Proposed Solar PV Development

RWE

Byers Gill Solar
EN010139

6.4.2.13 Environmental Statement Appendix 2.13 Outline Battery Fire Safety Management Plan (oBFSMP)

Planning Act 2008

APFP Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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1. Introduction and context

1.1 Introduction

1.1.1. This document provides the outline Battery Fire Safety Management Plan (oBFSMP) for the operation of Byers Gill Solar (the Proposed Development). It is based on the assumption that a Battery Energy Storage System (BESS) using Lithium Iron Phosphate (LFP) battery technology will be adopted for the Proposed Development.

1.1.2. RWE (the Applicant) has prepared this document as part of an application for a Development Consent Order (DCO) for the construction, operation and decommissioning of the Proposed Development. It demonstrates how the mitigation measures and monitoring requirements identified in the Environmental Impact Assessment (EIA) process will be implemented during operation and has been prepared with the objective of compliance with the relevant legislation.

1.1.3. The oBFSMP has been produced in order to respond to the risks and concerns around the potential for a battery fire event in the Battery Energy Storage System (BESS). It sets out the Proposed Development's proposals for:

- minimising the chances of a battery fire event through design measures;
- minimising the chances of fire spread in the event of a fire through design and operational measures; and
- setting out the proposed operational response to a fire event.

1.1.4. An EIA has been undertaken for the Proposed Development and an Environmental Statement (ES) (Volume 6 of the DCO application) has been prepared in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations). In accordance with the requirements of the EIA Regulations, the ES contains the assessment of the likely significant effects on the environment that may be caused during construction of the Proposed Development and describes proposed mitigation measures.

1.1.5. Prior to commencing operation, a detailed BFSMP will be produced by the Principal Contractor (PC) for the Proposed Development. The BSFMP will be prepared in accordance with the Outline BFSMP, (under requirement 11 of the DCO) and any relevant engagement undertaken with stakeholders. The BESS will be designed in accordance with the UK and internationally recognised good practice guidance and standards available at the time of writing. The BFSMP will be updated, including reviews of safety at the procurement, installation and operational phases to ensure that safety is not compromised in the future.

1.1.6. RWE has worked closely to date with technical experts in collating the technical and safety information necessary for the safe and optimal design, procurement, construction, and operation of the BESS, and will continue to do so.

1.2 Scope of the BFSMP

1.2.1 The BFSMP, is designed to identify the key standards, guidelines, and principals to adhere to during the detailed design and operation of the BESS within the Proposed Development. The document is intended to be a live document that will be updated as the design and installation of the Proposed Development is progressed in order to identify new and evolving project specific safety measures that should be put in place.

2. The Proposed Development

2.1 Description of the Proposed Development

2.1.1 The Proposed Development is a renewable energy scheme, covering an area of approximately 490 hectares (ha), and comprising solar photovoltaic (PV) panels, on-site Battery Energy Storage Systems (BESS), associated infrastructure as well as underground cable connections between Panel Areas and to connect to the existing National Grid Substation at Norton. The Proposed Development will have the capacity to generate over 50 Megawatts (MW) of electricity. The Proposed Development is located in the north-east of England.

2.1.2 A full description of the Proposed Development and a detailed description of the design and environmental mitigation is provided in ES Chapter 2 The Proposed Development (Document Reference 6.2.2).

2.2 Proposed Development Location

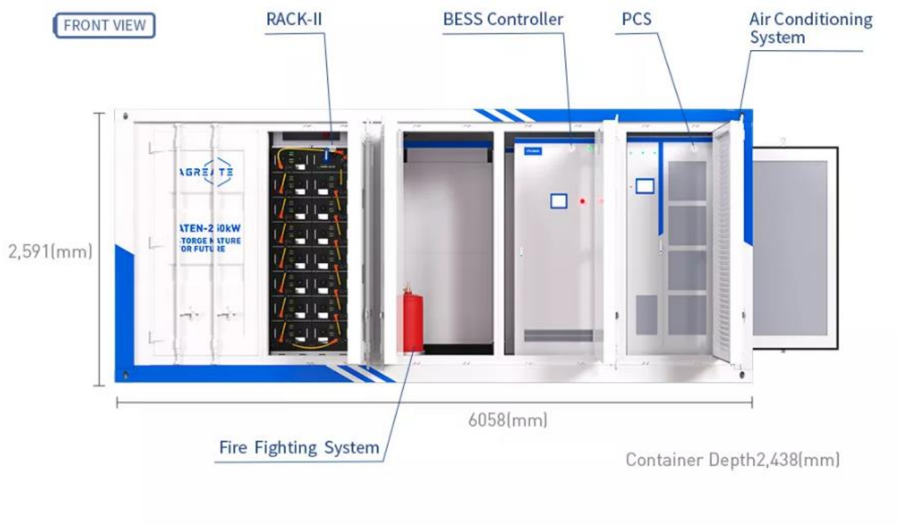
2.2.1 The majority of the Proposed Development is located within the administrative boundary of Darlington Borough Council, with a section of the cable route situated within the administrative boundary of Stockton-on-Tees Borough Council. A very small section of the Order Limits is within the administrative boundary of Durham County Council.

2.2.2 The Order Limits and surroundings comprise of agricultural fields, interspersed with individual trees, hedgerows, farm access tracks, woodlands and local farmholdings. There are several local villages located within close proximity to the Proposed Development, including Brafferton, Newton Ketton, Great Stainton, Bishopton and Old Stillington village to the north.

