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Outline Battery Safety Management Plan

Levedale Road Battery Energy Storage Facility

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Outline Battery Safety Management Plan

Project:	Levedale Road Battery Energy Storage Facility
For:	Anglo Renewables Ltd
Status:	Final
Date:	June 2023
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Reviewer:	Robert Gandy – **Principal Planning Consultant**

Contents

1.0 Introduction

1.1 Introduction

1.1.1 This Outline Battery Safety Management Plan (OBSMP) has been prepared by Enzygo Ltd. to accompany a full planning application which is to be submitted to South Staffordshire District Council for a proposed battery storage facility and associated works at Land on the South West of Levedale Road, Penkridge, Staffordshire, ST18 9AH (The development).

1.1.2 Enzygo Ltd have worked closely with Anglo Renewables Ltd in collating the technical and safety information used for the detailed design of the Battery Energy Storage Facility (BESF).

1.2 Purpose of Document

1.2.1 The OBSMP details the regulatory guidance reviewed by Enzygo Ltd., to ensure that all safety concerns around the BESF element of the development are addressed in so far as is reasonably practicable.

1.2.2 Battery storage technology is continuously evolving as are the regulations and guidance on the safe operation of a BESF. Whilst the current design is based on the latest regulations, Enzygo will continue to review the regulations and the manufacturers guidelines to ensure that the final design meets the best practice for the design and operation of a BESF.

1.3 Background

1.3.1 Anglo Renewables Ltd is seeking to develop a 50 MW BESF and associated infrastructure at Levedale Road.

1.4 Document Structure

1.4.1 This Outline Battery Safety Management Plan includes the following sections:

- Introduction, including purpose of the document, background, document structure, contributors and consultation requirements
- Description of proposed works
- Guidance
- Battery Energy Storage System Detailed Design Stage
- Conclusions and Summary of Outputs

2.0 Description of Works

2.1 Description of Works

2.1.1 The proposed development is a 50MW Battery Energy Storage Facility which will comprise the following:

- 132kv substation and transformer consisting of:
- 132/33kv transformer
- DNO & Customer switch yards
- Battery switch room
- Battery control room
- Underground cabling
- Battery compound:
- 42 Standalone Battery Cabinets
- 36 Inverters/Transformers
- Palisade & wooden noise mitigation fencing
- Parking facilities
- CCTV monitoring system

2.1.2 It is proposed that the Battery Energy Storage Facility will use Lithium Iron Phosphate battery cells (LFP) as its chosen form of Lithium-Ion battery technology. LFP batteries are proven to have a lower temperature rise when compared to other types of lithium-ion batteries during thermal runaway events. Thermal runaway is a condition that occurs when the chemical reaction inside a battery cell exceeds its ability to disperse heat.

2.1.3 LFP batteries charge at a rate of 1C which means that they can deliver a fast recharge and discharge response whilst generating little heat. They require less ventilation or cooling and can withstand higher temperatures without decomposing.

2.1.4 As well as LFP batteries having stable characteristics, the prismatic cell has multi-layered protection and are housed in sealed Aluminium casing, offering a further level of protection and most importantly good thermal conductivity and cooling performance.

2.1.5 The temperature of every cell is monitored and the temperature should be within the range of 15°C and 33°C. Each cell will be continually monitored to ensure that they stay within this range.

2.1.6 The systems have sensors at the cell, module, unit and system level and the necessary software to warn or if necessary, automatically shut down in the event of a problem.

2.1.7 The battery storage units will come equipped with fire suppression systems; these are set out in more detail below.

3.0 Guidance

3.1 Guidance

3.1.1 The following international guidance has been considered during the preparation of this OBSMP:

- Allianz Risk Consulting (ARC): *Battery Energy Storage Systems (BESS) Using Li-ion Batteries*, Tech Talk Volume 26 (2019)[1]
- National Fire Protection Association (NFPA): NFPA 855, Standard for the Installation of Stationary Energy Storage Systems (2020)[2]
- UL 9540A Test Method, Testing the fire safety hazards associated with propagating thermal runaway within battery systems [3]
- Consolidated Edison and New York State Energy Research and Development Authority- *Considerations for ESS Fire Safety* (February 2017)[4].

