FENWICK SOLAR FARM

Fenwick Solar Farm

EN010152

Framework Battery Safety Management Plan

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1. Introduction

1.1 Scope of this Document

1.1.1 This Framework Battery Safety Management Plan (BSMP) document, produced on behalf of Fenwick Solar Project Limited (hereafter referred to as ‘the Applicant’), outlines the key fire safety provisions for the Battery Energy Storage System (BESS) proposed to be installed at Fenwick Solar Farm (hereafter referred to as ‘the Scheme’) including measures to reduce fire risk and fire protection measures.

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

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

1.1.4 As the operation and maintenance phase is anticipated to commence in 2030, reference to current measures and guidelines are included here. However, this document will be updated prior to construction of the BESS to take account of prevailing guidance.

1.2 Project Description

1.2.1 The Order limits, shown on **ES Volume II Figure 1-2: Site Boundary Plan [EN010152/APP/6.2]**, identify the maximum extent of land anticipated to be acquired or used for the construction, operation and maintenance, and decommissioning phases.

1.2.2 In this report the following definitions are used to describe the key areas and elements of the Scheme. These are illustrated in **ES Volume II Figure 1-3: Elements of the Site [EN010152/APP/6.2]**:

a. The Order limits – the collective term for all land required for the Scheme comprising the Solar Photovoltaic (PV) Site, Grid Connection Corridor, and Existing National Grid Thorpe Marsh Substation; and

b. Solar PV Site – the total area covered by the ground-mounted Solar PV Panels, planting and mitigation areas, Field Stations, Battery Energy Storage System (BESS) Area, On-Site Substation, and associated infrastructure.

1.2.3 For the purposes of this document, a concept design has been considered that uses a BESS based upon LFP lithium-ion battery technology. This technology is considered to be a reasonable worst case for the purposes of the assessment in terms of BESS toxic gas emission potential (Hydrogen Fluoride production) and explosion risk (significant levels of hydrogen produced during thermal runaway).

1.2.4 The BESS design and system chemistry type is still to be determined and the final battery chemistry will be confirmed as part of the detailed design prior to the commencement of construction.

1.2.5 The design of the BESS and its impact are controlled in several ways. Prior to commencement of construction of the BESS, a BSMP (in accordance with this Framework BSMP) is required to be submitted to City of Doncaster Council and approved, in consultation with the Environment Agency (EA) and South Yorkshire Fire and Rescue Service (SYFR). The BSMP must be implemented as approved and maintained throughout construction, operation and decommissioning.

1.2.6 The concept design consists of the BESS enclosures and the associated transformers, inverters and switchgear (energy storage system (ESS) equipment). It is currently anticipated that the Scheme would include 432 BESS enclosures which would be located at a centralised BESS Area (of up to 250 m by 200 m), within Field SW10 of the Solar PV Site (refer to **ES Volume II Figure 2-3: Indicative Site Layout Plan [EN010152/APP/6.2]**) The final number of BESS would be determined during detailed design and will be dependent upon technology available at the time.

1.2.7 To ensure the BESS system remains within recommended operating parameters each of the individual BESS enclosures would have an integrated heating, ventilation and cooling (HVAC) system. This may involve a HVAC system that is external to the container, located either on the top of the unit or attached to the side of the unit. If this uses air to heat and cool the BESS enclosure, it will have a fan built into it that is powered by auxiliary power.

1.2.8 The concept design consists of the BESS enclosures and ESS equipment. The BESS enclosures, ESS equipment, and auxiliary systems, such as cooling, uninterruptible power supply (UPS), fire and gas detection systems, monitoring and control, will be designed in accordance with national and international BESS standards and good practice guidance available at the time. A separate BESS control building would also be located within the BESS Area. The BESS control building would consist of up to five shipping-type containers.

1.2.9 Once operational, the plant will be designed to operate unmanned with access required for maintenance only, with an anticipated design life of 40 years.

1.3 Potential BESS Failure

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

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

1.3.3 Regardless of the type of failure or the cause, the main potential hazard is thermal runaway and ultimately, if not controlled, a significant flaming or explosive gas venting incident and therefore this report focusses on reducing fire and explosion risks associated with the BESS and managing the hazard in the unlikely event that it occurs.

1.3.4 Other electrical systems than the batteries which form part of the BESS can carry fire risks, however due to the extensive historic long-term deployment of other technology such as transformers, inverters and switchgear, these risks are better understood and regulated, through longstanding industry guidance and codes. Therefore, only the battery component of the BESS is addressed in this report.

1.4 Safety Objectives

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

a. To minimise the likelihood of an event. This is an overriding priority;

b. To minimise the consequences should an event occur;

c. To restrict any event to the BESS Area and minimise any impact on the surrounding areas;

d. To automatically detect and begin to fight a fire as soon as possible;

e. To ensure any personnel on the BESS Area are able to escape safely away;

f. To ensure that firefighters can operate in reasonable safety where necessary;

g. BESS design and site layout should minimise the requirement for direct Fire and Rescue Service (FRS) intervention in a thermal runaway incident i.e. direct hose streams or spray directly on BESS battery systems. FRS intervention in worst case scenarios would ideally be limited to boundary cooling of adjacent BESS and energy storage system (ESS) units to prevent the fire from spreading. This strategy would be finalised with SYFR and be clearly communicated in an Emergency Response Plan (ERP), the production of which is secured by this document.

h. If the BESS system is designed to safely burn out to remove the risk of stranded energy in the battery systems, then full scale free burn testing will have been conducted to demonstrate that loss will be safely limited to one container without the intervention of SYFR.

i. To ensure that fire, smoke and any release of toxic gases do not significantly impact site operatives, first responders and the local community.

j. To ensure that firewater run-off is contained and tested before release or, if necessary, removed by tanker and treated offsite.