2.2.3 The Order Limits for the Proposed Development are shown in ES Figure 1.1 Site Location Plan (Document Reference 6.3.1.1).

2.3 Battery Energy Storage System (BESS)

2.3.1 The Proposed Development includes a Lithium-Ion (Li-Ion) BESS (Work No.2 of the DCO, Works Plans (Document Reference 2.2) housed in outdoor containers. These containers house Li-Ion batteries (in cells, arranged in modules which are in turn arranged in racks) and vary based on the supplier and the intended BESS operation modes. The containers also house Heating, Ventilation and Air Conditioning (HVAC), Battery Management Systems (BMS), temperature and smoke alarms, fire detection and suppression systems and deflagration venting as seen in



2.3.2 Figure 1.

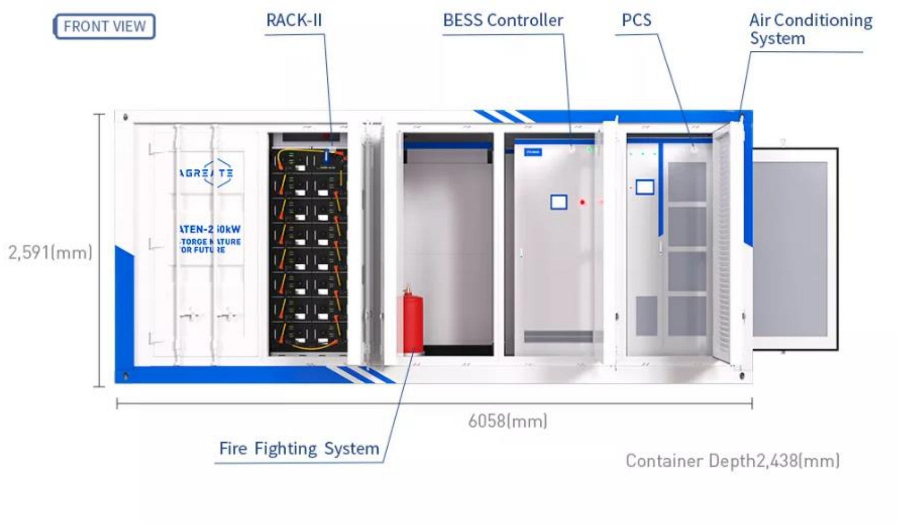


Figure 1 Sample of a BESS container (Source: Agreate)

2.3.3 DCO Requirement 3 requires that the detailed design of the Proposed Development must be in accordance with the ‘principles and assessments set out in the environmental statement’ and the Design Approach Document (DAD) (Document Reference 7.2). These set out that the BESS is likely to consist of lithium-ion batteries, which forms the working assumption of this outline BFSMP, although will be confirmed through detailed design. The DAD includes a number of controls for the design of the BESS; for example, the proposed siting of the BESS has been decided through engagement with the local fire and rescue service to ensure that proper access can be maintained throughout, whilst also reducing fire risk across the Order Limits. In addition, the BESS has been placed at least 300m from residential properties in the majority of cases, to reduce the visual and noise impact of the infrastructure.

2.3.4 The vast majority of utility-scale BESS are based on Li-Ion technology which uses either NMC (Lithium Nickel Manganese Cobalt) or LFP (Lithium Iron Phosphate) cells. NMC cells were favoured during the first few years of BESS deployment in the UK due to their comparatively higher energy density compared to LFP cells. However, as technology has advanced, LFP has become the favoured cell chemistry in recent years with most manufacturers now exclusively providing LFP solutions.

2.3.5 Due to the fact that LFP cells operate at higher temperatures than other cell chemistries such as NMC, they are at lower risk of thermal events such as burn-through (a process by which one cell ignites and adjacent cells catch on fire) and thermal runaway (a process resulting in a self-sustaining fire that persists even if outside sources of electricity are removed).

2.3.6 The risk of a LFP battery suffering from thermal runaway can be mitigated through proper design, testing, operation, ventilation, monitoring and cooling systems.

2.3.7 It is important to distinguish between thermal runaway (which is generally seen as the worst-case scenario for a BESS fire and commonly results in the full loss of the affected container), and electrical fires which can be the result of short circuits or other minor faults. The risks are separate, and the mitigation is therefore separate for each possible risk.

3. Specific risks

3.1 Overview

3.1.1 There are four main ways in which a Li-Ion cell can fail:

- thermal;
- electrical;
- mechanical; and
- chemical.

3.1.2 The causes of failure could include issues such as: manufacturing defects, overcharging, over-discharging, mechanical damage, overheating or abuse and short circuits. Failures can be caused by internal or external issues.

3.1.3 Regardless of the type of failure or the cause of the failure, the main potential hazard is thermal runaway and ultimately, if not managed, a fire will break out. This BSMP focusses on reducing fire risk associated with the BESS and managing the hazard in the unlikely event that it occurs.

3.1.4 Electrical systems other 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 well understood and regulated, through longstanding industry guidance and codes. Therefore, only the battery component of the BESS is addressed in detail in this report.

3.2 Thermal runaway

3.2.1 Thermal runaway is a self-perpetuating chain reaction in which excessive heat leads to more heat, potentially spreading from one battery cell to the next and causing widespread damage within BESS containers. Li-Ion battery fires are 'deep-seated' in nature, as the materials involved in the ignition and propagation of the fire are tightly integrated into a cell, making firefighting a challenge.