3.1.2 At the time of writing, the NFPA and UL United States of America standards are not explicitly relevant to the United Kingdom but notwithstanding this provide valuable guidance and are referred to in the ARC technical note.

3.1.3 More detailed UK guidance is emerging, and it is expected that the regulatory environment will be more developed by the detailed design stage. Examples of existing UK guidance include:

- The Energy Operations Forum: *Good Practice Guide* (December 2014)[5]
- Institute of Engineering and Technology - *Code of Practice for Electrical Energy Storage Systems* (August 2017)[6]
- The Energy Institute: Battery Storage Guidance Note 1- Battery Storage Planning (August 2019)[7].

3.2 Li-Ion Battery Transportation Guidance

3.2.1 International guidance for testing and certification for the transportation of Li-Ion batteries exists in the form of UN38.3[8], published by the United Nations as recommendations.

3.2.2 European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2019 [9] includes mandatory rules for signatory states based on UN38.3

[1] https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/pdfs-risk-advisory/tech-talks/ARC-Tech-Talk-Vol-26-BESS.pdf
[2] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=855
[3] https://www.ul.com/services/ul-9540a-test-method
[4] www.nyserda.ny.gov
[5] https://www.eatechnology.com/engineering-projects/electrical-energy-storage/
[6] https://shop.theiet.org/code-of-practice-for-electrical-energy-storage-systems
[7] https://bit.ly/3LiJ2YP
[8] https://www.unece.org/fileadmin/DAM/trans/danger/ST_SG_AC.10_11_Rev6_E_WEB_-With_corrections_from_Corr.1.pdf
[9] https://www.unece.org/fileadmin/DAM/trans/danger/ST_SG_AC.10_11_Rev6_E_WEB_-With_corrections_from_Corr.1.pdf

recommendations. In the ADR UN 38.3 is mentioned as obligatory. The United Kingdom is a signatory to these rules, so must apply them.

3.2.3 UK guidance on the transport of dangerous goods is available online on the Government's "*Moving dangerous goods, Guidance*" website[10].

3.3 Consultation response from Staffordshire Fire and Rescue Service

3.3.1 Staffordshire Fire and Rescue Service (SFRS) are a statutory consultation body in the consideration of this application.

3.3.2 The applicant seeks to undertake best practice and is committed to approaching SFRS separately to work develop a site-specific response plan. This is discussed in more detail in the recommendations below.

3.4 Anglo Renewables Ltd Energy Storage System Design Approach.

3.4.1 The Development will minimise fire risk by:

- Procuring components that comply with all relevant legislation and best practice guidance
- Employment of construction techniques that comply with all relevant legislation and best practice guidance
- Including automatic fire detection systems in the facility design
- Including automatic fire suppression systems in the facility design
- Including redundancy in the system design to provide multiple layers of protection
- Designing the facility to contain and restrict the spread of fire through the use of fire-resistant materials, and adequate separation between elements of the BESS
- Workings with SFRS to develop a tactical response that will minimise risk in the event of fire

3.5 Allianz Risk Consulting Battery Energy Storage System Design Recommendations

3.5.1 The recommendations set out in the ARC publication are set out in the table below, alongside a demonstration of compliance with the guidance and response from the applicant as appropriate.

Table 1: ARC Recommendations

ARC Recommendation	Project Response
Fire department	Staffordshire Fire and Rescue Service (SFRS) as statutory consultees have been asked to