1.5 Relevant Guidance

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

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

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

a. National Fire Chiefs Council (NFCC) Grid-Scale Battery Energy Storage System planning – Guidance for FRS (2024) (Ref. 1).
b. National Fire Protection Agency (NFPA) NFPA 855 (2023) Standard for the Installation of Stationary Energy Storage Systems (Ref. 2).
c. NFPA 68: Standard on Explosion Protection by Deflagration Venting (Ref. 3).
d. BS EN 14797 (2006): Explosion venting devices (Ref. 4).
e. NFPA 69: Standard on Explosion Prevention Systems (Ref. 5).
f. Underwriters Laboratories (UL) UL 9540A (2019) Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems (Ref. 6).
g. UL 1642 (2020): Standards for Lithium Batteries (Ref. 7).
h. UL 1973 (2022): Batteries for Use in Stationary and Motive Auxiliary Power Applications (Ref. 8).
i. UL 9540 3rd Edition (2023): Standard for Energy Storage Systems and Equipment (Ref. 9).
j. FM DS 5-33 (2023) FM Global Datasheet. Lithium-Ion Battery Energy Storage Systems (Ref. 10).
k. United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116: Fire Energy Storage Systems, 2016 (Ref. 11)
l. DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid-Connected Energy Storage Systems, 2017 (Ref. 12)
m. Scottish and Southern Energy TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide, 2019 (Ref. 13).
n. BS 5839 Part 1 2017: Fire Detection and Fire Alarm Systems for Buildings (Ref. 14)
o. The Regulatory Reform (Fire Safety) Order (RRO) 2005 (Ref. 15).
p. BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC – AC (Ref. 16).
q. BS EN IEC 62619 (2017) Secondary cells and batteries containing alkaline or other non-acid electrolytes. Safety requirements for secondary lithium cells and batteries, for use in industrial applications (Ref. 17).

2. BESS Safety Requirements

2.1 Safe BESS Design

Procurement

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

2.1.2 The Applicant only works with leading battery integrators with global presence – whose expertise in system integration of battery cells and modules, inverters and transformers, in combination with intelligent software for management and optimisation of energy services from the battery – is critical for successful operation of any battery project.

2.1.3 The Applicant’s policy is to work with battery storage integrators and component manufacturers which are ISO 9001, ISO 14001 and OHAS 18001 certified companies. We require the designs to incorporate the most advanced fire suppression systems, including adhering to the UL9450 A and NFPA 855 standards, as well as conform to local and UK industry standards.

BESS Design

2.1.4 The BESS will be designed to address prevailing industry standards and good practice at a time of detailed design and implementation. BESS system and components used to construct the facility will be certified to UL 9540 (2023) and/or BS EN IEC 62933-5-2 standards (or any future standards which supersede this).

2.1.5 As a minimum, the battery system will have completed unit or installation level UL 9540A testing, demonstrating that thermal runaway propagation will not spread between modules or between battery racks and the generation of explosive gases will not threaten container structural integrity. This offers a high level of protection against fire and explosion risk.

2.1.6 NFPA 855 provides the most comprehensive guidelines for BESS design and site installation specifications. The BESS enclosure will be designed to withstand overpressures generated by the battery system during thermal runaway, explosion protection systems should ensure that overpressure does not exceed 3 psi-g. As a minimum, an integrated BESS active ventilation system will comply with NFPA 855/NFPA 69 guidelines. If the BESS design integrates hybrid systems, sparker system or performance design explosion protection systems should be validated through BESS free burn testing, lean gas mixture testing and requisite pressure testing required by NFPA and EN standards. Further, the BESS enclosure will have completed full UL 9540A testing or large-scale Third Party Fire and Explosion testing without pressure waves occurring or shrapnel being ejected.

2.1.7 A BESS fire suppression system, if integrated by the BESS Original Equipment Manufacturer (OEM), will conform to NFPA 855 guidelines, and the suppression system should be tested to UL 9540A latest standard or significant scale third party fire and explosion testing. The current trend for BESS cabinet systems is not to integrate automatic fire suppression systems and to demonstrate that a worst-case scenario is the safe burn out of a single BESS cabinet without fire brigade intervention, decommissioning is an easier process if stranded energy (live battery modules) risks are removed. In most BESS cabinet designs a dry pipe sprinkler system can be installed for SYFR to operate if they believe that internal suppression is required during a thermal runaway event. BESS Area water supply capability must factor in additional volume for this potential requirement.

2.1.8 If a BESS enclosure is a container design (20 ft, 40 ft), a fire suppression system will need to be integrated unless a full free burn test has shown that both fire and explosive events can be safely contained. If the BESS enclosure is a walk-in design, a fire suppression system must be installed. As good practice, fire suppression system performance will be benchmarked against free burn testing and a minimum of three suppression tests will have been conducted. An independent Fire Protection Engineer (FPE) specialising in BESS will review all UL 9540A test results and any additional fire and explosion test data which has been provided and validate the suppression system design.

2.1.9 NFPA 855 (2023) confirms water is the most effective battery fire suppression agent and, therefore if a BESS Fire Suppression System (FSS) is integrated, a water-based system will be considered for each BESS enclosure designed to control or fully suppress a fire without the intervention of SYFR. The suppression system must be capable to operate effectively in conjunction with a gas exhaust/ventilation system to minimise deflagration risks. System design and water supply requirements will be fully agreed with SYFR.

2.1.10 If the BESS system is designed to safely burn out without internal fire suppression systems (to remove the risk of stranded energy in the battery systems), full-scale free burn testing will be conducted to demonstrate that loss will be safely limited to one container without the intervention of SYFR. BESS designs available in 2024 compliant with this good practice include the Tesla Megapack 2XL, Fluence Cube, and Wartsila GridSolv Quantum BESS systems. These BESS designs have conducted UL 9540A and 3rd Party full scale free burn testing to validate safe equipment spacing and demonstrate that deflagrations do not occur or can be safely constrained. UL 9540A heat flux test data can also establish safe distances between containers and ESS equipment but will not be conclusive if full propagation of the battery system does not occur in the test.

2.1.11 As good practice, additional 3rd Party fire and explosion testing should be utilised by the BESS Original Equipment Manufacturer (OEM) to demonstrate that structural integrity is maintained and toxic gas emissions to the closest receptors are below Public Health England (PHE) guidelines when the battery system is fully consumed (burnt out). An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results and any additional 3rd Party fire and explosion test data which has been provided and share conclusions with SYFR i.e. the need for additional water supply for boundary cooling or a dry pipe sprinkler system.

2.1.12 In addition to this, good practice guidance for electrical sites within the UK has been consulted with regards to BESS Area layout and separation distances for the transformers and inverters.

2.1.13 Safety Certifications and mitigation features typically found within battery module design, which the Applicant will commit to for the Scheme, include:

a. Internal fuses;

b. Liquid cooling system;

c. Active thermal management system (TMS);

d. Contactor at rack/string and bank level;

e. Overcharge safety device;

f. Internal passive protection products;

g. Venting systems and gas channels;

h. Thermal or multi-sensor monitoring devices.

2.1.14 Battery cell certified to UL 1973 and/or BS EN 62619 and tested to UL 9540A unit or installation level for BESS designs.