3.2.2 There are four main phases of Li-Ion battery failure while undergoing thermal runaway, explained below and illustrated in Figure 2:

1. Initial battery 'abuse' or Onset - The cause of cell damage being thermal, electrical, or mechanical factors.
2. Off-gassing or Acceleration - Decomposition of the Solid-Electrolyte Interface starts exposing the reactive part of the anode to exothermic reactions with the electrolyte. This is the stage where self-heating becomes prominent (often faster than 0.2°C/minute) and rises linearly with increasing temperature. If this heat is not dissipated by the system, the elevated temperature will cause increasingly severe exothermic reactions. Minute quantities of gas and other cell vapours are generated at this stage including hydrocarbons, benzene homologues and hydrogen halide. Gas levels do not typically occur in detectable concentrations until shortly before thermal runaway; however, research shows that off-gas detection is the most effective

method of predicting thermal runaway. As seen in the figure below, Li-ion battery temperature above 60°C will often result in the rapid progression to thermal runaway. There is typically a prevention window of 11.6 minutes from off-gas detection to thermal runaway as shown in Figure 3.

3. Thermal Runaway - Further heating causes the cells to enter Stage 3 or Thermal Runaway. The cell temperature starts rising rapidly due to the higher rates of cathode and anode reactions, which are fuelled by the rising temperature, in a self-propagating process. Internal arcing, flame or rapid breakdown of materials may occur. Thermal runaway occurs when the rate of self-heating is 10°C/min or quicker. At this high self-heating rate, no preventive intervention is likely to be effective and the event will continue till all energy within each affected cell is released entirely. The temperature at which the thermal runaway occurs is called the Runaway Temperature, T(runaway) and depends heavily on the cell size, cell materials and the cell design (may vary from about 130°C to over 200°C in lithium batteries). Smoke is often seen along with thermal runaway.
4. Destruction - Catastrophic failure is imminent, resulting in a 'fire' with the potential for propagation and even an explosive event.

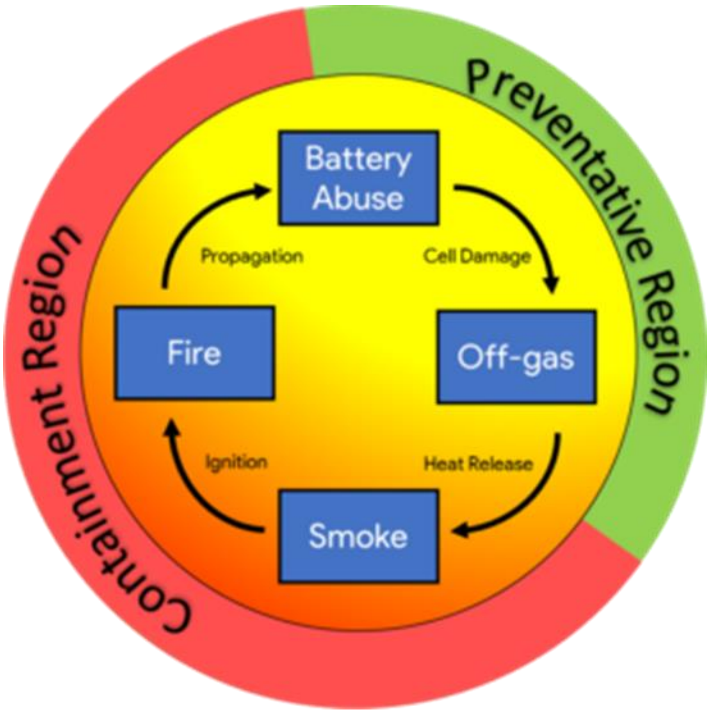


Figure 2 Thermal runaway cycle

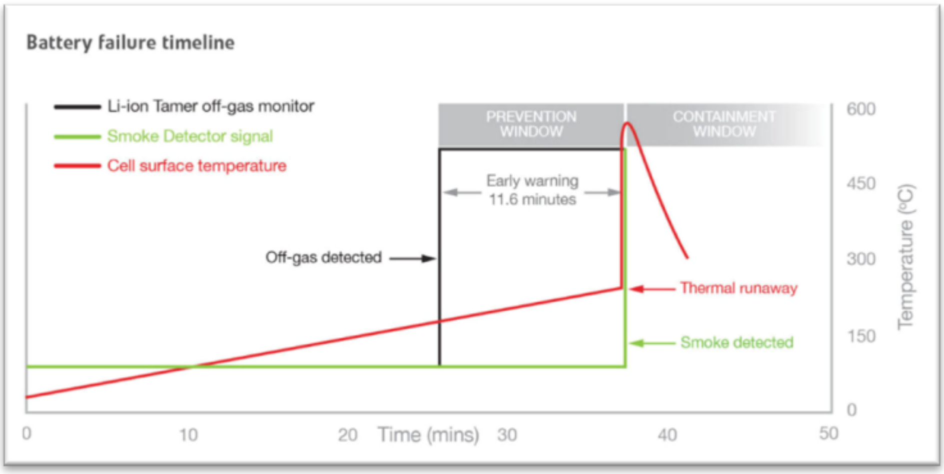


Figure 3 Sample battery failure timeline (Source: Li-ion Tamer)

4. Safety and control measures

4.1 Overview

4.1.1 The below section covers the various safety features which will be incorporated into the Proposed Development to help reduce the risk of a major incident.

