind rose for the Whitestone BESS Site

2.5.2.1 Smoke can be produced by battery fires and may be a concern to local residents and businesses regarding its toxicity.

2.5.2.2 **Figure 2.4** shows the wind rose for the BESS Site from the **BESS Plume Assessment [EN0110020/APP/7.2]**. The prevailing wind direction for the BESS Site is from the south west, this factor shall be taken into account in the design of the access points for the BESS Site.

2.5.2.3 Dispersion modelling and a risk assessment (Process Hazards Analysis Software Tool (PHAST) or similar) can be carried out, if required. This would be able to provide more detailed information around the potential risks. Modelling from similar projects suggest that the distances to the nearest residential property, approximately 470m west, is sufficient to minimise risk[6,7]. The nearest commercial property is 341m to the west of the BESS Site. However, taking into account the prevailing wind direction, the nearest residential property to the north east is approximately 800m away from the BESS Site.

2.5.2.4 According to the 2017 DNV report OAPUS301WIKO(PP151894)[8], studying the risks when installed inside a building, the levels of toxicity were found to be similar to that of a plastics fire. The toxicity of the battery fires was found to be mitigated with ventilation rates common to many occupied spaces. In an outdoor environment smoke may be better mitigated.

2.5.2.5 A site-specific risk assessment of a potential failure scenarios and any resulting emissions to the air and potential impacts to nearby receptors shall be conducted.

2.5.2.6 The **BESS Plume Assessment [EN0110020/APP/7.2]** has been submitted with the DCO Application and should be read in conjunction with this oBSMP.

2.5.2.7 In line with Section 5.3, there shall be at least two points of access to the BESS Site providing an alternative access route for fire rescue service personnel should smoke restrict one access route. The current design has two access points for the BESS Site.

2.5.3 Electric Shock

2.5.3.1 When an alarm is raised, the battery should be automatically disconnected and isolated from the grid. Should there be damage to any electrical protection equipment, there is a risk of electric shock as the batteries may still hold a residual charge. Responders should confirm if the BESS has been disconnected and treat any exposed cables or equipment as “live”. A controlled burn strategy is expected to be adopted as detailed in Section 5.2 so it is expected that firefighters will only point water jets at battery units adjacent to the impacted unit, as a preventative measure to eliminate propagation, thus reducing the risk of electrocution. Residual charge should not pose an electrical shock risk when firefighting with water but if the fire has damaged electrical protection, it may be a risk if firefighters touch exposed cables.

3 RELEVANT GUIDANCE

3.1.1 There is limited UK specific guidance available at this time for BESS installations. In the absence of UK specific standards or legislation, many insurance companies are now using international standards as guidance combined with best practice both from the UK and around the world.

3.1.2 The Applicant will develop the BESS in accordance with all relevant legislation and good practice such as NFCC guidance. Where any variation occurs, this will be agreed with the local fire service through justified evidence.

3.1.3 **Table 3.1** summarises relevant guidance factored into the BESS safety design. This list is not exhaustive and aims to provide an overview of current guidance.

Table 3.1: Relevant Guidance and Legislation

Standard Identifier	Title	Issued By	Applicability
Grid Scale Battery Energy Storage System planning – Guidance for FRS[1]	Grid Scale Battery Energy Storage System planning – Guidance for FRS	National Fire Chiefs Council. UK	Provides guidance for the fire service on assessing the risk management process of BESS installations and supporting the FRSs in providing consistent and evidence-based contributions to the planning process. The 2026 NFCC document sets out the following guidance compared to the 2022 version: • Reduction in recommended spacing without heat flux / Computational Fluid Dynamics (CFD) analysis; • Reduction in water supply requirements 180,000l of water (1500 litres per minute (l/m) for 2 hours); • Consideration for firefighting tactics "defensively fire fight and boundary cool whilst allowing the BESS to consume itself" which may reduce firewater capture requirements; and • More clear turning / access requirements.
FM Global DS 05-33 July 2024[9]	Property Loss Prevention Data Sheets	FM Global	FM Global is an American mutual insurance company with an Engineering specialism. This data sheet describes loss prevention recommendations for the design, operation, protection, inspection, maintenance, and testing of electrical energy storage systems (ESS) that use lithium-ion batteries. FM Global have identified thermal runaway, electrical fire, and potential for explosion due to insufficient venting as the principal risks for property loss for a BESS system.

NFPA 855[10]	Standard for the Installation of Stationary Energy Storage Systems	National Fire Prevention Association. USA	A new standard was developed by a United States (US) organisation to define the design, construction, installation, commissioning, operation, maintenance and decommissioning of stationary ESS. Provides a general reference for this document and its safety principles are applicable worldwide.
UL 9540A[1]	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	Underwriter's Laboratory. USA	Guidance document applicable to BESS facilities and used to aid the manufacturing and testing process for BESS.
IEC 62619[11]	Safety requirements for secondary lithium cells and batteries	International Electrotechnical Committee. Europe	Specifies requirements and tests for the safe operation of BESS including general safety considerations such as ventilation and temperature management, impact tests and the prevention of over-charging.
IEC 61936[2]	Power installations exceeding 1 kV AC and 1,5 kV DC – AC	International Electrotechnical Committee. Europe	Provides guidance on for inverters and transformers and other equipment associated with BESS.
BS 5839[12]	Fire Detection and Fire Alarm Systems for Buildings	British Standards Committee. UK	Provides guidance on fire detection and alarm systems that will be designed and installed at the BESS Site.
IEC 62281[13]	Safety of primary and secondary lithium cells and batteries during transport	International Electrotechnical Committee. Europe	Provides guidance on the testing and requirements to ensure the safety of BESS during transport as well as the packaging used.
BS EN 15004[14]	Fixed firefighting systems. Gas extinguishing systems	British Standards European Norm. UK	Provides guidance on extinguishing systems.

