Plas Power Solar and Energy Storage Project

3.0.7 Outline Battery Safety Management Plan

February 2024

DNS Ref: DNS/3253253

Abbott Risk Consulting Limited

ARC-1198-001-R3

Lightsource bp Plas Energy Storage – Outline Battery Safety Management Plan

Issue 1 – February 2024

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APPROVAL AND REVISION RECORD						
Issue No.	**Date**	**Prepared**	**Reviewed**	**ARC Approved**	**LSbp Reviewed**	**Revision Notes**
Draft A	Sep2023	J Tough	J Hatherall	P O'Sullivan	NA	Draft for client input
Issue 1	Feb 2024	J Tough	J Hatherall	T Lambert		Site Layout change

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Executive Summary

This Outline Battery Safety Management Plan (OBSMP) is for the proposed Plas Battery Electrical Storage System (BESS) installation near Wrexham. The aim of the OBSMP, at this planning phase of the programme, is to define the proposed safety strategy, requirements, and processes necessary to meet derived safety objectives and to set a level of safety performance that the installation is to be measured against. These standards are derived from the following sources:

1. Planning Practice Guidance (PPG) for Renewable and Low Carbon Energies.

2. Fire and Rescue requirements detailed in the National Fire Chiefs Council (NFCC) Report Grid Scale Battery Energy Storage System Planning – Guidance for the Fire and Rescue Services (FRS).

3. FM Global Loss and Prevention Datasheet 5-33 (as cited in the NFCC Report).

4. Lightsource bp (LSbp) Tiln BESS Fire Strategy and Emergency Response.

It also provides the basis for the safety management processes and procedures required to satisfy the identified safety requirements for a BESS system capability.

The preliminary safety hazard identification and analysis, based on like for like energy storage systems of this type, namely Lithium-Ion Battery technology, has determined the likely causes and hazards associated with BESS technology of this type and enabled the initial identification of potential control measures that when implemented will ameliorate the level of risk posed to an acceptable level.

It is proposed that, as far as reasonably practicable and for this planning stage of this BESS installation, that the currently foreseeable hazards associated with the technology proposed have been identified. These will form the initial safety foundation going forwards and be actively managed as the project and installation matures. At this juncture of the programme the selection of the BESS to be positioned at Plas has yet to be decided.

The design, development, and manufacture of the BESS requires the development and maintenance of high standards in respect of safety and operational sustainability. It will be the responsibility of all personnel involved in the future development of the proposed undertaking to strive to reduce the potential for accidents to the lowest practicable level by being a 'risk aware'. Promoting a supportive safety and environmental culture at all stages of the development. This OBSMP is the starting point from which the project will progress.

It will be essential that the design process is subject to Design Risk Analysis by a competent designer or design house in compliance with the CDM Regulations 2015.

Abbreviations

ALARP	As Low As Reasonably Practicable
ARC	Abbott Risk Consulting Ltd
BESS	Battery Electrical Storage System
BMS	Battery Management System
BoM	Bill of Materials
CDM	Construction Design and Management
CID	Current Interrupt Device
DBSMP	Detailed Battery Safety Management Plan
EM	Electro-Magnetic
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
FAQs	Frequently Asked Questions
FDSS	Fire Detection and Suppression System
HSAWA	Health and Safety at Work Act
HSE	Health and Safety Executive
HV	High Voltage
IEC	International Electrotechnical Commission
LSbp	Lightsource British Petroleum
NFCC	National Fire Chiefs Council
NFPA	National Fire Prevention Association
OBSMP	Outline Battery Safety Management Plan
OC	Over Current
OV	Over Voltage
PCIP	Preconstruction Information Plan
PPG	Planning Practice Guidance
PTC	Positive Thermal Coefficient
REACH	Registration, Evaluation, Authorisation & Restriction of Chemicals Regulations
RFQ	Request for Quotation
RoHS	Restriction of Hazardous Substances Directive
S&E	Safety and Environmental
SIL	Safety Integrity Level
SME	Subject Matter Expert
SMS	Safety Management System
SQEP	Suitably Qualified and Experienced Person
UK	United Kingdom
UL	Underwriters Laboratory
US	United States
UV	Under-Voltage

Contents

1.0 OBSMP Purpose

1.1 Aim

The aim of this report is to outline the safety management approach that will be adopted. Furthermore, the overall BESS safety aim is that the levels of risk of accident, death or injury to personnel or other parties, and to the environment due to BESS activities are to be mitigated and managed as far as possible through diligent development, design, construction, and operation. In accordance with the Health and Safety Executive (HSE) Reducing Risk, Protecting People - Guidance [Ref. 1], BESS development should aim to reduce risks to 'As Low As Reasonably Practicable' (ALARP).