[10] https://www.gov.uk/guidance/moving-dangerous-goods

• Invite the fire department to your property to discuss BESS hazards. An adequate emergency response is the key to avoiding an uncontrolled fire. Keep in mind that some fire fighters will not fully understand the hazards and may assume that lithium-ion batteries are the same as lithium batteries • Key questions to discuss with the fire department include: - What is the main difference between extinguishing and cooling? - How to handle a damaged battery? - How to manage the flammable and toxic gases? • Plan training exercises with the fire department when the system is commissioned. • Standard Operating Procedures (SOP) & standard Operating Guidelines (SOG) are of major importance and should be updated and tested on a regular basis.	comment on the planning application; SFRS have formally responded with no objection. Anglo Renewables Ltd have committed to approaching SFRS following consent in order to discuss a site-specific response plan, in the form of a Tactical Information Record, for Levedale Road Battery Storage Facility. If the LPA considered it appropriate, and with agreement from SFRS, the applicant would be agreeable to the undertaking of the Tactical Information Record being managed by way of a suitably worded condition.
Construction and Location • Install BESF outdoors a minimum of 20 m (65 ft.) from important buildings or equipment. Maintain a minimum of 3 m (10 ft.) separation from lot lines, public ways and other exposures. • Within the module, maintain a minimum of 1 m (3 ft.) separation distance between enclosures for all units up to 50 kWh when not listed, or up to 250 kWh when listed. • Install a thermal barrier where the minimum space separation cannot be provided. • If the BESS must be located indoors, install in a 2 hour fire rated cut-off	The design of the BESF will reflect prevailing legislative requirements and UK industry recommendations. Separation distances between components within BESS containers/modules will comply with identified applicable UK regulations and legislation identified at the time of detailed design. Thermal barriers will be utilised where the minimum space separation cannot be provided, also in accordance with applicable regulations. The BESF containers will be located outdoors Access to the BESF containers will only be available to competent operational staff who have received appropriate training and certification where required by legislation,

room, which is accessible directly outdoors for manual firefighting. • Restrict the access to competent employees or sub-contractors. • Ensure enclosures are non-combustible.	or under the supervision of competent operational staff. All enclosures will be non-combustible to EI120 standard.
Material, equipment and design • BESF will be tested in accordance with UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*. This standard evaluates thermal runaway, gas composition, flaming, fire spread, reignition and the effectiveness of fire protection systems. Data generated can be used to determine the fire and explosion protection requirements for a BESF. • Place capacitor, transformer, and switch gear in separate rooms according to best engineering practices.	The BESF utilised will hold the relevant test certificates and meet the electrical safety regulation applicable under UK regulations and legislation. The detailed design will identify the location of capacitors transformers and switch gear. The design responses to fire risk requirement will specifically address the placement of these items.
Ventilation and temperature control • Maintaining temperature control is vital to these batteries' longevity and proper operation as they degrade exponentially at elevated temperatures. • Ensure ventilation is provided in accordance with the manufacturer's recommendations. • Install and maintain the ventilation during all stages of a fire. Ventilation is important since batteries will continue to generate flammable gas as long as they are hot. Also, carbon monoxide will be generated until the batteries are completely cooled through their core.	All enclosures will include adequate Heating Ventilation and Air Conditioning (HVAC) installations incorporating redundancy. The behaviour of HVAC and air circulation in the event of a pre-alarm and main alarm will be defined by the manufacturer (and, if applicable, the certifier) with due regard to the extinguishing agent used.
Gas detection and smoke detection	A minimum of two types of fire detection system will be deployed, (e.g., optical, heat, chemical etc.). The fire detection system will

• Install a very early warning fire detection system, such as aspirating smoke detection. • Install carbon monoxide (CO) detection within the container or BESS room.	be installed with fire resistant wires and components. Carbon monoxide detectors will be installed as required.
Fire protection • Install Liquid cooled gas suppression system. • This includes: - Smoke detection - Water dry pipe - Fused sprinkler heads - Thermal detection - Flammable gas detection - Vent - Aerosol - Arc Flash: ≤12cal/cm2	The fire protection concept will be based on the prevention of propagation with high construction standards, suppression systems and distances to adjacent installations. The BESF will include a gas-based extinguishing fire suppression system, as a first barrier of security against fire propagation within a container. Separation between adjacent installations is a security redundancy measure to limit fire propagation in case of a suppression system failure or a non-typical failure event.
Maintenance • Follow original equipment manufacturer recommendations for the inspection, testing and maintenance of BESS. In addition, ensure that the following are completed: - Measure the internal resistance of the cells. Replace cells when a dramatic drop is detected. Keep in mind that the internal resistance is mainly independent of the state of charge, but increases as the battery ages. Therefore, it is a good gauge of predictable life. - Perform infrared scanning at least once per year. - Check for fluid leakage.	Internal resistance is measured as part of the State of Health (SOH) control system, with maintenance and replacement carried out regularly to respond to the results. Constant insulation monitoring of each battery bank detects potential leakage. Prepare an operating procedure for the swap-out of faulty cells/modules. This will include plans for suitable storage locations for the modules prior to removal from site. Torque tests are part of the operation and maintenance process. Infrared scanning will take place annually.

- Implement electric terminal torquing procedures to maintain connection integrity.	

4.0 Battery Energy Storage System Detailed Design Stage- Pre-construction Information

4.1 Battery and Rack Safety Standards

4.1.1 The batteries that will be installed in the BESF will be Lithium Iron Phosphate type Li-ion battery cells. Each cell will be compliant with the following standards:

- UN38.3[11] - International guidance for the transportation of Li-Ion batteries
- UL1973[12] - Batteries for Use in Stationary and Motive Auxiliary Power Applications
- UL9540A[13] - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.
- IEC62619[14] - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications

4.1.2 The racks that house the cells will be compliant with the following standards:

- UL1973 (see above)
- IEC62619 (see above)
- IEC62477-1[15] - Safety requirements for power electronic converter systems and equipment - Part 1: General
- UL9540A (see above)
- IEC61000-6-2[16]/-4[17] - Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments; Part 6-4: Generic standards - Emission standard for industrial environments

4.1.3 The primary fire safety standard above is UL9540A, a test method and methodology developed to address safety concerns around lithium-ion batteries and battery energy storage systems to be permanently installed in mixed occupancy or high rise buildings, identified by the building codes and the fire service in the United States.

4.1.4 All cells, modules, and racks to be installed at the proposed battery storage site will have passed the UL9540A evaluations for thermal runaway fire propagation. At the level of the cell the methodology develops cell thermal runaway initiation technique and characteristics including gas composition. At the module level the approach determines propagation behaviour within the module and thermal energy release outside of the module. Concerning the units is the consideration of both open and closed room unit to unit fire spread with heat release rate and gas analysis to determine the potential for explosion, and the same with fire mitigation equipment.

[11] 1520832_E_ST_SG_AC.10_11_Rev6.pdf (unece.org)
[12] https://standardscatalog.ul.com/ProductDetail.aspx?productId=UL1973
[13] https://www.ul.com/services/ul-9540a-test-method
[14] https://webstore.iec.ch/publication/28895
[15] https://webstore.iec.ch/publication/7080
[16] https://webstore.iec.ch/publication/25630
[17] https://webstore.iec.ch/publication/26622

4.1.5 Results from the UL 9540A Test Method addresses the following key issues identified by building codes and the fire service:

- BESS installation instructions
- Installation ventilation requirements
- Effectiveness of fire protection (integral or external)
- Fire service strategy and tactics

4.1.6 The current ICC International Fire Code (2018 IFC) allows an individual battery energy storage system (BESS) unit not exceeding 50 kWh and having a maximum quantity of systems totalling 600 kWh of energy per indoor fire area (battery room). The 2018 IFC and the draft NFPA 855 standard for installation of energy storage systems currently limits the individual BESS unit size for UL 9540 listed units to 250 kWh.

4.1.7 These BESS units are to be installed with a minimum separation distance of 3 feet (1 metre) between units and between units and any wall. The latest IFC and NFPA 855 drafts allow the code official (AHJ) to approve larger individual BESS units, and separation distances less than 3 feet based on large scale fire testing conducted in accordance with the UL 9540A Test Method.

4.1.8 The proposed battery storage units do not exceed 50kWh, and are within a broader system (100kWh) which is significantly less than 600 kWh.

4.2 Fire Detection and Suppression

4.2.1 The battery room cabinets are provided with an aerosol fire extinguishing system that consists of:

- Smoke detector
- Temperature detector
- Aerosol fire extinguishing device

4.2.2 When either the smoke or temperature detectors are triggered it is classified as a first level fire alarm. When this happens the alarm cabinet quits the state of operating and sends a signal to the Environmental Management System (EMS).

4.2.3 When both the detectors are triggered it is classified as a second level fire alarm. When this happens the aerosol of the alarm cabinet is released, with all of the electrical cabinets in the system out of operation and signal reported to the EMS.