BS 6266[15]	Fire protection for electronic equipment installations – Code of practice	British Standards Committee. UK	
BS 5306-8[16]	Fire extinguishing installations and equipment on premises – selection and positioning of portable fire extinguishers	British Standards Committee. UK	Provides guidance on type, quantity and location of fire extinguishers.
BS EN 60079-29-2[17]	Explosive atmospheres. Gas detectors. Selection, installation, use and maintenance of detectors for flammable gases and oxygen	British Standards European Norm. UK	Provides guidance on fire and gas detection and alarms
BS EN 12101[18]	Smoke and heat control systems	British Standards European Norm. UK	Provides guidance on smoke and heat venting.
NFPA 204[19]	Smoke and Heat Venting	National Fire Prevention Association. USA	Provides guidance on calculating vent areas for fire safety.
NFPA 68[20]	Explosion protection by deflagration venting	National Fire Prevention Association. USA	Provides guidance on design, installation and maintenance of deflagration vents.
NFPA 69[21]	Explosion prevention systems	National Fire Prevention Association. USA	Covers the minimum requirements for installing systems for the preventions of explosions.
	The Regulatory Reform (Fire Safety) Order (RRO) 2005[22]	UK Government, UK	Governs the fire safety in England and Wales. Applies to almost all non-domestic premises, including commercial buildings and workplaces, ensuring fire safety and reducing the risk of fire.

4 BESS SAFETY DESIGN REQUIREMENTS

4.1 BESS Units

4.1.1 The BESS is designed to be both operated and maintained remotely. During operation, the Site will be remotely managed and visited only for maintenance, inspections, and ongoing land and habitat monitoring and management. Access for operations and maintenance shall be conducted externally and will not require entry into containers.

4.1.2 Planning design has considered a BESS supplier which priorities safety and engineering performance.

4.1.3 The BESS Site will include MV stations. Next to each MV station there will be a land footprint that can accommodate the required number of battery units. Within this footprint the battery units will have appropriate fire rating as per standards in Section 3. The precise number and configuration of units is subject to change as battery technologies are rapidly evolving, however, a preliminary general arrangement is illustrated in **Figure 1.1**.

4.1.4 The final number of battery units is subject to detailed design. It should be noted that the overall footprint will not vary greatly between battery suppliers however the number and therefore capacity of each battery unit can vary.

4.1.5 The batteries will be compliant with testing requirements of UL 9540A Testing the fire safety hazards associated with propagating thermal runaway within battery systems[5] and demonstrates acceptable performance criteria consistent with UL 9540A test results. The Applicant shall provide the certification and evidence that confirms the adherence to the requirements and that testing was undertaken by an approved testing laboratory.

4.1.6 The BESS must be designed, commissioned, and installed at the BESS Site in full accordance with the criteria given in the test. No deviations are permitted.

4.2 System Layout

4.2.1 The BESS system layout provides adequate separation between key components. The BESS will be separated into discrete groupings of battery units and MV skids.

4.2.2 NFPA 855 specifies a minimum separation of 0.9m between BESS groups. NFCC guidance requires 0.9m between BESS units where validated by UL 9540A testing. UL 9540A testing assesses thermal runaway propagation at the cell, module, and unit levels. If unit-level testing meets all performance criteria, shorter separations may be permitted under NFPA 855, and back-to-back installation can be validated. If shorter separation is implemented, evidence of fire safety testing, such as UL 9540A results, should be provided.

4.2.3 Furthermore, compliance with the battery suppliers BESS installation manual is deemed of high importance and should be followed regarding separation distances.

4.2.4 Separation of inverters and transformers will be dictated by the final technology and materials used and will comply with NFPA 855[10] and / or IEC 61936[2], whichever is the most appropriate.

4.2.5 Areas between units and equipment shall be finished with gravel lined with an impermeable membrane and shall be kept free of combustible vegetation or any other material which could act to spread a fire.

4.2.6 According to NFPA 855[10], a minimum separation of 3m (10 feet) will be maintained between BESS groups and the following BESS Site features:

- Public rights of way;
- Site boundaries;
- Buildings;
- Stored combustible materials;
- High piled stock; and
- Any other exposure hazards not associated with electrical grid infrastructure.

4.2.7 The above noted limits may be reduced to 0.914m where testing to UL 9540A has been successfully undertaken.

4.2.8 Comparing two standards, as summarised in **Table 4.1**, the BESS Site has adopted the largest distance in each scenario.

Table 4.1: System Layout Standard Comparison

Item	Manufacturer Guidance	NFPA 855 (section)	FM Global 5-33 (section)	Adopted Distance (Minimum) (subject to industry best practice at time of detailed design)
Battery unit to Battery unit (including back-	N/A	0.914m (9.4.2.2)	1.5m (2.3.2.2)	3m

to-back configurations)				
Battery unit to MV station				3m
MV station to MV station				3m
Battery unit to Battery unit - Group				12m
MV station to MV station - Group				12m

4.2.9 All manufacturers' enclosures have a fire rating of a minimum 1 hour.

4.2.10 The separation distance between combustible vegetation and battery enclosures shall be 3m as stated by the NFCC guidance and by NFPA 855[10]. Vegetation shall be trimmed regularly to ensure they do not grow within the minimum of 3m from the batteries. Further details shall be provided in the **Outline Landscape and Ecology Management Plan [EN0110020/APP/5.13]**.

