Balance Power Projects

Outline Battery Fire Safety Management Plan-Newburn Haugh

CLIENT	Balance Power Projects Ltd
PROJECT	7464
CLIENT PROJECT NO.	N/A
TITLE	Outline Battery Fire Safety Management Plan - Newburn Haugh
DOCUMENT NO.	W7464103 **Revision** 0

REVISION NO.: 0	**PURPOSE:** Client Review and Comment		
Name	**Position**	**Signature**	**Date**
Shane Stevenson Author	Senior Design Engineer	Shane Stevenson	20/09/2023
Adrian Watson Approver	Technical Director	[signature]	20/09/2023

History of Issues / Approvals

REV	DATE	DESCRIPTION OF CHANGES	FILE NO.
0	20/09/2023	First Issue for Client Review	W7464103

Table of Contents

1 Introduction

Battery storage technology is continuously evolving as are the standards and guidance which regulate their use. As such selecting the correct Battery Energy Storage System (BESS) technology provider can be challenging, with many options available from a fast-growing industry.

However, to meet this challenge and ensure that for each new site the best BESS technology is selected, Balance Power Projects Ltd carry out an extensive review of the grid scale BESS available on the market, by using the BATNEEC principle (Best Available Technology Not Entailing Excessive Cost).

This review is carried out during the detailed planning phase of the project to ensure the technology selected is compliant with the latest iterations of the evolving standards and guidance governing their use.

This report provides an overview of the minimum safety features any BESS technology selected for use by Balance Power Project Ltd will incorporate and the steps taken to reduce any potential risk to life, property, and the environment from the BESS.

2 What is a BESS?

A Battery Energy Storage System (BESS) is an electrochemical device that charges (or collects energy) from the grid and then discharges that energy at a later time, to provide electricity or other grid services when needed. Battery Energy Storage Systems are typically designed to provide large capacity over a short period of time i.e., 0-120 minutes.

As demand on the existing electricity grid increases with the growing number of Electric Vehicles (EV's), new homes and a greater number of electrical devices in these homes there is a need for greater flexibility in how the grid supplies power. Currently Electricity generating power stations cannot react quickly enough to cope with unexpected spikes in demand, these facilities typically take up to 1 hours to increase their output. However, the use of BESS technology allows for rapid response from the grid to an unexpected spike in energy demand. The 0-120 minutes of power supplied by the BESS technology allows time for the electricity generating stations to ramp up generations to meet the new demand without any interruption to supply.

Furthermore, the increasing number of wind turbines, solar farms and other renewable energy sources being installed to supply renewable power to the grid has led to instances of too much supply and not enough demand, requiring these sources of power to be curtailed. This means that even on windy or sunny days where power from wind and solar could be harvested this potential energy is lost. Installing BESS technology ensures that when the grid cannot accept energy from these sources that instead of missing the opportunity to harvest this green energy it can be captured by either redirecting the power from these sources directly to the BESS or using the BESS to create and artificial demand on the grid during times of low demand such as throughout the night when most of the population are asleep.

The image in Figure 1 below illustrates the fundamental principles of how a BESS can take power from a grid connection and then supply it back to the grid when needed.