2.1.15 Module design will be certified to UL 1973 and/or BS EN 62619 and tested to UL 9540A unit or installation level.

System Location

2.1.16 Within the Solar PV Site, the selection of the location of the BESS has been based on a number of factors. The most pertinent factor being the selected BESS Area has maximised the distance to receptors where practicable. This has the benefit of reducing the visual and noise impact but also minimises any potential impacts on the local population should an event occur. The proposed location of the BESS Area has been identified using the following minimum offsets:

a. Residential properties at least 500 m

b. Public Rights of Way at least 30 m

c. All woodland at least 15 m

d. Individual veteran/ancient trees at least 15 m (or greater if required by the root protection area)

e. Hedgerows (with trees) at least 15 m

f. Hedgerows (no trees) at least 5 m;

g. All trees above 4 m in height at least 15 m (based on the extent of the canopy drip line and heights indicated on the topographic survey);

h. Ponds at least 10 m;

i. Watercourses at least 10 m measured from the bank top; and

j. Trees with bat roost potential at least 15 m.

2.1.17 The above offsets relate the edge of the BESS Area (i.e. the BESS perimeter fence line). The BESS enclosures will be set back a further 25 m (minimum) from the BESS perimeter fence line.

System Layout

2.1.18 Both the indicative site design and final detailed site design will provide separation between key system components or groups of key system components.

2.1.19 The BESS will be broken into discrete groups consisting of battery containers and inverters and transformers. Each group will be separated from the next. This separation will limit any fire that is not able to be contained to the affected group or part of the battery system and allow emergency access in case of an intervention.

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

a. Potential debris impact radius is defined as 100 feet (ft) or 30.5 metres (m) i.e. this is a typical explosion risk safe exclusion zone radius as modelling and previous BESS incidents typically show 25 m to be maximum radius.

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

2.1.21 The separation distance between the battery enclosures and Order limits boundary will be a minimum of 30 metres.

2.1.22 The separation of the inverters and transformers will, depending on the architecture and volume of oil, be optimised at detailed design stage to minimise the likelihood of any spread of fire between adjacent components.

2.1.23 The layout of the Scheme provides adequate separation between enclosures, additional ESS equipment i.e. transformers, inverters, PCS, switchgear, and other key site structures and infrastructure. The UK National Fire Chiefs Council (NFCC) 'Grid Scale Battery Energy Storage System planning – Guidance for FRS (2024)' will be followed at an indicative design stage, which comprises:

a. To protect BESS enclosures from exterior risks, they shall be provided with impact protection to prevent damage to battery enclosures by vehicles or construction equipment and use Damage Limiting Construction (DLC) techniques.

b. The BESS layout (refer to **ES Volume II Figure 2-3: Indicative Site Layout Plan [EN010152/APP/6.2]**) allows a separation distance of 3 m between BESS enclosures and ESS equipment, and 3 m between adjacent BESS enclosures. This exceeds the NFPA 855 (2023) guidelines of 3 feet, considered safe practice by the latest NFCC guidelines if UL 9540A testing shows propagation does not occur.

c. NFCC guidelines allow reduced separation distances if suitable design features can be introduced. If reducing distances, a clear, evidence-based case for the reduction will be shown in the detailed design phase and supported by heat flux test data i.e. UL 9540A unit or installation testing and/or third party fire and explosion testing and agreed with SYFR.

d. Areas within 10 m of BESS enclosures do not contain combustible vegetation and would not be planted with any new combustible vegetation wherever possible. Where this is not feasible a full risk assessment would be conducted, and mitigation features applied if required by SYFR. Any other vegetation on site would be kept in a condition such that they do not increase the risk of fire on site.

e. The BESS enclosure would have an internal fire resistance rating of at least one hour (according to NFPA 855, BR 187 and FM Global Datasheet 5-33).

f. The BESS area would be designed to integrate fire hydrants and static water tanks for firefighting. Water tanks will be located at least 10 m and hydrant at least 15 m from the nearest BESS enclosure. Water access points, whether hydrants or tank connections, would be located in consultation with the SYFR to provide redundancy and safe operating distances for firefighters.

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

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

Battery System Enclosures

2.1.25 BESS enclosures will house the battery systems, electrochemical components and associated equipment. Being either one, or multiple containers joined, or close coupled to each other. They will be mounted on a concrete foundation, although other types of foundations (for example ground screws, metal piles, or compacted stone/gravel) may be used depending on the local geology or land quality.

2.1.26 The BESS enclosure will be installed by a certified and qualified installer. The BESS enclosure will be UL 9540And/or BS EN IEC 62933-5-2 certificated. Ingress protection testing of BESS enclosures is conducted under UL 9540And/or BS EN IEC 62933-5-2 certification of any BESS system. Typical BESS enclosure ingress protection levels are IP55/NEMA 3R or IP66/NEMA4. IEC Factory Acceptance Testing (FAT) or an independent manufacturing audit will be carried out to ensure the supplied BESS enclosures comply with the requisite certified ingress protection levels.

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

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

2.1.29 Where required, BESS enclosure walls will have a minimum one-hour fire resistance rating to BS EN 13501-2 and BS EN 1364-1 standards.

Fire Detection and Suppression

2.1.30 In order to achieve the safety objectives, the Scheme will employ monitoring systems that will help identify any abnormal operation and safely shutdown the system before it develops, these systems will be independent of the control systems and equipment that can cause the abnormal event and avoid the use of Safety Integrity Level (SIL) rated risk controls. Other measures include:

a. Thermal monitoring of the battery containers and automated cut-out beyond safe parameters;

b. Battery cooling systems with automated fail-safe operation;

c. Emergency Stop – both remote and local;

d. The fire and gas detection system for the Scheme will comply with NFPA 855 (2023) and NFPA 69. This means that smoke, fire and gas detection equipment will be installed on site. New BESS multi-sensor equipment in development which measures combinations of air temperature, hydrogen, volatile organic compounds, overpressure, shock and vibration, and moisture ingress will also be considered if fully tested with the BESS design. The gas detection systems should have external BESS beacon and audible alert facility. If the BESS enclosure does not integrate internal fire and gas detection equipment then fire and explosion mitigation protection systems must be validated through full scale burn testing and deflagration modelling i.e. Tesla Megapack XL2. The final fire detection design will be validated by an independent Fire Protection Engineer under the responsibility of the Operations, Engineering and Maintenance Contractor prior to construction, and will be approved by SYFR.

e. If a BESS fire suppression system is integrated to provide thermal runaway mitigation it will conform to NFPA 855 (2023) guidelines, and the suppression system will be tested to UL 9540A latest standard or significant scale third party fire and explosion testing. Fire suppression system performance will be benchmarked against free burn testing. An independent Fire Protection Engineer specialising in BESS will be contracted by the Operations, Engineering and Maintenance Contractor to review all UL 9540A test results and any additional fire and explosion test data which has been provided and validate the suppression system design.