4.2 Heating, Ventilation and Cooling (HVAC)

4.2.1 Temperature and humidity within each BESS container must be carefully controlled, both to avoid excessive degradation of the energy capacity and to remove excess heat that can cause breakdowns or lead to fires. BESS manufacturers typically provide specific limits for the maximum and average yearly container temperature and average hourly temperatures. It is important to monitor temperature at various points within the container to ensure the air (if the solution is using air cooling) or the liquid medium (if the solution is using liquid cooling) is circulating properly and there are no hotspots in certain parts of the container.

4.2.2 A suitable BESS with the appropriate HVAC will be installed and it will be operated and maintained as per recommendations of the manufacturer and as per good industry practice. RWE will have its own operating procedures for all its assets, and will be continuously monitoring the data from BESS assets.

4.3 BMS and fire detection

4.3.1 All BESS units are equipped with a Battery Management System (BMS), which is typically provided by the BESS supplier. The BMS is designed as a three-level system which monitors and manages operational and safety parameters at the cell, module and rack level. This ensures that quick and effective remedial action can be taken automatically if an issue is identified even at the individual cell level.

4.3.2 The BMS monitors all essential data associated with each sub-component of the BESS, including current, voltage and temperature.

4.3.3 Thermal runaway is always seen to start at a certain temperature range and continues as temperature rapidly increases. The BMS detects this. When thermal runaway or the potential for thermal runaway is detected, the BMS disconnects the relevant cell, module or rack and thus limits the progression of thermal runaway. Most BMSs begin disconnection of the respective component significantly before thermal runaway commencement temperatures are reached.

4.3.4 Along with this disconnection, alarms are automatically activated as soon as any concerns are observed.

4.3.5 A key step in BESS fire risk management is to ensure that the BESS is equipped with a robust fire detection system. In addition to monitoring temperatures, not just at container level but also at rack, module and cell level, this also includes detecting off-gassing and smoke, or any other sudden changes in battery operating parameters that could be indicative of a fire or thermal runaway. Emergency-stop functionality is automatically triggered by the BESS' control system when fire risk is detected, and in most cases, ensures that the BESS can be shut down far before thermal runaway occurs.

4.3.6 The fire detection system will be provided by the BESS supplier and will be certified to the relevant industry standards. The fire detection system and monitoring of alarms will be managed by the site's operators.

4.4 Fire suppression

4.4.1 If a fire occurs within a container, an automated fire suppression system is triggered. Depending on the asset, this can be based on water sprinklers, a clean agent (aerosol), or a combination of both. RWE intention is to use an automatic clean agent rather than water-based system as this regarded as good practice for a number of reasons:

- Flooding a container with water will almost certainly destroy the electrical equipment within it and is not considered an appropriate solution for combatting electrical fires.
- While the application of water is a straightforward way to reduce temperatures, this does not essentially remove the issue of thermal runaway and is not always a practicable solution as large volumes of water are required to suppress a thermal runaway fire, requiring large on-site water storage or fire hydrants.
- If a container is flooded, there is a risk for contaminated water to leak into the surrounding area and cause contamination, this requires specific fire water containment to be installed and leads to increased costs and design complexities.

4.4.2 Due to these reasons, most BESS suppliers now provide clean agent fire suppression rather than water-based solutions and the majority of BESS projects in the UK are being designed and installed on this basis. Insurance providers and first responders are generally comfortable with these systems provided appropriate certification and testing is in place.

4.4.3 Clean agent systems interrupt the chemical chain reaction of fire, deplete oxygen and reduce temperatures below what is required for combustion. Unlike water-based fire suppression, clean agents do not cause damage to electronic equipment and have found long-standing use across a wide range of sectors to combat electrical fires. In the case of clean agent fire suppression being triggered, the risk of pollution or impact on human health in the wider Proposed Development surroundings can be considered negligible as the (relatively small) amounts of gas will disperse in atmosphere and BESS containers on the Proposed Development site will be placed at least 300m from the closest residential properties. Emergency response personnel will be appropriately trained to handle containers that use this suppression type, and modern BESS containers can be fully accessed from the outside which minimises any potential exposure.

4.4.4 Early engagement with local fire safety personnel will be carried out to ensure that all relevant stakeholders are clear on the proposed system and the fire response strategy. RWE also proposes that at the entrance to the there is an Information Box which contains details of each battery on site, its chemical make up, the exact location, and any details from the manufacturer about how to tackle a fire from the unit, as well as information about the fire suppression systems installed.

4.4.5 It should be noted that clean agents will not stop thermal runaway. For AC-coupled systems, where there are large numbers of BESS containers located in close proximity to each other, emergency response services may seek to spray water onto adjacent containers to prevent a thermal runaway-related fire from spreading between containers. This risk is much less relevant to the Proposed Development due to the BESS containers being distributed across the solar farm site.

4.4.6 The spread of fires can be assessed via a fire risk assessment and mitigated considerably by allowing sufficient space between the BESS containers and other site infrastructure. A spacing of at least 3m will be provided between BESS containers and two sides of access to the containers maintained for local fire service access.

4.4.8 Further details on the steps taken to minimise fire risk is detailed in Table 2. A list of other standards that would be expected for this battery system is detailed in Appendix A.

4.5 Deflagration

4.5.1 Modern BESS containers, following National Fire Protection Association (NFPA) 68 standards, are equipped with deflagration panels that are designed to direct the force of an explosion upwards in the event of high-pressure gases building up inside the container. Venting upward, rather than outward, reduces the risk of damage to adjacent equipment or injury to first responders.