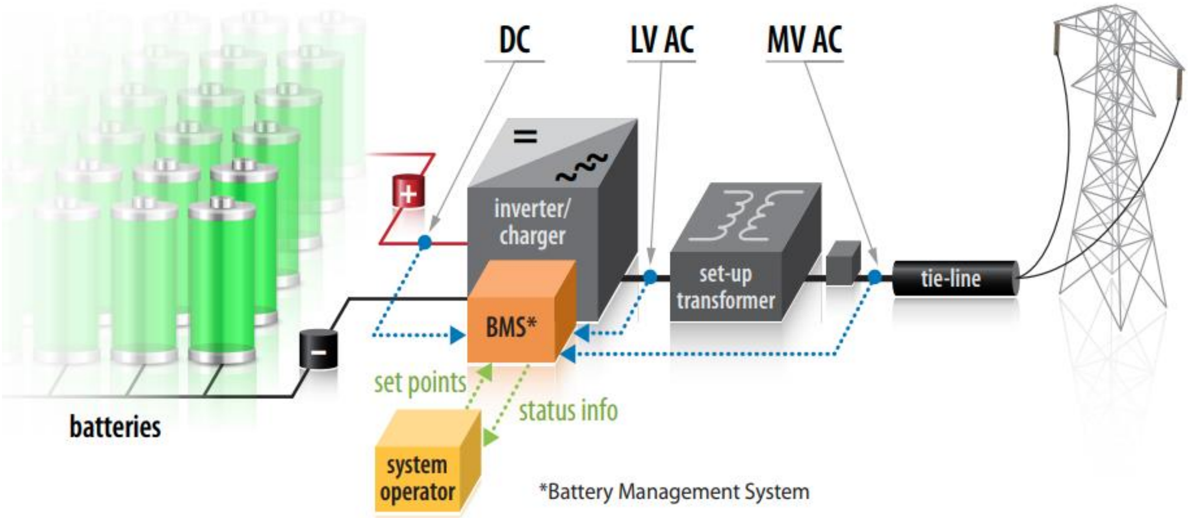

Figure 1: How a BESS Operates

2.1 The Future of Battery Storage

Battery storage capacity in the United Kingdom is likely to heavily increase as the move towards operating a zero-carbon energy system continues. At the end of 2019, the UK battery storage capacity was 0.88 GWh, forecasts suggest that it could be as high as 2.30 GWh in 2025.

Battery storage technology has a key part to play in ensuring homes and businesses can be powered by green energy even when the sun is not shining, or the wind has stopped blowing.

For example, the UK has the largest installed capacity of offshore wind in the world, but the ability to capture this energy and purposefully deploy it can increase the value of this clean energy; by increasing production and potentially reducing costs. The UK government estimates technologies like battery storage systems supporting the integration of more low-carbon power, heat, and transport technologies could save the UK energy system up to £40 billion by 2050, ultimately reducing people’s energy bills.

3 Guidance and Standards

As grid scale BESS technology is a relatively new technology, not all regulative authorities have issued standards and guidance to cover their use. Therefore, until an equivalent British Standard has been issued the industry is defaulting to both the 2021 International Fire Code and 2023 NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.

This is a normal practice, as many of the standards used in the energy industry originated in America, with organisation such as the British Standards Institution working with and then adopting these standards, issuing their own version under a BS title whose contents does not substantially deviate from the original standards.

The following guidance has been considered during the preparation of this report:

- National Fire Protection Association (NFPA): NFPA 855, Standard for the Installation of Stationary Energy Storage Systems (2023)
- 2021 International Fire Code
- UL 9540A Test Method, Testing the fire safety hazards associated with propagating thermal runaway within battery systems.
- The Energy Institute: Battery Storage Guidance Note 1 - Battery Storage Planning (First Edition August 2019)
- The Energy Institute: Battery Storage Guidance Note 2 - Battery Energy Storage Fire Planning and Response (First Edition February 2020)
- The Energy Institute: Battery Storage Guidance Note 3 - Design Construction and Maintenance (First Edition October 2020)
- National Fire Chiefs Council (NFCC) - Grid Scale Battery Energy Storage System planning – Guidance for FRS

3.1 Battery Cell, Module and Rack Safety Standards

United Laboratory Solutions (UL) developed the industry leading methodology for testing the fire safety and hazards associated with propagation of thermal runaway within battery energy storage systems (BESS).

UL 9540A includes a series of progressively larger tests to destruction, beginning at the Cell level and progressing right up to the destructive test of an installation level BESS. Each test is carried out with all battery Cells charged to maximum capacity while all safety features are disabled. Electrical heating plates are used to artificially raise the temperature of the Cells under test until they are forced into thermal runaway.

Each test generates specific data used to evaluate thermal runaway characteristics and fire propagation. The data generated during these tests is used by BESS manufactures to determine the fire and explosion protection requirements for their equipment.

To be considered compliant with the requirements of both the International Fire Code (IFC) and NFPA 855 a BESS system must have undergone and passed the requirements of UL 9540A.

Table 1 below provides a list of the typical safety standards and codes that the battery Cells, Modules and Racks used will be certified to.