f. NFPA 855 (2023) confirms that water is the most effective battery fire suppression agent, therefore if an automatic water-based system is integrated into BESS enclosures this must be designed to control or fully suppress a fire, without the intervention of SYFR. The suppression system will be capable of operating effectively in conjunction with a gas exhaust/ventilation system to minimise deflagration risks. System design, water supply requirements and drainage capture design will be fully agreed with SYFR.

g. NFCC (2024) guidance acknowledges that it is increasingly common for BESS enclosures to be designed without integrated automatic fire suppression systems because high levels of thermal insulation are integrated which allows enclosures to be closely spaced whilst preventing propagation of fire to adjacent BESS.

h. If a BESS enclosure design does not integrate automatic fire suppression systems and a dry pipe sprinkler or spray system is integrated, then NFCC (2024) guidance will be followed. Connections to any dry pipe systems that are required to be installed on the BESS Area should installed in accordance with BS 9990 Non-automatic firefighting systems in buildings code of practice (Current Edition) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (Current Edition). If a dry pipe system is integrated for the scheme, SYFR instantaneous connection points will be located at a safe distance from enclosures and clearly signed for SYFR response, in accordance with NFCC guidelines.

i. The NFPA 855 working group on BESS fire and explosion protection issues is likely to prohibit deflagration venting (passive protection) being used as the sole form of explosion control. The performance requirement for all types of explosion protection systems to avoid catastrophic structural failure of BESS enclosure designs, is to limit thermal runaway incident overpressure below 3 psi-g. Explosion protection systems not covered by NFPA 68 and 69 standards are commonly referred to as performance design explosion mitigation systems, these include automatic doors or vents which open to ventilate explosive gas mixtures and/or relieve pressure.

j. The NFPA 855 working group is also proposing to prohibit the use of clean agent or aerosol fire suppression systems within BESS enclosures unless fire and explosion testing can demonstrate that use of such systems does not present a deflagration hazard. If an aerosol fire suppression system (FSS) is integrated into each BESS enclosure, then the system must be designed and certified to discharge specifically for an ‘electrical fault’ fire and shall not discharge in any thermal runaway scenario ensuring a gas exhaust system can remain in operation.

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

l. Energy Storage Management Systems/Battery Management Systems (ESMS/Battery Management System (BMS) controls will follow NFPA 855 (2023) recommendations (new IEC and IEEE standards are being drafted). Battery system data analytics will be integrated into ESMS/BMS systems and controls which reduces Thermal Runaway risks. Data Analytics can also be used to predict accurate End-of-Life timeframes and provide operator maintenance alerts.

2.1.31 Other measures to minimise the risk of a fire event that will be implemented include:

a. Any ventilation and gas extraction system will be designed to exhaust flames and gases safely outside in case of fire inside the BESS enclosure, without compromising the safety of first responders. The ventilation system should be provided with suitable ember protection to prevent embers from penetrating BESS enclosures (HVAC, gas exhaust, deflagration panels).

b. As a minimum, a BESS active ventilation system will comply with NFPA 855 (2023)/NFPA 69 guidelines which require the prevention of a dangerous build-up of explosive gases (25% LEL). The gas exhaust/ventilation system must have redundancy and can be separate to any HVAC system providing climate control. Heating and cooling of the battery modules will be provided by an independent liquid cooling system which is separate to any HVAC system providing climate control for the BESS enclosure. When mechanical ventilation is required to maintain concentrations below the required limits, it shall be interlocked, so that the system shuts down upon failure of the ventilation system.

c. Where active emergency gas ventilation is used to mitigate an explosion hazard, the disconnect for the ventilation system should be clearly marked to notify personnel or first responders to not disconnect the power supply to the ventilation system during an evolving incident.

d. The BESS enclosure will be designed to withstand overpressures generated by the battery system during thermal runaway, explosion protection systems should ensure that overpressure does not exceed 3 psi-g. If the BESS design integrates hybrid systems, sparker system or performance design explosion protection systems should be validated through BESS free burn testing, lean gas mixture testing and requisite pressure testing required by NFPA and EN standards. Further, the BESS enclosure will have completed full UL 9540A testing or large-scale Third Party Fire and Explosion testing without pressure waves occurring or shrapnel being ejected. An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results and any additional fire and explosion test and modelling data which has been provided.

2.2 Safe BESS Construction

2.2.1 The following activities would be undertaken to construct the BESS Area:

a. Installation of fencing, CCTV, roads, drainage;
b. Installation of electric cabling;
c. Construction of foundations;
d. Import of components to Site;
e. Installation of BESS enclosures, transformers, inverters, and switchgear;
f. Installation of control building; and
g. Installation of fire water tanks, hydrants, fire water containment.

Transportation

2.2.2 The appointed contractor will ensure transported BESS equipment will be prepopulated with batteries and will have undergone Factory Acceptance Testing (FAT) to IEC 62933-5-2 standards. Site Acceptance Tests (SAT) will follow IEC 62933-5-2 and IEEE 2962 (in development) standards and protocols.

2.2.3 By following a logical sequence of works with each step being built upon the preceding one the system can be safely assembled without risk and all mitigations against issues in place before the next step occurs.

2.3 Safe BESS Operation

Control Room

2.3.1 The BESS will be monitored by the on-site control building as well as 24/7 monitoring by a remote-control room.

a. Staff will be fully trained and familiar with the BESS technologies and will be responsible for alerting SYFR and for connecting SYFR with BESS incident Subject Matter Experts (SMEs).

b. A 24/7 remote control room will monitor the security of the BESS Area, and monitoring and detection systems will be repurposed in an emergency to support first responders. NFPA 855 (2023) defines the minimum monitoring and control standards

c. The 24/7 control room will have the capability to immediately shut the system down should an incident occur, and the need arise. It will also implement the ERP, acting as a point of contact to the emergency services.

d. In some circumstances it will be necessary to discharge the batteries to enable the first/second responders to deal with the incident. This capability could potentially be achieved through the remote facility (24/7). The precise methodology in this regard will be agreed in the ERP once the detailed design of the BESS is known. This will be prepared in conjunction with SYFR and is secured through this document.

e. The control room will also be responsible for the security of the Order limits with state-of-the-art detection and monitoring systems. These can be repurposed in an emergency to support first responders.

f. The control room will have the ability and authority to immediately shut the system down should the need arise.

g. The control room will be responsible for the implementation of the emergency plan acting as a point of contact to emergency services.

h. Signage should be installed in a suitable and visible location on the outside of the BESS enclosures, identifying the presence of a BESS system. Signage would be as per NFCC guidelines and will also include details of:

    i. Relevant hazards posed i.e. the presence of High Voltage DC Electrical Systems is a risk, therefore their location should be identified.