Figure 4 below illustrates a sample deflagration venting arrangement on a BESS container.

Figure 4 Sample deflagration venting on BESS container (Source: Fike Corp)

4.6 Access

4.6.1 Older BESS projects may feature a design where personnel must enter into a container in order to perform scheduled and unscheduled maintenance or emergency response. As fire safety best practice has evolved, most modern BESS are designed to be accessed purely from the outside. This reduces the risk of injuries to maintenance staff and first responders in the event of a fire. A sample access arrangement for the proposed BESS is shown in Figure 5.

Figure 5 BESS access from the outside (Source: NREL)

4.7 Contamination and avoidance of water suppression

4.7.1 Li-Ion batteries contain hazardous chemical substances and concerns have been raised on some projects, particularly regarding the risk of large volumes of water being contaminated and draining into surrounding water courses (if water is used to suppress a battery fire). Specific containment would need to be designed to ensure this contamination does not spread. This, as detailed in the fire suppression section above, is one of the reasons why most BESS projects developed and installed in the UK at present use aerosol-based fire suppression rather than water-based fire suppression where possible.

4.7.2 Water for firefighting purposes would be sourced from the nearest available supply: this water would be used only to cool areas adjacent to a BESS container to prevent fire spread, rather than being used to attempt to directly fight a fire within a BESS container.

4.8 Layout considerations and benefits of DC Coupling

Landscaping

4.8.1 There is a risk of a BESS fire incident causing damage to the PV modules and combiner boxes in the vicinity of the affected container. We note that this kind of damage can take place even on solar farms that have no BESS component, e.g. in the case of an inverter failure or grass fire. Regular vegetation management is key to mitigating the risk of any fire spreading across the site and this will be carried out as part of the Solar PV maintenance.

4.8.2 The layout of the site has taken vegetation and landscape screening into consideration to ensure that whilst landscape visual mitigation is incorporated there is no additional risk to the BESS units. This is actioned through noting within our ES Appendix 2.14 Outline Landscape and Ecological Management Plan (LEMP) (Document Reference 6.4.2.14), the grass around the BESS units will remain trimmed, and low, on a more frequent basis than compared to other elements of the site like the wildflower meadow. Any vegetative screening, for example hedgerows and trees, will be located at least 10m away from the edge of a BESS unit to prevent fire spreading and impacting local wildlife.

Turning heads and site access

4.8.3 In order to allow fire vehicles to remain in forward gear and not need to undertake a three point turn within the site, a number of turning circles have been provided. The location of these will be on maps at the site entrance so that fire and rescue services can understand how to navigate the site.

4.8.4 The road perimeter will be of a grade suitable of accommodating the weight of a fire and rescue service vehicle.

4.8.5 The majority of solar/BESS schemes, developed and constructed in the UK to date, are AC-coupled. Here, the BESS and solar components have their own dedicated inverters and the BESS containers are typically installed within a compact BESS compound in one section of the site, close to the Proposed Development substation.

4.8.6 The Proposed Development is designed on a DC-coupled basis, whereby the BESS and solar modules share the inverter/transformer stations. As a result, the BESS containers are distributed across the entire site, with each BESS container being immediately adjacent to an inverter/transformer station. While this is a less common configuration in the UK market, there are some projects that have been built out in a similar layout in the UK. DC coupling is widely established in other markets such as the US, where subsidy schemes incentivise this type of layout.

4.8.7 From a fire safety perspective, a DC coupled scheme reduces the risk of a widespread fire event as it is much less likely that a fire in an individual BESS container could spread to another container, compared to an AC-coupled scheme. Industry best practice recommends maintaining at least 3m spacing between containers and this distance is comfortably respected in the case of the Proposed Development, where each pair of BESS and inverter stations are separated by at least 3m. Careful engagement with emergency response services will ensure that there is suitable access to each of the container locations, and that individual containers can be clearly identified in the case of a fire incident. Notice boards will be placed at all entrances showing the exact location of the board with respect to the overall site, showing the shortest route to other parts of the site and detailing the agreed procedure to manage an emergency situation.

4.8.8 At least 3m spacing will be left between the inverter station and BESS within each pair. This would reduce the risk of a BESS fire incident damaging the adjacent inverter as well. Lastly, proof of Certification and testing of the BESS will be provided prior to commencement of the proposed development. This will be manufacturer specific and details can be provided as part of a pre-commencement condition once the final manufacturer has been chosen.

4.9 Certification and testing of the BESS

4.9.1 UL9540A is an internationally recognized test method for evaluating thermal runaway fire propagation in BESS. It was first published in 2017 and is regularly updated to reflect the maturing BESS market.

4.9.2 When procuring a BESS, it is essential to confirm that the selected technology has been tested according to UL9540A at all relevant levels (cell, module, and unit). This testing procedure evaluates whether cells can exhibit thermal runaway, and how a fire propagates within a module and a container. The tests also capture data on heat and gas release rates, composition and other hazards. This information is then used by the BESS supplier to design the overall layout, system, fire detection and suppression systems and further informs emergency response plans.

4.9.3 It is recommended to also obtain UL9540A test results at the installation level, which assess the effectiveness of the fire and explosion mitigation methods of the BESS.