1.2 Scope

The scope of this report for the proposed Plas BESS development (The Project) and capability covers the physical and functional aspects of the equipment. The BESS safety management will cover design, validation, siting, operation, fire strategy and emergency response, and removal from site (post use). It will also include any remote monitoring and control, maintenance, storage / transportation, and calibration.

1.3 Context

This OBSMP has been developed by Abbott Risk Consulting Ltd (ARC) in the role of the Safety Subject Matter Expert (SME) and aims to identify the safety requirements (and any additional derived safety requirements) such that the proposed Plas BESS development can be assessed against a common benchmark, criteria set and safety targets.

This BESS OBSMP has been developed at this early planning stage with the client LSbp to identify and assess the potential risks associated with the BESS design, installation, and operating capability, and to provide a robust safety argument, supported by evidence, prior to full commissioning. It is proposed that the safety programme will develop following 3 phases reflecting the maturity of the programme:

1. **OBSMP (Planning)** – this report. The OBSMP informs on how safety management is to be conducted. It outlines:

    a. The processes, procedures and means by which the BESS safety management is to be conducted, implemented, and assessed, such that the BESS design and development, initial construction, and operation safety performance can be conducted with an acceptable level of residual risk.

    b. It provides the criteria and targets against which the installation will be assessed.

    c. It provides the initial the compliance status against key requirements contained in the PPG (and referenced guidance).

d. It identifies the common hazards associated with BESS installations of this type.

2. **Detailed Battery Safety Management Plan (DBSMP) (Installation and Implementation)** – The DBSMP will be produced post planning consent and will build upon the OBSMP and reflect the maturity of the project and availability of detailed information and evidence to support safety claims, the DBSMP:

    a. Assesses the level of residual risk posed by the BESS design to individuals (both those directly involved in the operation and 3rd parties), the immediate environment, the asset (BESS), interfacing / interdependent assets and property / equipment that could be affected by the operation of the BESS (noise, radiated emissions etc.).

    b. Contains the Emergency Response and Contingency Plans.

    c. References to supporting evidence.

    d. Details any recommendations for improvement.

3. **Site Safety Audit (Operation) –** Validates the BESS installation against the safety requirements and identified control measures in the DBSMP. It also validates that the safety processes and procedures required to ensure that the risk posed by the design remains within the bounds established and associated requirements have been implemented i.e., training, provision of Personal Protective Equipment, calibration, scheduled maintenance etc. Appropriate reports by the manufacturers and installers will be included in the Site Safety Audit to validate competency and technical due diligence. This will be further validated independently via input from the Client's Owner's Engineering Consultants.

The incumbent technology at the time of writing is primarily based on Lithium-Ion batteries. Due to the pace at which battery technology is developing, the precise battery chemistry will not be selected, and solution confirmed until the detailed design phase of the development. As such, this report this written leaning on the subject matter expertise that ARC have in this technological domain more widely, industry good practice and regulation. Selection of equipment will be based on proven and evidential technical and safety performance.

A section of Frequently Asked Questions (FAQs) is provided at Appendix A to the OBSMP.

2.0 Project Overview

2.1 The Project

The application site covers approximately 140 hectares and is located wholly within the administrative boundary of Wrexham County Borough Council. The site is approximately 2.5km to the west of Wrexham city centre.

The site comprises two interconnected areas north and south of the A525 Ruthin Road. The southern and larger part of the site is bound by the A525 Ruthin Road to the north, to the east by the A483, to the south by Plas Power Woods and its westernmost point by agricultural fields beyond which lies Rhos Berse Road and Nant Road.