    ii. The type of technology associated with the BESS.

    iii. Any suppression system fitted.

    iv. 24/7 Emergency Contact Information

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

Control Architecture

2.3.2 NFPA 855 (2023) stipulates that a BMS should at a minimum provide the following safety functions:

a. High cell temperature trip to isolate the module or rack when detecting cell temperatures that exceed limits.

b. Thermal runaway trip to isolate the battery system when a cell is detected to have entered a thermal runaway condition.

c. Rack switch fail-to-trip to disconnect the rack if any failure is detected. Inverter/charger fail-to-trip to isolate the BESS enclosure at the breaker if the inverter/charger fails to respond to a trip command.

d. Inverter/charger fall-to-trip (supervisor level): This function initiates a trip command to an upstream breaker to isolate the ESS if the inverter/charger fails to respond to a trip command. The 'supervisor' control system controls the entire system, including the combination of racks, the environmental support systems, and the charging/discharging status. The supervisor level should isolate the ESS if the inverter/charger fails to trip on an appropriate signal, or if communication is disrupted between the inverter/charger and the supervisor control.

2.3.3 The BMS should, at minimum, incorporate NFPA 855 (2023) monitoring and control features. Three new IEEE standards are in development (IEEE P2686, IEEE P2688 and IEEE P2962) which cover BESS data analytics, electrical controls and maintenance/replacement of battery components/systems. These standards should be adopted by the BESS system provider once the standards are published.

2.3.4 If data analytics are not directly integrated by the battery OEM or BESS integrator, the Applicant will ensure a Data Analytics package is integrated to provide a greater range of performance and safety data i.e. predict ageing of the cells in battery systems, alert BMS faults or malfunctions, identify electrical abuse during operations, alert the operator when modules need maintenance or decommissioning. Data Analytics facilitate more accurate assessment of operating temperature variations, voltage anomalies, State of Charge (SOC), and State of Health (SOH). Data Analytics can also monitor complimentary BESS safety features i.e. smoke and gas sensors, BESS multi-sensor equipment, ground fault detectors, etc.

2.3.5 Cybersecurity will form a fundamental part of the system design and architecture as there is an increasing focus in this area from national and international regulatory bodies. International standards such as IEC 62443, UL 1741, IEEE 1815, and IEEE 1547.3 will be consulted and guidance from national sources such as National Cybersecurity Centre inform the implementation and protection measures. Reference should be made to the Health and Safety Executive (HSE) Operational Guidance document OG86.

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

Security

2.3.7 The Order limits security profile will be assessed by an on-call team with dedicated service level agreement in place with input from all local key safety stakeholders. The package of security measures will be agreed with this stakeholder group and would include City of Doncaster Council, SYFR and the police.

2.3.8 The BESS area will have security fencing with a minimum of two points of ingress/egress for first responders and will be clearly signed, with incident emergency response contact details, clear identification of BESS Area hazards, details of site access arrangements such as key codes, which will be provided to SYFR.

2.3.9 The Scheme will also have thermal imaging cameras to alert and locate on site fire risks and integrate high definition CCTV with video analytics to alert and respond to unauthorised site access.

Maintenance

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

2.3.11 Routine maintenance will typically be undertaken on the BESS equipment every 6-12 months depending on the risk profile of equipment. This will encompass all BESS and supporting equipment supplied by the OEM including the fire protection and explosion prevention system. Maintenance will also typically include an automated or visual daily/weekly inspection and rectification of any accumulated noncritical defects.

2.3.12 All maintenance will be undertaken in a carefully controlled manner following the Order limits safety rules and in accordance with the **Framework Operational Environmental Management Plan (OEMP) [EN010043/APP/7.8]** submitted in support of the Application.

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

2.3.14 The operation of the BESS will be managed in accordance with the **Framework OEMP [EN010043/APP/7.8]**.

End of Life/Disposal

2.3.15 All end of life disposal will be undertaken in accordance with the **Framework Site Waste Management Plan (SWMP) [EN010043/APP/7.18]** submitted in support of the Application.

2.3.16 With regards to the decommissioning of the BESS, the requirements will be determined at the procurement contract stage, with the contractor remaining clear that they are the producer of the battery components and the party placing the battery components on the UK market pursuant to the Waste Batteries and Accumulators Regulations 2009 (as amended) and pursuant to the Waste Batteries and Accumulators Regulations 2009 (or such equivalent regulations in force at the time of decommissioning) it has certain obligations in respect of battery disposal.

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

2.3.18 The Applicant will follow the hierarchy of waste management through the life of the Scheme.

3. Firefighting

3.1 Fire Service Guidance

3.1.1 Guidance for the Fire Service for dealing with sites such as powerplants, substations etc. is contained in the Fire Service Manual Volume 2 Fire Services Operations – Electricity (Ref. 18).

3.1.2 The Fire Service Manual stipulates that in all cases involving electrical apparatus, it is essential to ensure, on arrival, that the apparatus is electrically isolated and safe to approach. This should be carried out by the operator at the premises concerned. It is strongly advised that electrical or associated equipment should not be touched or even approached unless it is confirmed to be isolated and safe.

3.1.3 In the event of a fire, the battery system and the transformers serving the BESS will be automatically electrically isolated when a fire is detected within a container. However, the batteries within the BESS enclosures will still hold charge in the event of a fire, even after the electrical system is isolated. It will not be possible to confirm that there is no residual risk from the energised batteries within the enclosure, and this will inform the strategy for firefighting in the emergency plan.

3.1.4 Fire Hydrants and connections to any dry pipe systems that are required to be installed on the BESS Area should installed in accordance with BS 9990 (Non-automatic firefighting systems in buildings - Code of Practice) (current edition) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (current edition).

3.1.5 If a dedicated automatic water-based suppression system or thermal management system (system engineered to directly access cells within battery modules) is provided within each BESS enclosure this will be tested at UL 9540A installation level or through significant scale third party fire and explosion testing. The suppression or thermal management system will be capable of operating effectively in conjunction with a gas exhaust/ventilation system to minimise deflagration risks. The system design must be capable to control or fully suppress a fire, without the direct intervention of SYFR.

3.1.6 The Applicant has consulted NFCC guidelines and engaged with SYFR throughout the pre-application phase and will ensure that the detailed BSMP will include any revisions made to NFCC guidelines due to be published in Q4 2024. Close consultation will continue with SYFR throughout the planning process.

3.2 Fire Water

3.2.1 The design includes four water tanks supplying six fire hydrants (pump driven supply) within the BESS Area as shown in **ES Volume III Appendix 2-2: BESS and On-Site Substation [EN010152/APP/6.3]**. Water tank and hydrant positioning will be agreed with SYFR. The water supply for the fire water tanks will be supplied by potable water mains connected to tanks.

3.2.2 Fire Hydrants provided will achieve a flow rate of 1500 - 1900 litres per minute, flow rate will be agreed with SYFR and will align with the latest NFCC guidance.

3.2.3 The BESS Area design includes the following for water storage structures for the purposes of fire fighting:

a. Four firefighting water storage tanks will be located in or adjacent to the BESS area.

b. The four external firefighting water storage tanks will be between 180,000 to 244,000 litres in capacity.

c. Water storage will either be in sectional steel panel tanks, or cylindrical steel tanks, above ground.

d. Tanks will be supported on structural concrete slab foundations.

3.2.4 Site and BESS design principles and ERP content will ensure that the SYFR are expected to employ a defensive strategy i.e. only boundary cooling should be employed for cooling of adjacent BESS or associated supporting equipment, this ensures that environmental pollution risks are minimised. Boundary cooling typically involves firefighters directing water fog or spray pattern discharge to ensure the incident does not spread to adjacent BESS enclosures. NFCC guidance states: *"If it can be confirmed that the recommended firefighting tactic for the BESS is to defensively fire fight and boundary cool whilst allowing the BESS to consume itself, this will reduce the water requirements, and thus the drainage/environmental protection requirements significantly."*

3.2.5 The BESS scheme will integrate external firefighting water capture drainage. To prevent potential contamination to the surrounding ground, the gravel basins will be non-infiltrating, underlain with an impermeable liner. Penstocks will also be in place at the outlets from the gravelled areas to hold any fire water in that cell of the system. This allows the stored water to be tested before release or, if necessary, removed by tanker and treated offsite.

3.2.6 Water storage tanks will be located at least 10 m away from any BESS enclosure. They must be clearly marked with appropriate signage. They will be easily accessible to SYFR vehicles, and their siting should be considered as part of a risk assessed approach that considers potential fire development/impacts. Outlets and connections should be agreed with SYFR. Any outlets and hard suction points should be protected from mechanical damage (e.g. through use of bollards).

3.2.7 Fire hydrants and connections to any dry pipe systems that are installed on the BESS Area will be installed in accordance with BS 9990 Non-automatic firefighting systems in buildings code of practice (Current Edition) and should be identified in accordance with BS 3251 Indicator Plates for Fire Hydrants (Current Edition).

3.3 Fire Service Access

3.3.1 Access will be designed such that emergency services are able to access the Order limits easily with roads being clearly laid out and signed in accordance with the requirements outlined below.

3.3.2 The proposed access-route width around the BESS area will be 8 m and there are no dead-end access routes.

3.3.3 Road networks within the Order limits will enable unobstructed access to all areas of the BESS Area, two separate SYFR access points to the BESS

Area have been integrated to ensure firefighters do not have to drive through a smoke or gas plume to access the BESS Area.

3.3.4 Signage will be installed in a suitable and visible location on the outside of BESS enclosures identifying the presence of a BESS system. Safety signage will be installed in accordance with Health and Safety (Safety Signs and Signals) Regulations 1996. Signage will include details of:

a. Relevant hazards posed.

b. The type of technology associated with the BESS.

c. Any suppression system fitted.

d. 24/7 Emergency contact information signs on the exterior of a building or enclosure should be sized such that at least one sign is legible at night at a distance of 30 metres or from the Order limits, whichever is closer.

3.3.5 A swept path analysis for emergency vehicles has been undertaken and the roads have been confirmed as suitable for emergency vehicle access.

3.4 Site plans and maps

3.4.1 In accordance with latest NFCC guidance (2024) the detailed BSMP will include a site plan that shows all sensitive receptors within a 1 km radius of the Order limits that could be affected by a fire. The plan will have a compass rose showing north and the prevailing wind direction.

3.4.2 A site plan will be provided to the SYFR that may include, as relevant:

a. The layout of buildings.

b. Any areas where hazardous and flammable materials are stored on site (location of gas cylinders, process areas, chemicals, piles of combustible wastes, oil and fuel tanks).

c. All permanent ignition sources within the Order limits and show they are a minimum of 6 m away from combustible and flammable waste.

d. Any areas where combustible waste is being treated or stored including non-waste material.

e. All separation distances.

f. Any areas where combustible liquid wastes are being stored.

g. Any area where depollution of end of life vehicles (ELVs) takes place.

h. Any area where crushing, shredding, baling of metals or ELVs takes place.

i. Main access routes for fire engines and any alternative access.

j. Access points around the perimeter of the Order limits to assist firefighting.

k. Hydrants and water supplies.

l. Areas of natural and unmade ground.

m. Drainage runs, pollution control features such as drain closure valves, and fire water containment systems such as bunded or kerbed areas (this may be easier to show on a separate drainage plan).

n. Storage areas with pile dimensions and fire walls (where applicable) – this includes wastes stored in a building, bunker, or containers – include indicative pile layouts and ensure it is geographically representative.

o. The location of fixed plant or storage location of mobile plants when not in use.

p. The location of spill kits.

q. The quarantine area.

r. Anything site specific considered needing to be added.

3.5 Emergency Planning

3.5.1 The BESS will have a robust and validated emergency plan, developed in consultation with SYFR.

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

a. Battery chemistry integrated into BESS – can provide fire and explosive risk profile.

b. Battery form factor (cylindrical, pouch, prismatic).

c. Battery energy Wh/KWh – confirmation of new vs second life cells.

d. Battery module cooling system details (e.g. liquid cooling design, air cooling design) – cooling or thermal management system (TMS) capability assessment to stop or reduce battery cell thermal runaway propagation.

e. Battery module vent or gas exhaust specifications.

f. Battery module KWh energy + number of cells contained in the module + battery circuitry details (number of cells in series vs number of cells in parallel).

g. Direct suppression system details – module or rack level integration.

h. Rack design – number of modules and KWh energy, spacing between modules, passive protection features, gas exhaust features, electrical isolation functions, heat or thermal runaway sensor integration, etc.

i. Rack configuration – spacing to adjacent racks, number of racks in BESS, spacing to walls, doors, gas vents and roof.

j. Type of BESS design e.g. container or cabinet, gas exhaust/ventilation features, deflagration vent design features, BESS enclosure level fire protection and suppression system details (proof of testing with BESS design + test data), additional fire or explosion protection features i.e. thermal barriers.

k. EMS/BMS data monitoring capabilities and incident response integration capacity.

l. Number of BESS enclosures on site.

m. Size and MWh capacity of each BESS enclosure.

n. BESS and ESS equipment spacing; spacing to other equipment, boundaries, vegetation, roads or access routes, fire hydrants/water tanks, site building structures, etc.

o. Access routes, observation points, turning areas, LFR equipment and assets, water supply locations and capacity, drainage, and water capture design.

p. Definition and frequency of BESS equipment testing and maintenance requirements.