4.9.4 Ultimately, UL9540A testing services to demonstrate that the risk of thermal runaway starting with an individual cell is minimal, and that in the rare case of a thermal event the BESS is adequately designed to contain and suppress the fire.

4.9.5 RWE will procure, install and operate the BESS as per these industry standards and good industry practices.

Information boxes

4.9.6 At all entrances to the site there will be an Information Box which will contain information that will be shared with the emergency services ahead of the site becoming operational, but will be located in hard copy on site to ensure that any responder is aware of the assets on site.

4.9.7 The information box will contain information covering:

- a map of the site and location of different assets including BESS;
- manufacturer details of all assets including any on site fire suppression equipment, including those inbuilt to assets;
- chemical content information for the batteries;
- make, model, and details of all batteries on site;
- manufacturers recommended course of action in the event of a fire (if available);
- contact details for the operator of the site; and
- location of emergency isolation points.

4.9.8 The information box will be checked and updated were changes are made to the site.

4.10 Electrical safety devices

4.10.1 In addition to the above measures to the elements raised above, there are a number of electrical safety devices employed to limit the risk of an electrical fault within the battery. These risks are considered smaller than the thermal runaway due to the technology being more established, however the safety measures are still considered in detail to ensure that all risks are minimised:

- internal fuses at battery cells;
- contactor at rack/string and bank level;
- overcharge safety device;
- over discharging safety device;
- thermal monitoring;
- smoke detectors; and
- heat detectors.

4.11 Summary of safety features

4.11.1 Below is a summary of the safety features incorporated within the BESS units.

- For the BESS units themselves, they have specific industry standard and good practice design elements integrated including external access and maintenance points.
- The current industry standard is NFPA 855, Standard for the Installation of Stationary Energy Storage System (Ref 1-1) and the Applicant also requires any system selected to comply with UL9540 (Ref 1- 2), which demonstrates the fire propagation for Li-Ion batteries at cell, module unit level.
- HVAC to monitor, regulator, and control the operating temperature of the batteries with inbuilt isolation trips in case of temperature which deviates the approved allowance and cannot be rectified.
- Battery Management System monitoring which monitors the individual cells, modules, and racks.
- Aerosol fire suppression to reduce the chances of fire starting.
- Deflagration panels to ensure that any build-up of pressure is directed upwards as opposed to outwards.
- External access panels as opposed to internal.
- Layout design to limit the proximity of batteries to each other.
- Certification and testing of procured.
- Information Box at the site entrance for Local Fire Authorities detailing the site location, layout, and information relevant for the batteries.

5. Consultation

5.1.1 This section outlines the consultation carried out with County Durham and Darlington Fire and Rescue Service (CDDFRS), summarises relevant guidance from the National Fire Chiefs' Council (NFCC) and sets out how the proposed development responds to the issues raised.

5.1.2 The National Fire Chiefs Council (NFCC) issued guidance1 in relation to Grid Scale Battery Energy Storage Systems in November 2022. This guidance was designed for developers and Local Planning Authorities to consider elements of BESS schemes which could be amended to reduce the risk of fire, and ensure that should an adverse incident occur, that Local Fire and Rescue Services are well supported in their response.

5.1.3 RWE welcomes the guidance from the NFCC and supports their comment that local Fire Rescue Services are engaged throughout the process. This is something RWE endorse and act upon to ensure that the Proposed Development will take onboard any views / comments at the earliest stage.

5.1.4 The NFCC guidance document has a number of points that developers should consider in the design of their sites (inter alia):

- access to the site;
- suppression devices;
- proximity to vegetation;
- information boards for emergency plans;
- BESS layout;
- isolation equipment employed; and
- emergency vehicle access design.

5.1.5 RWE has consulted the guidance and used it to design the Matrix of safety measures included as Table 2. The guidance is also used as a framework for consultation with the relevant Local Fire Authority, County Durham and Darlington Fire and Rescue Service (CDDFRS).

5.1.6 A meeting was held with CDDFRS in October 2023 where the Proposed Development was outlined and the key design and management procedures relevant to fire risk explained. Following this meeting, CDDFRS posed a number of queries relating to the system design and construction. These queries, alongside responses from RWE and where the detail is provided within this BSMP or other documents that form part of the DCO are outlined below in Table 1.

[1] Grid Scale Battery Energy Storage System planning – Guidance for Fire and Rescue Services, National Fire Chiefs' Council, November 2022 , https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf

5.1.7 It is noted that engagement is ongoing with CDDFRS on this outline BFSMP and agreement outstanding. RWE will ensure that the management measures within the outline BFSMP are agreed as principles of common ground prior to operation of the BESS. Engagement will continue and outputs updated in the detailed BFSMP.