3.2 Typical Safety and Code Compliance

Table 1: Typical Safety and Code Compliance

Battery Cells
UL 1973: Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
UL 9540A: Testing the fire safety hazards associated with propagating thermal runaway within battery systems.
UL 1642: Standard for Lithium Batteries
IEC 62619: Specifies requirements and tests for the safe operation of secondary lithium cells and batteries used in industrial applications including stationary applications.
UN38.3: Transport of Dangerous Goods
Battery Modules
UL 1973: Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
UL 9540A: Testing the fire safety hazards associated with propagating thermal runaway within battery systems.
IEC 62619: Specifies requirements and tests for the safe operation of secondary lithium cells and batteries used in industrial applications including stationary applications.
IEC 62933-5-2: Safety Requirements for Grid-Integration EES Systems - Electrochemical -Based Systems
UN38.3: Transport of Dangerous Goods
UL 1741 PCS: Inverters, Converters, Controllers, and Interconnection System Equipment for use with Distributed Energy Resources - Power Control System (PCS) - Certification Requirement Decision
UL 1741 SB: Standard for Inverters Converters, Controllers, and Interconnection System Equipment for use with Distributed Energy Resources - Supplement B
IEC 62109-1: Safety of Power Converters for use in Photovoltaic Power Systems - Part 1: General Requirements

EN 61000-6-2: Electromagnetic Compatibility (EMC) - Part 6-2: Generic Standards - Immunity for Industrial Environments

Battery Racks

UL 9540A: Testing the fire safety hazards associated with propagating thermal runaway within battery systems.

4 Proposed BESS Site

4.1 Planning Application

The recent submission of the planning application 2023/1294/01/DET to Newcastle City Council is supported by this Outline Battery Safety Management Plan.

4.2 Description of BESS Site

The proposed development is a BESS, located on at Newburn Haugh Industrial Estate. It includes the construction and operation of the following equipment:

- 28 prefabricated/modular battery and inverter units
- 14 transformers
- 2 auxiliary transformers
- Control room and welfare unit
- District Network Operator Control Room
- Private Substation
- 132 kV Substation
- Storage Room
- Security and Acoustic Fencing
- Pole Mounted CCTV cameras; and,
- Access track

An extract of the Site Location and anticipated Site Layout Plan (this may be subject to amendment and revision) are shown below:

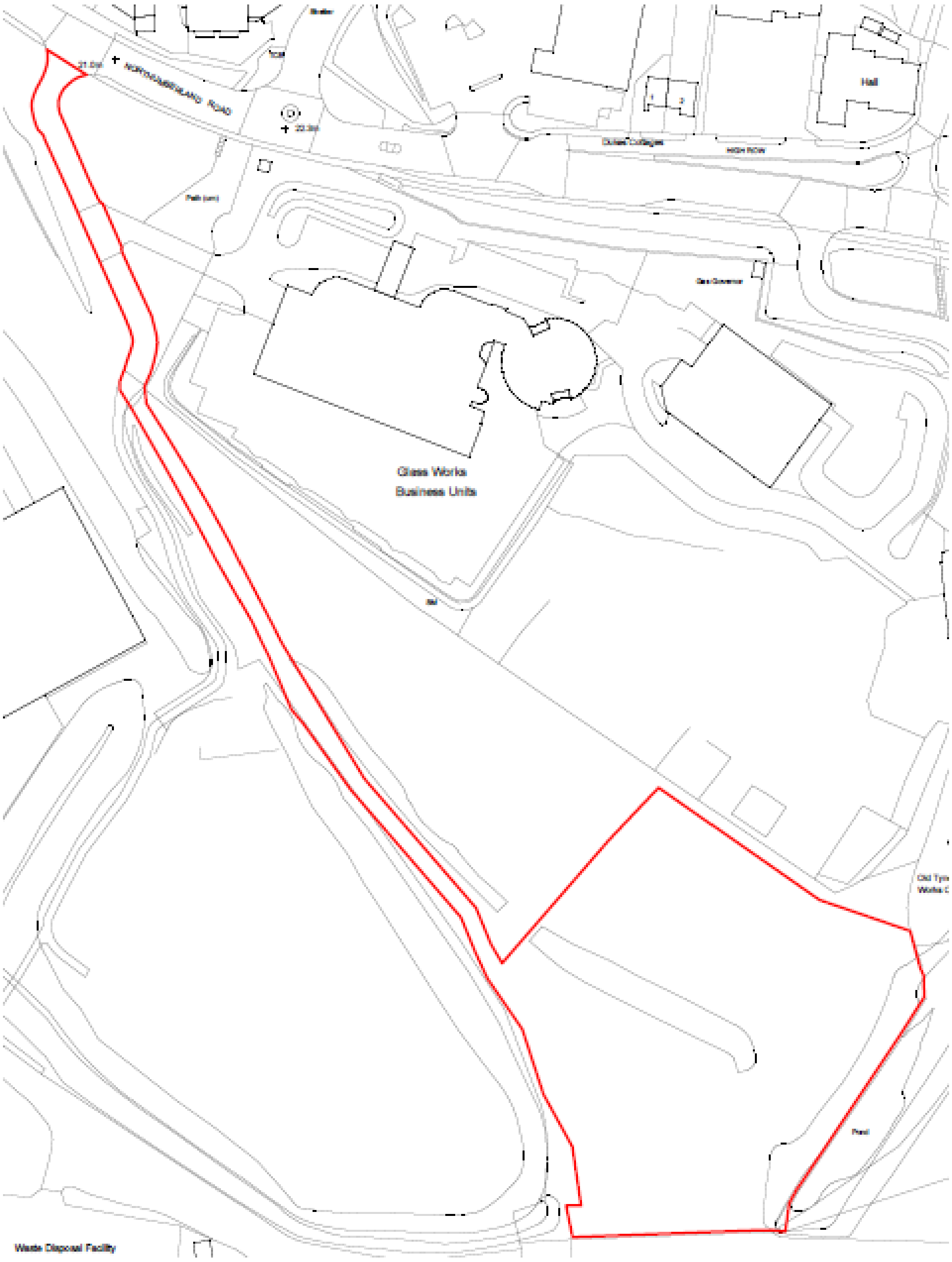

Figure 2: Extract from Site Layout Plan

Figure 3: Proposed Site Layout Plan

5 Battery Fire Safety Approach

5.1 Fire Suppression

At present the standards and guidance for BESS do not require an automatic fire detection or suppression system for outdoor ground mounted BESS installations, although many modern BESS include such a system. These are only required for BESS installed inside a building, room, areas within buildings or walk-in units.

However, in the very unlikely event of an uncontrolled thermal runaway incident, the affected unit should be allowed to consume itself in a controlled 'burn down' as per the recommendation provided in the Energy Institute Battery Storage Guidance Note 2. Applying water to a BESS unit will only slow its eventual combustion.

5.2 Equipment Monitoring

Each battery Cell is continuously monitored and controlled by a Battery Management System (BMS). The main function of the BMS is to protect the battery Cells from any form of electrical or thermal stresses that may happen during normal operation of the battery, and which might lead to thermal runaway.

This is accomplished by the continuous monitoring of parameters such as voltage, temperature and current of each battery Cell. These values are compared against established normal operating parameters as well as historical data collected for each battery Cell. This historical information is used to predict and detect deterioration of any individual battery Cell which is not conforming to the normal operating parameters giving an early warning of a potential issue within that Cell.

If a fault is detected corrective action can automatically be taken by the BMS. These actions range from a warning message for the operator, adjustment of thermal management systems to increase or decrease the BESS internal temperature, isolation and shutdown of an individual battery Module Assembly, entire BESS, or the entire site.

All information gathered by the BMS is captured, recorded, and displayed via the sites Supervisory Control and Data Acquisition (SCADA) system. The SCADA system allows the site operator to remotely monitor and control one or multiple BESS installation from an offsite centralised control room.

The current operational state of the BESS site as well as any warnings generated by the BMS will immediately be displayed by the SCADA system. Any deviation from normal operating parameters will trigger a visual and audible alarm in the centralised control room which in turn allows the operator to interact directly with the BESS control system to address a fault or if needs be to remotely shut down an individual BESS unit or the entire site depending on which action may be appropriate.

This remote access capability also allows the site operator to access support quickly and seamlessly from the BESS suppliers technical support team, should they be required. However, the BMS does not require outside intervention to automatically intervene and bring the BESS into a safe state, nor can the operator override the BMS when a safety shutdown has been triggered.

5.3 Fire Service Access

The proposed Site access and internal roads shown in Figure 3, will provide unobstructed access to the development areas. These roads will be constructed from suitable durable materials and gradients allowing vehicles to safely access the BESS equipment.

5.4 Site Design

The proposed BESS will minimise fire risk by:

- Procuring components that comply with all relevant legislation and best practice guidance at a time of design and implementation.
- Employment of construction techniques that comply with all relevant legislation and best practice guidance at a time of design and implementation.
- Including automatic monitoring and control system
- Connection to manned remote monitoring and control of system including automatic warnings and alarms when a non-normal parameter is detected.
- Including redundancy in the system design to provide multiple layers of protection.
- Designing the facility to contain and restrict the spread of fire using fire-resistant materials, and adequate separation between elements of the BESS - The

separation distance between the battery containers and site boundary shall be in accordance NFPA 855 (2023), which has a guidance of 3 m. (NB: These limits may be reduced to 1 m where testing to U L9450A has been undertaken)

- Offering to work with the local FRS to develop a tactical response that will minimise the risk in the event of fire and mitigate impacts.
- Production of a dedicated Emergency Response Plan, showing full understanding of hazards, risks, and consequences.