4.2.4 The extinguishing agent is composed of ultra-fine potassium salt particles and inert gas. Potassium salt is considered to be one of the most effective fire-extinguishing agents; its fire-extinguishing mechanism is similar to the highly effective Halon[18] which extinguish fires by impeding the complex chemical chain reaction of combustion or explosion. The combustion chain reaction requires the participation of OH, H and O radicals, and ultrafine potassium salt particles can quickly consume these free radicals and prevent the combustion chain reaction from proceeding.

[18] The use of Halon extinguishers and other CFCs was linked to Ozone depletion and their use is banned in the UK and internationally.

4.2.5 In the event of the detectors both being triggered a specified concentration of fire extinguishing agent is sprayed to fill the entire protection area, and which will result in total flooding of the area that will extinguish any open flame. This method is effective in combating electrical fires, electrolyte fires and other combustibles fires (A/B/C fires).

4.3 Safety Information

4.3.1 The table below sets out a guide for the information that will be maintained as a 'safety log' by the operator so best practice is followed to minimise fire risk. The applicant has committed to producing and maintaining this document as part of a best practice approach.

4.3.2 The information in the safety log will help to inform the Tactical Information Record developed with SFRS.

Table 2: Detailed Design Information for Safety Log

Specification	Reason for Inclusion
Statement of Compliance with Applicable Legislation	To demonstrate compliance with legislation.
Detailed Design Drawing of Battery Energy Storage Facility	To ensure available and safe access for fire appliances To enable Fire and Rescue Service to evaluate the available access for fire appliances to all parts of the BESF. To show separation between components of the BESF.
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 that Fire Rescue Service are aware of the specific type of batteries installed. This would include the battery chemistry as well as size and format of each cell.
Fire Detection System Specification	To demonstrate how the requirement for fire suppression has been addressed.
Fire Suppression System Specification	To demonstrate how the requirement for fire suppression has been addressed.
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.
BESF Installation Contractor Emergency Protocol (during construction)	To demonstrate that protocols are in place to manage a fire during construction.

Site Operator Emergency Protocol (during operation, including decommissioning)	To demonstrate that protocols are in place to manage a fire during the operation and decommissioning.
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.

5.0 Conclusion

5.1 Summary

5.1.1 The OBSMP outlines the proposed development for a proposed 50MW battery storage facility and associated works, and how it will be managed from a fire safety risk mitigation perspective.

5.1.2 The document collates the technical and safety information used for the detailed design of the BESF to ensure that all safety concerns around the facility are addressed in so far as is reasonably practicable.

5.1.3 The OBSMP may be updated once the proposed phasing of development is known and in line with any new regulations and/or guidelines that are introduced.

5.2 Outputs

5.2.1 The applicants have committed to working towards the following Fire Safety outputs:

Tactical Information Record

5.2.2 Anglo Renewables Ltd have committed to approaching SFRS to develop a Tactical Information Record for Levedale Road Battery Storage Facility; which will facilitate Fire and Rescue responders to the site with technical and tactical information about the site and best approaches in the event of a fire event.

5.2.3 If the LPA considered it appropriate, and with agreement from SFRS, the applicant would be agreeable to the undertaking of the Tactical Information Record being managed by way of a suitably worded condition.

Safety Log

5.2.4 The applicant will produce a ‘safety log’ which will be maintained and updated by the operator as part of a best practice approach. A guide to the information to be included in the safety log is set out above.

5.2.5 The safety log will be made available to SFRS, and could be used as the basis for the Tactical Information Record set out above.

Glossary

- ADR - Agreement Concerning the International Carriage of Dangerous Goods by Road
- ARC - Allianz Risk Consulting
- BESF - Battery Energy Storage Facility
- BESS – battery energy storage system
- CO - Carbon Monoxide
- ESS – Energy Storage System
- HVAC - Heating Ventilation and Air Conditioning
- Li-ion - Lithium-ion
- LFP - Lithium Iron Phosphate battery cells
- LPA - Local Planning Authority
- NFPA - National Fire Protection Association
- OBSMP - Outline Battery Safety Management Plan
- SFRS - Staffordshire Fire and Rescue Service
- SOG - Standard Operating Guidelines
- SOH - State of Health
- SOP - Standard Operating Procedures

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