Table 1: County Durham and Darlington Fire and Rescue Service (CDDFRS) Consultation

Element consulted upon	Applicant Response
The battery chemistries being proposed (e.g Lithium-Ion Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC)). This is important because: a) Battery chemistries will directly affect the heat released when a cell goes into thermal runway b) Battery chemistries will influence vapour cloud formation c) An understanding of the battery chemistry is useful when requesting scientific advice during an incident	Refer to Section 2.3 of this outline BFSMP. ES Chapter 2 The Proposed Development (Document Reference 6.2.2) and the Design Approach Document (Document Reference 7.2) also outline key characteristics of the BESS.
The battery form factor	Refer to Section 2.3 of this outline BFSMP ES Chapter 2 The Proposed Development (Document Reference 6.2.2) and the Design Approach Document (Document Reference 7.2) also outline key characteristics of the BESS.
Type of BESS	Refer to Section 2.3 of this outline BFSMP ES Chapter 2 The Proposed Development (Document Reference 6.2.2) and the Design Approach Document (Document Reference 7.2) also outline key characteristics of the BESS.
Number of BESS containers / cabinets	Refer to ES Chapter 2 The Proposed Development (Document Reference 6.2.2) and the Design Approach Document (Document Reference 7.2).
Size/Capacity of each BESS unit (typically in MWh)	The capacity of each BESS container is not defined at this stage
How the BESS units will be laid out relative to one another	Refer to section 4.4.6 of this outline BFSMP; also Works Plans (Document Reference 2.2) – Work No 2 and the General Arrangement Plans provided in ES Figures 2.2 – 2.8 (Document Reference 6.3.2.2-8).
A diagram / plan of the site	Refer to Works Plans (Document Reference 2.2); the Environmental Masterplan (Document

Element consulted upon	Applicant Response
	Reference 2.5), and ES Figures 2.2 – 2.8 (Document Reference 6.3.2.2-8).
Evidence that site geography has been considered (e.g. prevailing wind conditions)	Refer to ES Appendix 2.5 Major Accidents and Disasters Assessment (Document Reference 6.4.2.5)
Access to, and within, the site for FRS assets	Refer to Sections 4.6 and 4.8 of this outline BFSMP
Details of any fire-resisting design features	Refer to Section 4 and Table 2: Matrix of Safety Measures in this outline BFSMP
Details of any: a) Fire suppression systems b) On site water supplies (e.g. hydrants, EWS etc.) c) Smoke or fire detection systems (including how these are communicated) d) Gas and/or specific electrolyte vapour detection systems e) Temperature management systems f) Ventilation systems g) Exhaust systems h) Deflagration venting systems	Refer to Section 4 and Table 2: Matrix of Safety Measures in this outline BFSMP
Identification of any surrounding communities, sites, and infrastructure that may be impacted as a result of an incident	Refer to ES Appendix 2.5 Major Accidents and Disasters Assessment (Document Reference 6.4.2.5)

Table 2: Matrix of safety measures

Project Stage	Fire Department	Location/Layout	Equipment	Operation and maintenance
Feasibility	▪ Identification of the local Fire and Rescue service (FRS).	▪ Identification of proximity to buildings, trees, utilities. ▪ Identification of prevailing wind direction and site conditions. ▪ Identification of potential access routes. ▪ A preliminary site layout is prepared based on best industry practices. These include a minimum of 3m from each BESS container and other project equipment or structures. ▪ Where practically feasible, guidance from National Fire Chief's Council on battery storage is followed for the preliminary design.	▪ Battery technology selected. This is expected to be Lithium Iron Phosphate (LFP). ▪ A preliminary list of battery suppliers is drafted and reviewed. ▪ The battery is housed in containers with a suitable fire rating. The containers will be accessed from the outside with no personnel entering the containers.	▪ The design is developed while considering safety and ease of access and maintenance of the batteries.
Planning	▪ Preliminary engagement with the relevant FRS. ▪ Develop Emergency Response Plan (ERP) with local FRS.		▪ Refine design while considering feedback from the FRS. ▪ Where minimum spacing cannot be provided thermal barriers will be used in accordance with applicable codes and standards.	

Project Stage	Fire Department	Location/Layout	Equipment	Operation and maintenance
Procurement	▪ The requirements for the procurement are developed based on planning requirements, recommendations from the FRS and industry leading technical and safety requirements. ▪ The preferred supplier/contractor (once selected) and local FRS interact and discuss the solutions and designs. ▪ Continue to develop ERP in line with design progression.	▪ The final design and selected equipment will adhere to all relevant international codes and standards. ▪ Equipment is procured from Tier 1 suppliers who have a good safety track record for BESS projects. ▪ The procured equipment will have: – suitable and automated cooling, ventilation, fire detection (heat and smoke) and fire suppression systems; – combustible gas sensors; – deflagration vents; and – appropriate HVAC to maintain temperature control; ▪ Once the equipment and design is finalised, a fire risk assessment (FRA) is carried out to identify scope and scale of fire spread. Where a change to the design is required to further reduce fire risk, as identified in the FRA, this will be considered and implemented.		▪ The containers will comprise a three level Battery Management System (BMS) that will monitor cell, module and rack level data. This ensures that quick and effective remedial action can be taken automatically if an issue is identified at each level of the BESS during operation. ▪ The BMS monitors temperature continuously and alarms are activated as soon as any concern is observed.
Construction	▪ Plan training exercises with local FRS. ▪ ERP to be in place for construction activities.	▪ Labels and signage will be installed clearly showing dangerous, electrical equipment/areas and evacuation locations. ▪ All equipment will be stored in a secure storage area, that complies with Original Equipment Manufacturer (OEM) guidelines. ▪ Site is secured with suitable fencing to prevent unauthorised access.	▪ All selected equipment will have necessary certifications and factory acceptance testing reports will be reviewed prior to shipping of equipment. ▪ BESS will be transported as per international transportation standards. ▪ BESS will be commissioned as per the BESS suppliers standard operating	▪ The construction will ensure that all access roads are constructed to ensure ease of access and safe operation and maintenance of the BESS. ▪ An O&M strategy is finalised before moving to the operations phase.