3.5.3 Digital provision of safety information and procedures must be provided to site operatives, first responders and SMEs during BESS incident response.

3.5.4 Hard copy printed materials must be available onsite (location agreed with SYFR). As a minimum content will include:

a. Digital emergency response plans.

b. Remote emergency shutoff procedures.

c. SDS/Hazardous material documentation.

d. Maps or design drawings.

e. Gas detection capabilities; could include multi-sensor data metrics e.g. Carbon Dioxide (CO2), Carbon Monoxide (CO), Hydrogen (H2), VOC off gas and overpressure and local temperatures.

f. Fire protection system data e.g. temperature, alarming, suppression status, etc. – establish discharge warrantee clauses, emergency BESS venting procedures, discharge times, impact on ventilation and detection systems, etc.

g. ERP training drills for site operatives + SYFR engagement (site familiarisation + training drills) and SME engagement (fire protection experts or battery experts).

h. Other documentation as required by specific BESS project i.e. local response stipulations, contact information for nominated response personnel, community contacts, etc.

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

a. How the fire service will be alerted and incident communications and monitoring capabilities.

b. Facility description, including infrastructure details, operations, number of personnel, and operating hours.

c. Site plan depicting key infrastructure:

i. Site access points, internal roads, agreed access routes, observation points, turning areas, etc.

ii. Firefighting facilities (water tanks, pumps, booster systems, fire hydrants, fire hose reels etc).

iii. Water supply locations and capacity.

iv. Drainage and water capture design and locations.

d. Up-to-date details of the emergency response co-ordinator including the subject matter expert (SME) for the Order limits.

e. Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems.

f. Details and explanation of warning systems and alarms on site and locations of alarm annunciators with alarm details (smoke, gas, temperature).

g. Hazards and potential risks at the facility and details of their proposed management.

h. The role of the FRS at incidents involving a fire, thermal event or fire spreading to the Order limits.

i. Emergency shutoff or isolator locations.

j. A list of dangerous goods stored on site.

k. Site evacuation procedures.

l. Site operation Emergency Management protocols - four phases: discovery, initial response/notification, incident actions, resolution and post incident actions/responses.

m. Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire, wildfires, impacts on local respondents, impacts on transport infrastructure.

3.5.6 The operator will develop a post-incident recovery plan that addresses the potential for reignition of the BESS and de-energizing the system, as well as removal and disposal of damaged equipment.

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

a. The hazards and risks to the facility and their proposed management.

b. Any safety issues for firefighters responding to emergencies at the BESS facility.

c. Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems. Establish response times and site arrival protocols.

d. The adequacy of proposed fire detection and suppression systems e.g. water supply on-site.

e. Natural and built infrastructure and on-site processes that may impact or delay effective emergency response i.e. firefighting water runoff capture.

3.6 Firefighting Consequences

3.6.1 As the BESS will not have personnel access into the battery enclosures, there is unlikely to be any immediate threat to life or safety, only property which forms part of the Scheme.

3.6.2 SYFR in foreseeable and credible emergency response scenarios would most likely adopt a defensive firefighting strategy by using water on neighbouring areas such as battery enclosures and structures to cool down and prevent further fire spread. The Scheme will select a BESS design that has undertaken full scale free burn testing to demonstrate thermal insulation protection capabilities of the BESS enclosure design, validate equipment spacing distances, and demonstrate that deflagrations do not occur and/or can be safely constrained. In accordance with NFCC guidance, the Order limits will be maintained to prevent a fire spreading to the BESS or inadvertently fire loading, by providing a ‘bridge’ or path between BESS enclosures to transmit flaming or radiant heat.

3.6.3 As recommended in NFCC guidance (2024) it is not anticipated that firefighting techniques will require direct hose streams or spray directly on battery systems and will be limited to boundary cooling of adjacent BESS enclosures and supporting equipment to prevent the fire from spreading. IP ratings of BESS enclosures will be shared with SYFR so that risks associated with boundary cooling can be understood. This strategy will be finalised with the SYFR at the detailed design stage and be clearly communicated in the ERP.

3.6.4 The BESS Area drainage design has also considered the management of fire water, and the likely contaminants potentially associated with a significant BESS fire incident. This means that potential pollutant infiltration is not allowed from the gravelled sections of the drainage system. To prevent potential contamination to the surrounding ground, the gravel basins will be non-infiltrating, underlain with an impermeable liner. Penstocks will also be in place at the outlets from the gravelled areas to hold any fire water in that cell of the system. This allows the stored water to be tested before release or, if necessary, removed by tanker and treated offsite.

3.6.5 Based on the factors of distance to the nearest sensitive receptors (see section 2.1) and the short-term nature of a fire incident it is considered that there is unlikely to be adverse effects at the closest receptor locations in the event of a single BESS thermal runaway incident. Notwithstanding, whilst there is low risk of adverse effects to the closest sensitive receptors, at the detailed design stage the developer will commission a comprehensive battery system and site specific plume study which will validate that there will be no significant off site visibility or toxic emission/pollution impacts from a BESS thermal runaway event The emergency response plan (ERP) produced at the detailed design stage (template outlined in Paragraph 4.5.5) will incorporate all necessary emergency response procedures and actions based upon comprehensive thermal runaway test data supplied by the BESS system provider.

4. Pre-construction Information Requirements

4.1 Summary

4.1.1 The detailed design phase of the Scheme will consider the lifecycle of the battery system from installation to decommissioning. At the detailed design stage, risk assessment tools will be utilised together with detailed consequence modelling to provide a comprehensive site operations and emergency response safety audit.

4.1.2 The battery system mitigation measures adopted in a final BSMP, will reflect the latest BESS safety codes and standards applicable at that stage. Mitigation measures will be discussed and coordinated with SYFR.

4.1.3 A Failure Modes and Effects Analysis (FMEA) of the BESS (BS EN IEC 60812) or Layer of Protection Analysis (LOPA) of the BESS will be conducted to lay the foundation for predictive maintenance requirements and complement the fault indicator capabilities of the BMS data analytics system

4.1.4 Comprehensive Hazard Mitigation Analysis (HMA) will be conducted by a BESS specialist independent Fire Protection Engineer following NFPA 855 (2023) guidelines and recommendations.

4.1.5 As recommended in NFCC guidelines (2024) a BESS system and site specific Plume Analysis study will be conducted to assess the environmental impact of a site incident to sensitive receptors within a 1 km radius. Toxic gas emissions to sensitive receptors must be below Public Health England (PHE) guidelines when the battery system of a BESS is fully consumed (burnt out). In addition to toxic gas emissions, production of Particulate Matter (PM) in a BESS fire should also be included in the assessment. The plume study will also include a visibility impact assessment on any transport links within a 1 km radius of the BESS area.

4.1.6 Additional risk assessments likely to be conducted at the detailed design stage are Fire Risk Analysis (FRA), Explosion Risk Analysis (ERA), Hazard and Operability Analysis (HAZOP). BESS system risk analysis reports are now automatically provided by Tier 1 BESS manufacturers or BESS integrators i.e. NFPA 69 Explosion Prevention Compliance report, Deflagration analysis report, Heat Flux and flame tilt analysis report, UL 9540A test interpretation reports, etc. These will provide SYFR with detailed insights into capability of BESS system hazard mitigation systems to protect against burning and venting thermal runaway scenarios and provide guidance for evaluating site-specific equipment spacing templates.

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

4.1.8 The detailed design phase will determine the approach to addressing the following specific requirements, which will be updated prior to construction of the BESS and submitted to City of Doncaster Council as a detailed BSMP prior to the commencement of construction. The detailed BSMP must include:

a. The detailed design, including drawings of the BESS;

b. A statement on the battery system specifications, including fire detection and suppression systems;

c. A statement on operational procedures and training requirements, including emergency operations;

d. A statement on the overall compliance of the system with applicable legislation;

e. An environmental risk assessment to ensure that the potential for indirect risks (e.g. through leakage or other emissions) is understood and mitigated;

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

4.1.9 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.

4.1.10 Safe decommissioning of the BESS will be addressed prior to decommissioning of the Scheme in a Decommissioning Environmental Management Plan (DEMP), and in accordance with the **Framework DEMP [EN010152/APP/7.9]** submitted as part of the DCO Application.

5. Conclusion

5.1.1 This Framework BSMP has demonstrated in a systematic way the mitigation of the safety risks posed by the BESS in the Scheme.

5.1.2 The detailed design phase will determine the approach to addressing the following specific requirements, which will be updated prior to construction of the BESS and submitted to City of Doncaster Council as a detailed BSMP prior to the commencement of construction. The detailed BSMP must include:

a. The detailed design, including drawings of the BESS;

b. A statement on the battery system specifications, including fire detection and suppression systems;

c. A statement on operational procedures and training requirements, including emergency operations;

d. A statement on the overall compliance of the system with applicable legislation;

e. An environmental risk assessment to ensure that the potential for indirect risks (e.g. through leakage or other emissions) is understood and mitigated; and

f. Emergency Response Plan(s) covering construction, operation and decommissioning phases will be developed once a construction team and an operator have been appointed. These plans will be developed in consultation SYFR and other local emergency services to include the adequate provision of firefighting equipment onsite and ensure that fire, smoke, and any release of toxic gases from a thermal runaway incident does not significantly affect site operatives, first responders, and the local community.

5.1.3 The implementation of the Framework BSMP is secured through a Requirement in Schedule 2 of the DCO. This will stipulate that a detailed BSMP will be submitted to and approved in consultation with SYFR and the Environment Agency by City of Doncaster Council prior to the commencement of the works for the BESS. This plan will be substantially in accordance with the Framework BSMP.

6. References

Ref. 1 National Fire Chiefs Council (NFCC) 2024, Grid Scale Battery Energy Storage System planning – Guidance for FRS

Ref. 2 NFPA 855 (2023), Standard for the Installation of Stationary Energy Storage Systems.

Ref. 3 NFPA 68 (2018), Standard on Explosion Protection by Deflagration Venting

Ref. 4 BS EN 14797 (2007), Explosion venting devices.

Ref. 5 NFPA 69 (2019), Standard on Explosion Prevention Systems

Ref. 6 UL 9540A (4th Edition 2019), Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Ref. 7 UL 1642 (2020): Standards for Lithium Batteries.

Ref. 8 UL 1973 (2022), Batteries for Use in Stationary and Motive Auxiliary Power Applications

Ref. 9 UL 9540 3rd Edition (2023): Standard for Energy Storage Systems and Equipment.

Ref. 10 FM Global, Datasheet 5-33 Electrical Energy Storage Systems, Factory Mutual Insurance Company, 2020.

Ref. 11 United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116: Fire Energy Storage Systems, 2016

Ref. 12 DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid-Connected Energy Storage Systems, 2017

Ref. 13 Scottish and Southern Energy TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide, 2019.

Ref. 14 BS 5839 Part 1 2017: Fire Detection and Fire Alarm Systems for Buildings

Ref. 15 The Regulatory Reform (Fire Safety) Order (RRO) 2005.

Ref. 16 BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC – AC.

Ref. 17 BS EN IEC 62619 (2017) Secondary cells and batteries containing alkaline or other non-acid electrolytes. Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

Ref. 18 Fire Service Manual Volume 2 Fire Services Operations – Electricity (2008)

Abbreviations

Abbreviation/Term	Meaning
BESS	Battery Energy Storage System
BSMP	Battery Safety Management Plan
CCTV	Closed-Circuit Television
DLC	Damage Limiting Construction
EA	Environment Agency
EMS	Energy Management System
ERP	Emergency Response Plan
ESS	Energy Storage System
FAT	Factory Acceptance Testing
FMEA	Failure Modes and Effects Analysis
FRA	Fire Risk Analysis
FRS	Fire and Rescue Service
FSS	Fire Suppression System
HAZOP	Hazard and Operability Analysis
HMA	Hazard Mitigation Analysis
HVAC	Heating, Ventilation, and Air Conditioning
IEC	International Electrotechnical Commission
IP	Ingress Protection
ISO	International Organization for Standardization
KWh	Kilowatt-hour
LFP	Lithium Iron Phosphate
LOPA	Layer of Protection Analysis
m	Metres
NFCC	National Fire Chiefs Council
NFPA	National Fire Protection Agency
OEM	Original Equipment Manufacturer
OHAS	Occupational Health and Safety Assessment Series
OEMP	Operational Environmental Management Plan
PHE	Public Health England

Abbreviation/Term	Meaning
PM	Particulate Matter
PV	Photovoltaic
SAT	Site Acceptance Tests
SIL	Safety Integrity Level
SME	Subject Matter Expert
SOC	State of Charge
SOH	State of Health
SWMP	Site Waste Management Plan
SYFR	South Yorkshire Fire and Rescue Service
TMS	Thermal Management System
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
Wh	Watt-hour

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