4.2.11 Please refer to **Figure 1.1** for the proposed BESS Site General Arrangement.

4.2.1 Combustible Materials

4.2.1.1 Combustible materials shall not be stored in proximity to BESS equipment and storage of such material shall be covered in the BESS Site Hazard Identification Study (HAZID) review process.

4.2.1.2 Combustible materials shall be stored at a distance greater than 3m from the BESS equipment stated by NFPA 855[10] and shall be permitted to be reduced to 0.9m with a 1-hour fire barrier. Suitable storage facilities shall be provided for consumables, maintenance tools and other equipment at the BESS Site.

4.3 Safety Design Features

4.3.1 The BESS and all associated equipment shall be designed to comply with all applicable standards and good engineering practice at the time of design and implementation. This is considered to be:

- NFPA 855[10];
- UL 9540[23];
- UL 9540A[5]; and
- IEC 61936[2].

4.3.2 Associated equipment, MV station, substations, transformers, switchgear, metering etc. shall be designed in accordance with established standards appropriate to the equipment type. Small transformers associated with the MV station will be filled with a low flammability ester and will adhere to IEC 61936 guidelines[2].

4.3.3 The MV station shall allow the system to dynamically control active and reactive power and meet all necessary operational requirements, grid connection and applications. All necessary self-protective and self-diagnostic features shall be

included in the design of the MV station to enable it to monitor and react to internal and external failure or damage such as sensors, alarms and protection systems.

4.3.4 The BESS system design will incorporate appropriate provision for fire safety. These may vary slightly between manufacturers, but would typically be expected to include:

- Internal fuses;
- Rack, string and bank level contactors;
- Overcharge prevention safety device;
- Internal separation layers;
- Fire and smoke detection with local and remote indication; and
- Automatic disconnection of AC power in the event of a fire or other major incident.

4.3.5 The Applicant shall provide certification and evidence that confirms the adherence of the BESS units to the requirements and that testing was undertaken by an approved testing facility. Where applicable, the BESS must be designed commissioned and installed at the BESS Site in full accordance with the test criteria with no deviations permitted.

4.3.6 The final design shall have a Fire Risk Assessment (FRA) produced in accordance with The Regulatory Reform (Fire Strategy) Order 2005[22] as per the Applicant requirements.

4.3.7 In addition to fire suppression and detection systems and other systems of detecting fire, general fire prevention measures will be employed where applicable. Each BESS enclosure will have a fire rating of at least one hour. The specific system details will be determined in the detail design stage.

4.3.1 Battery Management System

4.3.1.1 The BMS, along with fire suppression systems must possess robust detection capabilities to identify potential fire risks allowing the appropriate fire suppression mechanisms to be activated effectively, limiting fire damage and preserving the BESS.

4.3.1.2 It shall ensure that the battery is operating within safe limits by monitoring the following main conditions as a minimum:

- Overcharging/overvoltage – monitor and control voltage during charging so that they do not exceed voltage limits;
- Over discharging – discharging at a low state of charge (SoC) can lead to a short circuit so BMS will monitor and control discharging such that overcurrent limits are not exceeded;
- Extreme temperatures – BMS will monitor and stop operating if the cell temperature exceeds temperature limits and controls the rate of charge at specific low temperatures to prevent failure. Indoor and outdoor humidity will also be regulated; and
- Imbalance – The BMS will monitor and regulate the cell during resting periods to balance SoC and state of health (SoH).

4.3.1.3 The BMS will monitor a minimum of 24 hours of pre-event and post-event data which shall be recorded and stored for long term data storage and retrieval.

4.3.1.4 The conditions will be monitored 24/7, 365 days a year by trained, experienced personnel from a remote control centre. Should any deviations be identified, the affected battery rack, or full enclosure shall be shut down.

4.3.1.5 Operators shall be given clear guidance on how to respond through methods such as on screen or written procedures should any deviations to normal operating limits be identified.

4.3.1.6 Fire detection and suppression systems shall remain active via the auxiliary supply should the main supply fail.

4.3.2 Emergency Stop Switches

4.3.2.1 Emergency stop switches shall be provided at each grouping of batteries and shall trip all associated BESS inverters, isolate AC and DC breakers, and send a signal to the Fire Alarm Control Panel (FACP). Containerised BESS systems shall incorporate E-stops into the inverter control panel or local Human Machine Interface (HMI) and shall shut down only the affected BESS equipment train.

4.3.3 Temperature Management Systems

4.3.3.1 High ambient and cell temperatures can result in overheating of the batteries. This can eventually lead to thermal runaway if not identified and mitigated effectively. Temperature shall be monitored in each BESS dedicated-use room, cabinet or container. Battery cell temperature will be kept within limits by the BMS and displayed at the control facility where it will be continuously attended. A liquid cooling system will ensure the internal temperature of the BESS enclosure is maintained.

4.3.3.2 Should temperatures exceed normal operating conditions a high temperature alarm will be raised, and heat diffusion mechanisms will be activated, mainly to suppress thermal runaway and reduce within the cell, module and container.

4.3.3.3 Experienced technicians and engineers will perform ambient temperature checks and specific cell temperature checks on a regular basis. This will be incorporated into the maintenance schedule of the BESS Site.

4.3.3.4 Cell temperature readings can be reviewed to identify the source of the initial battery fire and the number of affected cells.

4.3.4 Fire and Gas Detection Systems

4.3.4.1 Battery units will include automatic fire and smoke detection systems within the enclosures above the batteries to identify fire as early as possible and activate appropriate suppression mechanisms. All BESS manufacturers have multiple layers of detection systems, including gas, heat and smoke monitoring.

4.3.4.2 Very Early Smoke Detection by Aspiration (VESDA) systems detect minute smoke particles by continuously sampling the air within the enclosure. These may be employed to detect fire at an early stage. Fire detection systems will be employed at welfare areas to detect causes of fire that do not involve thermal runaway.

4.3.4.3 Fire Detection systems shall follow the below mentioned standards:

- BS EN 54;

- BS EN 5839; and
- BS EN 12094.

4.3.4.4 Gas detection systems will also be in place in all BESS enclosures to monitor the presence of flammable gases and instigate an emergency shutdown response should threshold limits be exceeded. LFP batteries will release combustible gas in the early stage of combustion and so gas detection systems will be key to identifying the early thermal runaway conditions. Specific gas detection systems can be installed to identify gases such as carbon monoxide and hydrogen.

4.3.4.5 Should any identifiers of fire be detected, or any components become offline or in a failed state visual and audible alarms will be raised and displayed on the HMI. All detected systems shall be connected to a FACP for a battery or group of battery units. The FACPs will be connected to a central FACP, this will be easily accessible to fire responders allowing them to identify the type and exact location of the fire.

4.3.4.6 After smoke, gas and temperature sensors detect a fire, an alarm will be raised, fire suppression systems will be activated, and the affected unit shall be shut down and isolated. The ventilation shall consequently exhaust any flammable gas, or smoke and allow thermal dissipation. In addition, the automatic penstock value controlling the outflow of run-off will be triggered to prevent any polluted water from entering waterways.

4.3.4.7 Should thermal runaway conditions, i.e., overheating, off gassing etc, be detected the fire service should be notified immediately, BESS Site operators will also attend to the BESS Site to provide guidance as necessary.

4.3.4.8 Fire alarms shall be designed and commissioned by an LPS 1014[24] certified firm as required by the Applicant.

4.3.4.9 Gaseous systems shall be designed and commissioned by an LPS 1204[25] certified firm as required by the Applicant.

4.3.4.10 In case of fire alarms causing plant shutdown and similar actions, there will be a test performed to demonstrate this.

4.3.5 Fire Suppression Systems

4.3.5.1 Automatic fire suppression systems, along with the BMS shall identify potential fire risks and activate the appropriate fire suppression mechanisms. The fire suppression systems shall also be capable of being activated remotely via the remote-control centre.

4.3.5.2 If fire or extreme temperatures are detected the suppressant will be automatically released into the environment actively targeting the flame and providing rapid cooling preventing reignition and cutting off the battery chain reaction.

4.3.5.3 Each manufacturer allows for an aerosol suppression system within the BESS enclosures. Depending on the manufacturer's specification 'Clean agent' extinguishing systems will be utilised. Clean agent extinguishing systems shall be Stat X or equivalent and will comply with NFPA 2010[26]. CO2 systems are not acceptable as they work by displacing the oxygen and do not directly cool the fuel source. Thermal runaway produces oxygen and so there is a chance of reignition once the CO2 is removed. Non-occupiable container solutions shall include a clean agent fire suppression system as required by NFPA 855[10].

4.3.5.4 If automatic sprinklers are required, they shall be designed and tested by an LPS 1014[24] certified firm. They shall be installed to LPS 1048-1[27] approval level 4 with supporting certificate on Site acceptance as per the Applicant requirements. BESS enclosures shall have an inlet to allow for connection to water pipes.

4.3.5.5 A design risk assessment shall be carried out to ensure the fire suppression system will effectively contain the fire, off gassing and reduce the potential of thermal runaway and reignition.

4.3.6 Ventilation and Exhaust Systems

4.3.6.1 Combined with the temperature management, ventilation systems shall ensure the battery unit will not overheat and ensure efficient heat dissipation or provide thermal insulation if extreme cold temperatures are experienced.

4.3.5.1 The ventilation systems shall comply with NFPA 69[21], the flammable gas concentration shall be maintained below 25% of the lower flammability limit (LFL). This is a preventative approach, with the aim to prevent an explosion from occurring.

4.3.5.2 Should the suppression agent discharge, pressure relief vents shall prevent structural damage of the protected enclosure.

4.3.5.3 Ventilation systems can also be used to purge the BESS enclosure should the presence of smoke or flammable battery off gas be detected.

4.3.5.4 Ventilation exhaust vents, releasing any product other than ventilation air (e.g., smoke or combustible gases), shall be designed to be facing away from any ventilation air intakes, windows or doors. Exhaust vents shall be directed away from access, pedestrian or escape routes to prevent exposure to personnel.

4.3.5.5 Smoke and heat venting shall be provided in areas identified by the FRA and shall aid safe access of firefighters and safe egress of personnel.

4.3.5.6 Information on the ventilation air flow rate shall be provided by the manufacturer however the ventilation and exhaust system design shall meet the requirements of NFPA 855[10].

4.3.7 Deflagration Venting Systems

4.3.7.1 Deflagration can occur with the build-up of pressure as smoke and gas build up within the enclosure. To relieve pressure and prevent an explosive atmosphere, deflagration panels may be fitted on each enclosure. Any venting shall be to a safe location away from access, pedestrian or escape routes to prevent exposure to personnel as per Applicant standards. Deflagration venting systems shall comply with NFPA 68[20].

4.3.8 Testing

4.3.8.1 The BESS will be compliant with testing requirements of UL 9540A Testing the fire safety hazards associated with propagating thermal runaway within battery systems[5] and demonstrate that fire will not propagate at a cell, module and rack level with preference for full system testing. The Original Equipment Manufacturer (OEM) shall provide the certification and evidence that confirms the adherence to the requirements and that testing was undertaken by an approved testing laboratory. The BESS shall be designed, commissioned, and installed

onsite in full accordance with the criteria given in the test. No deviations are permitted.

4.3.9 CCTV

4.3.9.1 A network-connected closed-circuit television (CCTV) system shall be installed at the BESS Site which can be utilised to assist with identifying issues and checking the battery enclosures status. These shall be monitored remotely via an operational control room.

5 GENERAL FIRE SAFETY

5.1 Consultation with Local Fire Service

5.1.1 As the design of the BESS Site progresses through the DCO examination and detailed design stage post-consent, the Applicant will periodically engage with the local FRS to provide input into the design. Following the selection of a supplier, the Applicant shall provide information relating to the BESS makeup. This includes but is not limited to chemistry, component design layout and means of containment (shipping containers, dedicated building, specially designed housing). The BESS layout will also be made available when known. The technology information will be updated as the design progresses to reflect the selected solution, including detailed safety considerations, mitigations and specifications, to ensure the fire service can undertake a meaningful review.

5.1.2 The final layout shall confirm BESS configuration, detailing internal Site roads, water sources, water storage (if applicable), fire hydrant location and any other information that may assist the FRS understanding of the BESS Site.

5.1.3 A summary of the main materials used at the Site will be prepared and be passed to the FRS.

5.1.4 It is probable that, as the installation project progresses, additional information may become available. There may also be design changes for a variety of reasons. Any changes which impact the fire safety of the BESS Site should be communicated to the FRS at the earliest opportunity.

5.2 Fire Service Guidance

5.2.1 It is assumed that an aerosol-based suppression system will be used in the battery containers so it is anticipated that in the unlikely event that this system should fail to extinguish a fire, a controlled burn strategy will be implemented. However, the final approach will be determined in consultation with the Environment Agency. The Applicant is providing water to allow adjacent units to be cooled, if necessary, in accordance with decisions confirmed within the Emergency Response Plan which will be developed at a future design stage. As a unit burns, the surrounding units will be doused with water to dissipate heat and prevent ignition of the adjacent units.

5.2.2 The risk of propagation is considered to be low due to the design decisions covered within Section 4.

5.2.3 The main risk to firefighters is the potential for rapid combustion and explosion of the cells affected by the fire or close enough to the fire to be affected. To mitigate this, exhaust systems and, depending on the selected supplier, deflagration panels may be in place to prevent explosion. Rapid combustion will be mitigated by minimising thermal runaway conditions through fire suppression systems. Although the BESS design will be specifically designed to self-contain fire risk, the risk is not reduced to zero.

5.3 Site Access

5.3.1 The Site access will be designed such that emergency vehicles are able to access the BESS Site easily in all weather conditions.

5.3.2 Prevailing wind at the BESS Site is from south west to north east, this shall be taken into account when designing BESS Site access points. At least two access points shall be provided to account for wind directions, should one be obstructed during an emergency (e.g. by smoke). The location of these access points are as below. Two access points are proposed, see **Figure 1.1**.

- Access Point 1 (CFL-01) is adjacent to where Stow Bridge Ln Meets Morthen Ln and Field Lane. This main access road will be sized for Abnormal Indivisible Loads (AILs), and be suitable for firefighting appliances; and
- Access Point 2 (EFL-01) is via Field Lane, on the eastern end of the land parcel, and will be sized for firefighting appliances.

5.3.3 An emergency responder information pack will be located at or near access points and the BESS Site roads shall incorporate suitable signage to assist FRS personnel.

5.3.4 A swept path analysis has been completed for emergency vehicles and roads within the BESS Site to ensure they shall be suitable for emergency vehicle access. BESS units shall maintain sufficient clearance from overhead obstructions (e.g., trees and overhead power lines) and site roads shall remain unobstructed to ensure safe separation and unobstructed fire service access. Further details shall be provided in **ES Chapter 13: Traffic and Transport [EN0110020/APP/6.13]**.

5.3.5 There are no dead-end access routes within the BESS compound planned at this time. Should this change during the detailed design phase, any such access route longer than 20m will have turning facilities or passing places.

5.3.6 The main BESS Site access road will up to 6m in width.

5.3.7 Emergency lighting, including external BESS Site lighting, shall be available along escape routes at all times and in the event of power failure, emergency or fire event and shall direct personnel to a place of safety. This shall be triggered upon detected of an emergency via the remote control centre.

5.4 Water Supply

5.4.1 The preliminary design shall include at minimum two 120,000 litre static water tank at the BESS Site, the current design shows four static water tanks. These may be connected to a network of fire hydrants. All water supply points, and any potential fire hydrant locations shall be clearly identified with appropriate signage and shown on the BESS Site plans. The delivery rate of water will be a minimum of approximately 25 litres/second or a minimum of 180,000l of static water supply, subject to discussion with the local FRS. The final number of tanks will be scaled in line with the quantity of BESS Units installed and agreed with the responsible FRS.

5.4.2 The water supply will be available for use by the FRS. The water tanks are not intended to feed any automated sprinkler system.

5.4.3 The final sizing, number and location of tanks is subject to detailed design, which will involve a risk review to ensure that the fire water response is appropriate. The

water tanks shall be located between 10m and 90m away from the nearest battery enclosure to allow for continuous firefighting operations.

5.5 Pre-Fire Planning

5.5.1 A pre-fire plan will be prepared by the Applicant following the detailed design stage and will contain the following information as a minimum:

- The battery type and chemistry;
- The number of batteries, capacities and the overall capacity of the BESS installation;
- A BESS Site plan layout which clearly shows which units contain batteries, and which contain associated equipment, access points and separation distances;
- Notable construction features of the BESS installation. To include muster points, emergency stop locations, fire water supply points and hydrants etc;
- Material Safety Data Sheets (MSDS);
- Control of Substances Hazardous to Health (COSHH) assessment, location of hazardous and flammable materials, ignition sources and combustible and flammable waste;
- Details of installed incident detections systems, including fire and gas detection, with type and speed of response noted;
- Details of any passive fire protection measures in place;
- Details of any active fire protection measures in place e.g., water spray / mist systems, dry agent systems;
- Consider reasonably practical containment measures for battery waste and electrolyte;
- Consider reasonably practical containment measures for firewater retention;
- Arrangements for alerting any impacted offsite parties;
- Arrangements for air quality monitoring in the event of a prolonged fire event; and
- Considerations for post incident monitoring, clean-up and disposal of both fire damaged and undamaged battery cells.

5.5.2 Following the consultation with the local FRS, the above information may be omitted or added. A concise emergency information pack with Site Specific Risk Information (SSRI) will be provided to the emergency responders at or near emergency access points. The contents of the pack are to be agreed with the local FRS.

5.5.3 The pre-fire plan shall be reviewed annually at a minimum. Any changes to the BESS Site, equipment or changes in industry best practice shall be reflected in the pre-fire plan at the earliest opportunity.

5.6 Signage

5.6.1 Appropriate signage shall be available onsite marking access and escape routes, water supply points and hydrants, safety signage, and emergency response

guidance. The Main FACP shall also show directional signage to guide firefighters to the affected location as required.

5.6.2 Signage for the BESS units shall detail the type of BESS technology, suppression system fitted, hazards associated, and 24-hour emergency contact information.

5.6.3 Signs on at least one of the enclosures should be visible at night from a distance of 30 metres.

5.7 Emergency Response Plans

5.7.1 An Emergency Response Plan detailing the construction, operation and decommissioning phases will be developed in consultation with the local FRS and other local authorities as required during the detailed design phase and prior to the construction of the BESS Site. The plan shall include information that can support operators and firefighters in effectively responding to a fire incident at the BESS Site.

5.7.2 While the response plan is still to be developed, some indicative content topics which will be covered are as follows:

- Information on alerting fire service;
- Facility infrastructure details;
- BESS Site plans;
- Emergency and evacuation resources;
- Dangerous goods stored list;
- Contact details of relevant stakeholders (including downstream abstractors);
- Procedure for safe shutdown, de-energisation, or isolation of equipment and systems;
- Procedures for inspection and testing of associated alarms, interlocks, and controls;
- Procedures to be followed in response to notification of system alarms;
- Emergency procedures to be followed in case of fire, explosion, or other dangerous conditions; and
- Procedures for dealing with BESS equipment damaged in a fire or other emergency event.

5.7.3 The full contents will be developed during the detailed design stage, with a copy shared with the local FRS for consultation. Local storage of this document at the BESS Site is envisioned to be at all possible access locations to ensure in the event of a fire the FRS is able to safely access the information.

5.7.4 A clear firefighting strategy shall be communicated, and information shall be available on BESS Site, including contact information, until a qualified attendant is present onsite.

5.7.5 A risk management plan shall also be developed by the Applicant to identify potential hazards and risks of the BESS Site and provide advice to the fire service on how to manage these issues when dealing with an emergency incident. NFCC guidance listed below will be incorporated:

- The hazards and risks at and to the facility and their proposed management;

- Any safety issues for firefighters responding to emergencies at the facility;
- Safe access to and within the facility for emergency vehicles and responders, including to key BESS Site infrastructure and fire protection systems;
- The adequacy of proposed fire detection and suppression systems (e.g. water supply) onsite;
- Natural and built infrastructure and onsite processes that may impact or delay effective emergency response; and
- Impacts on sensitive receptors close to the BESS Site.

5.8 Post-incident, Recovery and End-of-Life Management

5.8.1 The pre and post incident data will be monitored and recorded by the BMS. This data, along with any relevant details, shall be available to share to the United Kingdom Association of Fire Investigators and NFCC for learning and information should any cell, system failure or recall occur.

5.8.2 A post-incident recovery plan shall be developed by the operator to safely deal with the removal and disposal of any damaged batteries and equipment and remediation of the site to remove any contaminants.

5.8.3 Safe lifting, removal of battery containers and end-of-life management shall be accounted for during the planning phase.

5.8.4 Following a battery fire there are potential issues that must be considered once the initial combustion has subsided. Prior to disposal, damaged batteries shall be stored separate to unreacted cells and end-of-life batteries, in small quantities in an open-air environment at least 15m away from other parts of the installation or structures in an impermeable, covered and bunded area. Gravel and other substrate materials may need to be removed and cleaned following a fire event.

5.8.5 Residual heat and stranded energy in the batteries can cause reignition and affect adjacent batteries long after initial extinguishment. Reignition can occur within minutes, hours or even days after the initial fire event. Appropriate heat detection systems can be used by emergency responders to identify persistent heat spots and mitigate the risk of reignition.

5.8.6 Battery waste that is burnt or unburnt contain corrosive and toxic substances and should be removed appropriately. PPE should be worn by personnel to prevent coming into contact with these hazardous substances.

5.8.7 Current knowledge of type and quantity of potentially harmful combustion by-products is based on the limited number of events to date worldwide. However, controls are in place as detailed in this document to manage risks proportionally.

5.8.8 According to the 2017 DNV report OAPUS301WIKO(PP151894)[8], studying the risks when BESS units are installed inside a building, the levels of toxic fumes were found to be similar that of a plastics fire. This could be mitigated by ensuring enough distance between residential areas and providing sufficient ventilation. Harmful smoke and gas emissions shall dissipate in the outdoor environment. Fire responders shall maintain safe distances to the smoke plume until it is certain that they do not pose a hazard. This can be determined by flammable gas detection at key points around the facility and local air quality monitoring.

5.8.9 Post-incident hazards shall be addressed in the pre-fire planning and post-incident recovery plan.

6 CONCEPTUAL DRAINAGE DESIGN

6.1 Firewater Runoff

6.1.1 Should water be used as the suppressant for the fire system, contaminated water will be contained within the BESS Site as part of the drainage design to prevent the release of polluted water. In the case of a fire event, an automatic penstock valve with manual override will automatically shut to capture run-off and rainwater that may have become contaminated.

6.1.2 Firewater used to cool the adjacent units shall also be collected by an appropriate drainage design.

6.1.3 The firewater shall be gathered into the Sustainable Drainage Systems (SuDS) pond with an estimated capacity of up to 8,047m^3, depending on quantity of BESS installed. There shall be no firewater runoff released to the environment before appropriate testing has been carried out by an UKAS accredited laboratory to assess if pollutants are present per the best-practice guidance at the time of operation. If required by the EA, this water would be trucked offsite.

6.1.4 The project will adhere to the latest NFCC guidance at the time of construction, including provisions for an appropriate fire water supply, and where applicable, firewater runoff capture based on the selected technology and the most up-to-date regulations. The BESS Site has been designed in accordance with current NFCC guidance.

6.1.5 The Site-specific FRA shall inform the final design and level of protection for this system.

6.1.6 Refer to the **Outline Surface Water Drainage Strategy [EN0110020/APP/5.17]** for further details.

7 PRE-CONSTRUCTION REQUIREMENTS

7.1 In accordance with Schedule 2 to the **Draft Development Consent Order [EN0110020/APP/3.1]** Construction of Work No.3 will not be able to commence until a Detailed Battery Safety Management Plan (Detailed BSMP) has been submitted to and approved by the relevant planning authority, following consultation with the SYFRS. The Detailed BSMP must be substantially in accordance with this outline BSMP.

7.2 As such, prior to the commencement of constructing the BESS, this oBSMP will be updated and developed into a Detailed BSMP which will include but will not be limited to:

- Detailed design drawings of the BESS;
- Details of the BESS specifications, including fire detection and suppression systems;
- A statement confirming overall compliance of the system with applicable legislation;
- An environmental risk assessment to ensure that the potential for indirect risks e.g., leakage and / or other emissions, is understood and mitigated against; and
- An ERP covering construction, operation and decommissioning phases.

7.3 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.

8 CONCLUSION

8.1 This document summarises the fire safety risks associated with the BESS and associated infrastructure installation at Whitestone BESS. It addresses the requirements set forth by the NFCC and other best practice fire safety guidance documents. It demonstrates how the Applicant aims to mitigate the identified risks and hazards and will aid discussion with the local FRS. To this end, the Applicant will be able to provide more information on the specifics of any relevant design parameter or technology as the detailed design process begins in an effort to build a design which satisfies all requirements.

8.2 The Applicant is committed to ensuring safety on the BESS Site and will engage with the local FRS to satisfy the safety requirements of their staff, the local residents, and the surrounding area in the unlikely event of a fire taking place at the BESS Site. **Table 8.1** details how the Applicant aims to adhere to the guidance in Grid Scale Battery Energy Storage System planning – Guidance for FRS (2026)[1] or alternative guidance where requirements are modified.

Table 8.1: Battery Fire Safety Compliance Checklist for the BESS Site.

Ref	Required by	Description	How this oBSMP adheres to guidance	Adheres to
1	NFCC NFPA 855 (2023)	Minimum separation of 0.914m (3ft) permitted where UL 9540A testing demonstrates no propagation between enclosures, in accordance with NFPA 855. Each BESS group shall be spaced a minimum 0.9m from other groups with validated UL 9540A testing unless evidence from relevant testing approves smaller group spacing and LPA permits it.	The Whitestone preliminary design has ≥ 3m separation (subject to industry best practice at detailed design) between each group of BESS which is considered as compliant with the standards, which is compliant with these standards with the following mitigations considered: • UL 9540A compliant equipment • 1 hour fire rated BESS enclosures • Appropriate fire suppression systems shall be installed. Furthermore, compliance with the battery suppliers BESS installation manual is deemed of high importance and should be	Mitigations to NFCC provided. Compliant with latest international standard FM Global 5-33 (2024)

			followed regarding separation distances. If back-to-back units are considered then evidence of fire safety tests shall be provided (i.e. UL 9540A) Additional information and justification to be provided by a competent fire engineer at later project stages.	
2	NFCC NFPA 855 (2023)	Areas within 3m on of outdoor BESS shall be cleared of combustible vegetation and other combustible growth.	To mitigate fire risk, vegetation shall be trimmed so that it is at least 3m (10m for tree canopies) away from the closest enclosure around the perimeter as per the min. requirements of NFPA 855 (2023)[10].	Compliant with latest international standard NFPA 855 (2023)
3	NFPA 855 (2023)	ESS located outdoors shall be separated by a minimum 3m from lot lines prior to any mitigations.	The distance of a BESS from the Site boundaries shall be greater than the minimum requirement. The minimum distance of BESS to the Site boundary exceeds 3m. Which is compliant with NFPA 855. If smaller spacing is required, the following mitigations shall be implemented: • UL 9540A compliant equipment • 1 hour fire rated BESS enclosures • Appropriate fire suppression systems shall be installed NFPA 855 (2023)[10] states that separation may be reduced up to 0.914m with a 1-hour fire barrier.	Compliant with NFPA 855 (2023)

4	NFPA 855 (2023)	BESS will be separated from any public rights of way by a minimum of 3m (10ft).	The closest public right of way to the BESS adheres with NFPA 855 (2023)[10] minimum requirements.	Compliant with latest international standard NFPA 855 (2023)
5	NFCC NFPA 855 (2023)	BESS will be separated from any occupied buildings by 30m prior to any mitigations. ESS installed in remote area is defined to be located more than 30.5m from buildings, lot lines that can be built upon, public ways, stored combustible materials, hazardous materials, high piled stock, and other exposure hazards not associated with electrical infrastructure grid.	The BESS Site is in remote area and no occupied buildings are present within 30m of radius.	Compliant with NFCC guidance and NFPA 855 (2023).
6	NFPA 855 (2023)	ESS located outdoors shall be separated by a minimum 3m from buildings prior to any mitigations.	All buildings on the BESS Site including the control building are unmanned and greater than 3m from any BESS unit. If smaller spacing is required, the following additional mitigations are proposed: Battery units shall have a 1-hour fire rated enclosure.	Compliant with NFPA 855 (2023)
7	NFPA 855 (2023)	BESS will be separated from stored combustible materials by a	A minimum 3m will be adhered to. Currently there is a minimum of 5m offset from the hedgerows to the BESS.	Compliant with NFPA 855 (2023)

		minimum of 3m (10ft).		
8	NFPA 855 (2023)	BESS will be separated from hazardous materials by a minimum of 3m (10ft).	A minimum 3m will be adhered to.	Compliant with NFPA 855 (2023)
9	NFPA 855 (2023)	BESS will be separated from high-piled stock by a minimum of 3m (10ft).	A minimum 3m will be adhered to.	Compliant with NFPA 855 (2023)
10	NFCC	Fire-fighting water tanks will be located a minimum distance of 10m from the nearest BESS enclosure (ideally upwind from the prevailing wind direction).	Fire water tanks will be located at least 10m away from BESS enclosures.	Compliant with NFCC
11	NFCC	Hydrant supplies for boundary cooling purposes should be located close to BESS enclosures (but considering safe access in the event of a fire) and should be capable of delivering no less than 25 litres per second. Where this cannot be achieved, an equivalent minimum of 180,000 litres of static water storage shall be provided for firefighting purposes.	If used, hydrants shall be located close to BESS enclosures and shall deliver the required amount of water of at least 25l per second. Four static water storage tanks are currently shown in the design and will provide the minimum water requirement of 180,000 litres.	Compliant with NFCC
12	NFCC (Undefined - Dead	Vehicle turning facilities will be provided in any dead-end access	There are no dead-end access routes longer than 20m onsite.	Compliant with NFCC

	end access)	route that is longer than 20m.	Passing places shall be provided onsite, where required.	
13	NFCC (Undefined - Access)	Preferable to have an alternative access point, taking account of likely wind direction. If the provision of an alternative access point is not practicable, an alternative may be to provide a perimeter 'loop' type of vehicle access around the site.	The design proposes two access points. The access roads shall be up to 6m in width. Requirements have been verified by a swept path analysis.	Compliant with NFCC
14	NFCC	Consideration given to management of water runoff (e.g. drainage systems, interceptors, bunded lagoons etc) and suitable environmental protection measures should be provided.	Appropriate drainage design to collect possible firewater runoff detailed in Section 6.1.	Compliant with NFCC
15	NFCC	Signage installed in suitable and visible location on the outside of BESS units identifying the presence of BESS system and in accordance with the relevant standards.	Signage requirements will be adhered to.	Compliant with NFCC
16	Industry best practice	All installation, maintenance and access to battery enclosures is from the outside. No personnel will ever be able to be inside a battery enclosure due to enclosure design.	No personnel access to battery enclosure at all times.	Compliant with industry best practice

17	NFCC	Details of any evidence-based testing of the system design should be requested, for example, results of UL 9540A testing.	Units will be UL 9540a compliant. Specific testing details including UL 9540A shall be provided at a later stage once battery supplier has been selected.	NFCC
18	NFCC	Effective and appropriate method of early detection of a fault within the batteries should be in place, with immediate disconnection of the affected battery / batteries.	Automatic temperature, gas, fire and smoke detection systems within enclosures to identify fire as early as possible and activate external audible and visual warnings and activate the appropriate suppression mechanisms. BMS shall automatically shut down or disconnect affected cell. FACP to identify type and location of fire. Further detailed in Section 4.3.	NFCC
19	NFCC	Suitable suppression systems shall be installed in units to prevent or limit propagation between modules. They shall be designed by a competent system designer	Appropriate fire suppression systems shall be installed. A design risk assessment shall be carried out to ensure the fire suppression system will effectively contain the fire, off gassing and reduce the potential of thermal runaway and reignition. Further detailed in Section 4.3.	NFCC
20	NFCC	BESS enclosures shall be fitted with deflagration or explosion protection and venting.	Adequate ventilation systems to prevent the build-up of gases shall be provided and shall vent away from access, escape routes and personnel. Deflagration and explosion protection may be fitted onto enclosures.	NFCC
21	NFCC	Emergency Plans including Risk Management and	An ERP shall be developed in consultation with the local FRS and	NFCC

		Emergency Response Plans (ERP) shared with the FRS.	include information to assist operators and firefighters in an effective fire response. These shall be reviewed and updated regularly. A risk management plan shall be developed.	
22	NFCC	Post-incident hazards and mitigations should be addressed in post-incident recovery Plan.	Post-incident recovery plan and mitigations are detailed in Section 5.8.	NFCC

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