Project Stage	Fire Department	Location/Layout	Equipment	Operation and maintenance
		▪ All personnel will have suitable training and certifications to ensure the BESS is installed and commissioned correctly.	procedures, local and international codes and standards to ensure it is installed correctly and safe to operate. ▪ Where necessary, a construction stage FRA will be carried out to validate the design and determine the final O&M strategy. ▪ BESS will be installed based on the design, in alignment with planning and as per the discussions with local FRS.	
Operations	▪ O&M strategy and ERP to be kept up to date and tested regularly. ▪ Detailed drawings, Battery, fire detection and fire suppression system specifications will be stored on site for easy access by FRS personnel.	▪ All H&S labels and signage are maintained. ▪ Information Box for Fire Rescue Services at all site access points.	▪ The BESS are contained in containers that are accessed from the outside. No maintenance personnel will have to enter the containers. ▪ The containers will comprise a three level BMS that will monitor cell, module and rack level data. This ensures that quick and effective remedial action can be taken automatically if an issue is identified at each level of the BESS.	▪ The O&M for the BESS will be carried out by certified personnel. ▪ The O&M will be carried out as per OEM recommendations and the O&M manual.

Project Stage	Fire Department	Location/Layout	Equipment	Operation and maintenance
			▪ The BMS monitors temperature continuously and alarms are activated as soon as any concern is observed. ▪ Any equipment that has failed or is at risk will be analysed and replaced with equipment of relevant standards and certification.	

6. Relevant standards and regulations

6.1.1 There are many design standards relevant to BESS design and safety: this section lists these standards for reference.

Table 3: General Standards

Regulation/Requirement	
Health and Safety at Work Act 1974;	
The lifting operations and lifting equipment regulations 1998 (LOLER)	
Provision and Use of Work Equipment Regulations 1998 (PUWER)	
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR)	
Workplace (Health, Safety and Welfare) Regulations 1992	
Personal Protective Equipment at Work Regulations 1992	
Management of Health and Safety at work regulations 1999	
The regulatory reform (fire safety) order 2005	
The Fire Regulations 2022	
Fire Safety in Construction Work (HSG168)	
The Construction (Design and Management) Regulations 2015 (CDM 2015)	
Compliance with the rules, regulations, installation and O&M Manuals	
Standard	**Definition**
ISO 9001:2015	Quality Management Systems
ISO 31000	Risk Management
ISO 14001:2015	Environmental Management Systems
ISO 27001:2022	Information Security Management Systems
ISO 45001:2018	Occupational health and safety management systems

Table 4: Design and Installation Standards - Transportation standards

Standard	Definition
UN38.3	Transport of Lithium metal and Li-Ion batteries
UN3480	Li-Ion Batteries
IEC 62281:2019	Safety of primary and secondary lithium cells and batteries during transport

Table 5: Design and Installation Standards - Fire protection standards

Standard	Definition
NFPA 855	Standard for the installation of stationary energy storage systems.
NFPA 68	Standard on explosion protection by deflagration venting
BS EN 54	Fire detection and fire alarm systems
BS EN 15276	Fixed firefighting systems
UL 9540	Standard for energy storage systems and equipment.
UL 9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.
NFCC Guidance	Grid Scale Battery Energy Storage System Planning

Table 6: Battery energy storage system standards

Standard	Definition
IEC 61427	Secondary cells and batteries for renewable energy storage for on-grid applications
IEC 60050-482:2004/AMD2:2020	International Electrotechnical Vocabulary
IEC 60050-631	International Electrotechnical Vocabulary – ESS
IEC 62485-1	Safety requirements for secondary batteries and battery installations
IEC 62485-2	Safety requirements for secondary batteries and battery installations
IEC 62485-5	Safety requirements for secondary batteries and battery installations
IEC 62619:2022	Secondary cells and batteries containing alkaline or other non-acid electrolytes
IEC 62620	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Large format secondary Lithium cells and batteries for use in industrial applications
IEC 62933	Electrical Energy Storage (EES) systems
IEC 62933-1	ESS: Terminology
IEC 62933-5-1 EES	Safety considerations related to grid integrated ESS
IEC 62933-5-2 EES	Safety considerations related to grid integrated ESS – electrochemical

Standard	Definition
IEC 62933-2 EES Part 2-1	Unit parameters and testing methods – general specification
IEC 62933-2 EES Part 2-2	Unit parameters and testing methods - Application and performance testing
IEC 62933-3 EES	Planning and Installation
EN 62933-4 EES	Environmental Issues
IEC 63056:2020	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries for use in electrical ESS
EUR 2016/631	Requirements for grid connection of Generators (RfG)
UL 1741/SA	Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for use with Distributed Energy Resources
IEC 62477	Safety requirements for power electronic converter systems and equipment
IEC 62116	Test procedure of islanding prevention measures for utility-interconnected inverters
IEEE P2030.3	Standard for test procedures for electric energy equipment and systems for electric power system applications
UL 1642	Standard for Safety – Lithium Batteries
UL 1973	Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
IEEE 1375	Guide for the Protection of Stationary battery systems
IEEE 1657-2018	Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries
IEEE 1679-2020	Recommended Practice for the Characterisation and Evaluation of Energy Storage technologies in Stationary Applications
IEEE 2030.2.1-2019	Guide for Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Applications Integrated with Electric Power Systems

7. References

[1] N. F. C. Council, "Grid Scale Battery Energy Storage System planning – Guidance for FRS," 2022. [Online]. Available: https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf.