Technical Appendix 3.3

Battery Safety Statement

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Battery Safety Statement

1 Introduction

1.1.1 The Proposed Development is planned to comprise approximately 415 megawatts (MW) of renewable energy generation and energy storage output capacity, consisting of approximately 130 MW wind energy, approximately 60 MW solar energy, approximately 200 MW of long duration energy storage, and approximately 25 MW of short duration energy storage. It should be noted that although the Proposed Development comprises approximately 415 MW of renewable energy, no more than 400 MW will be exported at any one time.

1.1.2 The power generation of wind and solar generation installations is dependent on wind and solar resource availability. Therefore, it cannot adjust generation to demand. For the decarbonisation of the UK power system the requirement of technologies that can respond to fluctuations in supply and demand the role of battery energy storage systems (BESS) is becoming fundamental. The capabilities of a BESS involve, amongst others, storing electricity to support the grid during peak hours, enhancing energy security and reducing reliance on fossil fuels. This helps balance supply and demand more efficiently, particularly with the growing use of renewable energy sources.

2 Battery Technology and System Description

2.1 Short Duration BESS

2.1.1 The Proposed Development short duration BESS (up to 4 hours discharge duration) will very likely involve Lithium-ion batteries as they are currently dominating the market scene in the UK for short duration BESS. Lithium-Ion provide longer lifespans, higher energy densities compared to other technologies, higher roundtrip efficiency and system costs have been falling over the last decade.

2.1.2 The outline information provided below is based on an assumption of Lithium-ion technology being used for the short duration BESS. However, technology continues to develop in the field of energy storage, therefore it is possible that the short duration BESS could comprise an alternative technology. Confirmation of the selected technology and final design details would be provided nearer to the commencement of construction, proposed to be secured by an appropriately worded planning condition. The design would conform with relevant safety standards and requirements for the selected technology.

2.1.3 A typical Lithium-ion BESS consists of key components that are responsible for the storage and energy management. The battery cells are organised into modules and packs where electricity is stored.

2.1.4 The Power Conversion System (PCS) involves a bi-directional inverter that controls the flow of energy between DC storage and AC grid power. The Battery Management System (BMS) is responsible for the safety in the system operation by monitoring variables such voltage, current, temperature and State of Charge (SoC). The Energy Management System (EMS) is responsible for the optimisation of the charge and discharging processes to enhance performance and longevity. The safety systems such as fire suppression, and monitoring contribute to the safe operational conditions and minimisation of risks such as fires, thermal runaway or system failures.

2.2 Long Duration BESS

2.2.1 The Proposed Development long duration BESS (minimum of 8 hours discharge duration and up to approximately 12 hours discharge duration) will likely comprise flow batteries as opposed to conventional Lithium-ion technology. Initial concept designs are based on Vanadium Flow Battery (VFB) technology. Unlike Lithium-ion batteries, flow batteries use a water based, non-flammable electrolyte, significantly reducing fire risk and allowing safe deployment at greater densities. Long duration BESS technologies like these provide much greater capacity and longer discharge durations than traditional short duration (lithium-ion) BESS schemes and, therefore, provide a different power balancing service to the National Grid.

2.2.2 Similarly to the short duration BESS, it is possible that the system could comprise an alternative technology, given the continuing development of technology in the field of energy storage. As above, confirmation of the selected technology and final design details would be provided nearer to the commencement of construction, proposed to be secured by an appropriately worded planning condition. The design would conform with relevant safety standards and requirements for the selected technology.

3 Risk Management and Mitigation

3.1 Short Duration BESS

3.1.1 Lithium-ion BESS have safety aspects that need to be addressed to ensure safe operation. It shall be noted that safety incidents for BESS are rather rare and potential fire events normally driven by what is called a ‘thermal runaway’ event. This involves a condition where the heat generated inside a battery exceeds the ability of the BESS cooling system to dissipate that heat potentially resulting into a fire event or even explosion. There are key points to consider for risk mitigation and management, these include the following measures.

- **BESS Operational Requirements:** The system operation will be monitored through the BMS and EMS to ensure optimal performance and identify any potential issues at an early stage.
- **BESS Maintenance Requirements:** Preventative maintenance for BESS requires scheduled, proactive actions to minimise the potential risk of plant failures, extension of system lifetime and contribute to system performance. This will result in a reduction of unplanned downtime, reactive repair needs, less frequent component replacements, and improve plant reliability and system efficiency.
- **Fire Suppression Systems (FSS):** The FSS will be fully detailed as part of the detailed BESS design; this is fundamental to detect, control, and extinguish fires before they propagate, especially under a potential thermal runaway scenario. A rapid response from the suppression system helps prevent fire spreading to other cells or modules.
- **Project Design:** The detailed design will allow for proper spacing between BESS units, inclusion of enclosures with suitable thermal resistance allowances, the allocation of water tank(s) with proper water volume sizing, storage containers with deflagration vents, etc. This will contribute to the potential reduction of fire propagation spread under a potential thermal runaway event.
- **Design & Installation Standards and Regulations:** The BESS will be designed and installed according to recognised national and international standards and guidelines (please refer to **Section 4**).
- **Water Supply:** The design will integrate fire hydrants and/or static water tanks depending on the site conditions and presence of a fire main. The placement of water access points near to the BESS is critical for ensuring both effective firefighting and the safety of personnel.
- **Drainage Systems:** A Sustainable Drainage Systems (SuDS) will be included within the detailed design of the BESS, as this is fundamental for the potential management of water runoff from a potential thermal runaway event to protect the environment and prevent contamination of water sources.

- **Site Access:** The BESS design will include provision of adequate access for the Fire and Rescue Service (FRS); firefighters should not have to enter the BESS site and drive through a vapour / gas cloud to reach the scene of operation. An alternative access point will therefore be provided, taking account of the likely wind direction.
- An Outline Battery Storage Safety Management Plan (OBSMP) will be developed at an early project stage and a Battery Storage Safety Management Plan (BSMP) will be developed at the detailed design work stage, to include an emergency response plan.

3.1.2 These measures collectively help in minimising the risk and managing the consequences of thermal runaway in BESS.

3.2 Long Duration BESS

3.2.1 VFB systems are chemically and thermally robust, and safe even when exposed to external fire. Independent testing to the UL 9540A standard (see **Section 4** below) has shown decisively that these batteries have no risk of thermal runaway and as such do not represent a risk of fire.

3.2.2 Regardless, the relevant safety and maintenance considerations noted in **Section 3.1** above will be prepared and implemented as appropriate for the long duration BESS.

4 Safety Standards for BESS

4.1.1 The compliance with relevant safety standards is essential for mitigating risks such as electrical faults, thermal runaway, fire and explosion. A summary list of safety standards to adhere when developing a large scale has been included below:

Lithium-ion

- National Fire Chiefs Council (NFCC), Grid Scale Battery Energy Storage System planning – Guidance for Fire and Rescue Services (FRS), Version 1.0, Published April 2023.
- NFCC, Draft Guidance on Grid Scale BESS, final version to be published in 2025.
- UL Solutions Inc. document UL 9540 Standard for Energy Storage Systems and Equipment.
- UL 9540A: Tests the system's ability to handle thermal runaway and limit fire propagation within and between battery modules.
- National Fire Protection Association (NFPA) 855 Standard for the Installation of Stationary Energy Storage Systems.
- International Electrotechnical Commission (IEC) 62619: International standard for rechargeable battery safety in industrial applications, focusing on preventing thermal runaway, overcharging, and electrical safety.
- FM Global Datasheet 5-33: Offers guidelines for fire protection and hazard mitigation specific to Lithium-Ion battery systems, including guidance on suppression systems for large battery arrays.

Flow Batteries

- IEC 62932-2-2:2020: Flow battery energy storage systems for stationary applications – Part 2-2: Safety Requirements.
- European Committee for Electrotechnical Standardisation (CENELEC) Workshop Agreement 50611:2013: Flow batteries – guidance on the specification, installation and operation

4.1.2 It must be noted that the listing shown represents a summary of BESS safety standards and that these may be updated or superseded by the time the Proposed Development BESS components are ready to be constructed.

5 References

European Committee for Electrotechnical Standardisation (CENELEC) Workshop Agreement 50611:2013: Flow batteries – guidance on the specification, installation and operation. Available at: https://www.nen.nl/en/cwa-50611-2013-en-182840

Florence, L.B., Hopper, D. (2020). UL 9540 Standard for Energy Storage Systems and Equipment. Available at: https://www.ul.com/news/ul-9540-energy-storage-system-ess-requirements-evolving-meet-industry-and-regulatory-needs

FM Global (2023). FM Global Datasheet 5-33: Offers guidelines for fire protection and hazard mitigation specific to Li-ion battery systems, including guidance on suppression systems for large battery arrays. Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjq7NSF57GKAxXaQkEAHUfDNP0QFnoECBwQAQ&url=https%3A%2F%2Fwww.fm.com%2FFMAApi%2Fdata%2FApprovalStandardsDownload%3FitemId%3D%257BFB314761-0A9C-4B8C-9410-A31D6792170B%257D&usg=AOvVaw0grfv1VcA-XZ70Zo4TfWWe&opi=89978449

NFPA (2023). NFPA 855 Standard for the Installation of Stationary Energy Storage Systems. Available at: https://www.nfpa.org/codes-and-standards/nfpa-855-standard-development/855

IEC (2020). IEC 62932-2-2:2020: Flow battery energy storage systems for stationary applications – Part 2-2: Safety Requirements. Available at: https://webstore.iec.ch/en/publication/28334

IEC (2022). International Electrotechnical Commission (IEC) 62619: International standard for rechargeable battery safety in industrial applications, focusing on preventing thermal runaway, overcharging, and electrical safety. Available at: https://webstore.iec.ch/en/publication/64073

NFCC (2023). Grid Scale Battery Energy Storage System planning – Guidance for Fire and Rescue Services (FRS). Available at: https://nfcc.org.uk/consultation/grid-scale-battery-energy-storage-system-planning-guidance-for-frs/