6 Requirements from NFCC Guidance

6.1 System Design and Construction

Table 2: System Design and Construction

1. The battery chemistries being proposed (e.g. Lithium-ion Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC)). Because: a. Battery chemistries will directly affect the heat released when a cell goes into thermal runaway. b. Battery chemistries will influence vapour cloud formation. c. An understanding of the battery chemistry is useful when requesting scientific advice during an incident.	Battery chemistry will be confirmed during the detailed design phase after planning permission is granted. A full account of the safety features of the selected BESS can be detailed in a BESS report submitted as part of satisfying pre-commencement conditions. However, any BESS selected for use will have undergone and passed the requirements of UL 9540A.
2. The battery form factor (e.g. cylindrical, pouch, prismatic).	Battery form will be confirmed during the detailed design phase.
3. Type of BESS e.g. container or cabinet.	Refer to Figure 3.
4. Number of BESS containers / cabinets.	Refer to Section 4.
5. Size / capacity of each BESS unit (typically in MWh).	Battery size / capacity of each BESS unit will be confirmed during the detailed design phase.
6. How the BESS units will be laid out relative to one another.	Refer to Figure 3.
7. A diagram / plan of the site.	Refer to Figure 3.
8. Evidence that site geography has been taken into account.	The site will be primarily flat, with adequate separation between equipment and structures.
9. Access to, and within, the site for FRS.	Refer to Figure 3 and Section 5.3.

10. Details of any fire-resisting design features	The selected BESS will comply with the fire and explosion prevention requirements of NFPA 855.
11. 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.	A full account of the safety features of the selected BESS can be detailed in a BESS report submitted as part of satisfying pre-commencement conditions. However, any BESS selected for use will have undergone and passed the requirements of UL 9540A.
12. Identification of any surrounding communities, sites, and infrastructure that may be impacted as a result of an incident.	The site will be laid out to provide the largest possible separation distances to any nearby residential property.

7 Additional Information to be Prepared

The following provides the additional information to be supplied at future stages of the design and development of the proposed BESS development.

7.1 Pre-Commencement Conditions

The applicant offers to produce an Emergency Response Plan to satisfy an appropriately worded planning condition and to show full understanding of how to manage the hazards, risks, and consequences. This can be prepared in collaboration with the local FRS to develop a tactical response that will minimise the risk in the event of fire and mitigate impacts. The Emergency Response Plan will provide site operator emergency protocol (during operation, including decommissioning) to demonstrate that protocols are in place to manage a fire during the operation and decommissioning.

The Emergency Response Plan will also include a section for BESS installation contractor emergency protocol (during construction) to demonstrate that protocols are in place to manage a fire during construction. An example pre-commencement condition is provided below:

"Development of the battery storage compound shall not commence until an Emergency Response Plan has been submitted to and approved in writing by the Local Planning Authority. The Emergency Response Plan must prescribe for measures to facility safety during the construction, operation and decommissioning of the battery storage facility, including the protocols to manage a fire during the operation and decommissioning."

7.2 Health and Safety File

Table 4 below lists information that will be maintained as a 'Health and Safety File' by the site operator to ensure best practice is followed to minimise fire risk. The applicant is committed to producing and maintaining this document as part of a best practice approach.

The information in the Health and Safety File will help to inform the Tactical Information Record developed with the Fire and Rescue Service.

7.3 Information Supplied at the Detailed Planning Phase

Table 3: Information to be Supplied to support the Health and Safety File

Documentation	Description
Statement of compliance with applicable legislation.	To demonstrate compliance with legislation.
Detailed design drawing of battery energy storage system.	To illustrate the sites safe access route and separation between components of the BESS.
Statement of design responses to fire risk.	To accompany the detailed design drawing and explain how the risk of fire spreading has been addressed through the Development Design.
Battery specification.	To ensure FRS are aware of the specific type and chemistry of batteries installed.
Standard operating procedures and guidelines (Relevant to Safety).	To demonstrate an ongoing commitment to regular checks and maintenance during operation e.g., plans for swap-out of suspected modules. Include a list of competencies and/or certification requirements for competent Site Operating Staff.
Battery transportation plan.	To ensure that the transportation of battery cells, including delivery of new, used failed and replacement battery cells to and from the site is carried out in accordance with prevailing legislation.