The proposed development will include a 33kV cable that will connect the solar farm, BESS and associated infrastructure to the Legacy Substation located approximately 1.2km to the south-west of the site, north of the B5246 Bronwylfa Road. See Figure 2.1 for the indicative BESS compound layout.

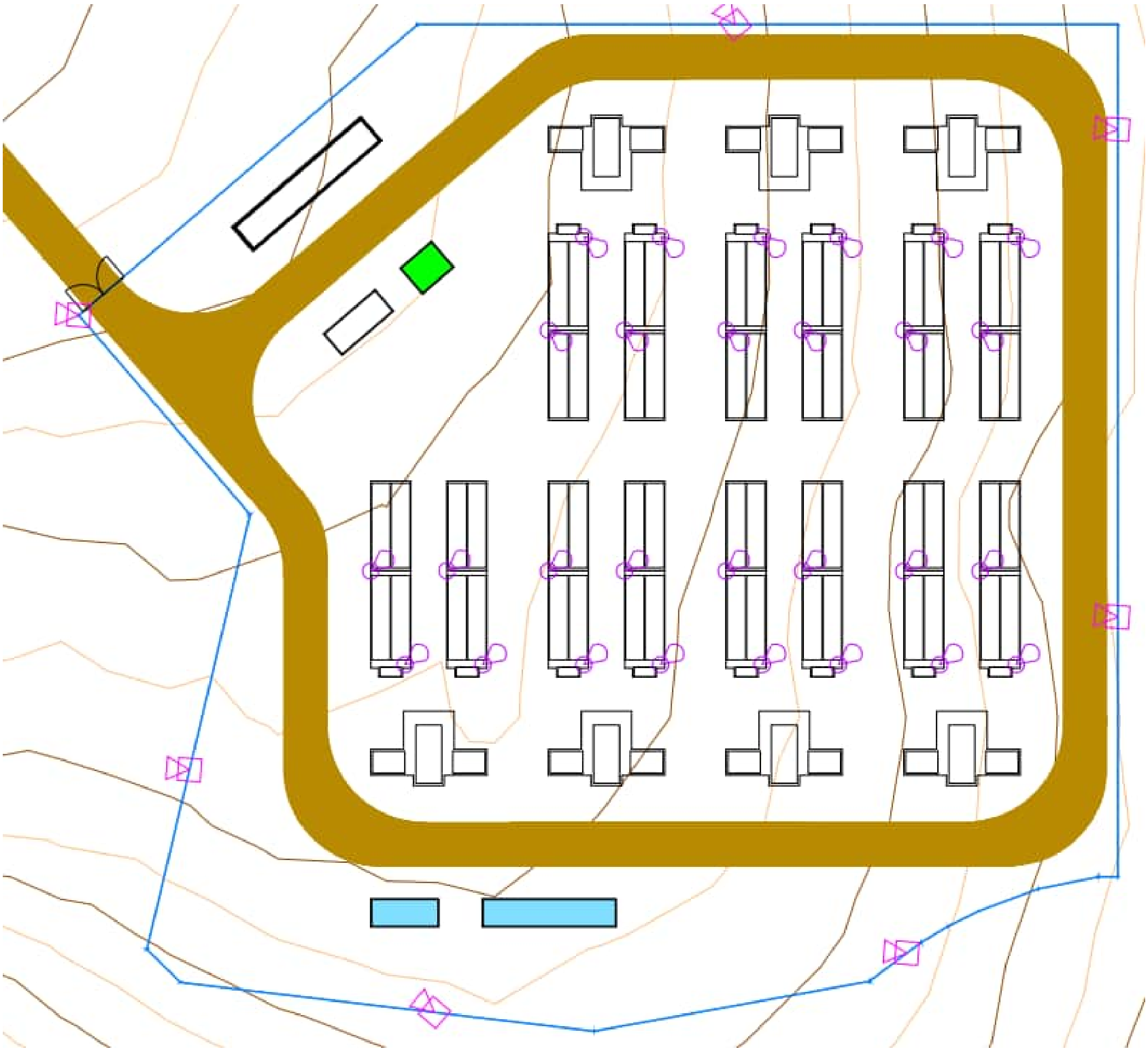

Figure 2-1 - Plas Site Layout and Boundary

The main components of the Proposed Development are:

- 14 x Battery Blocks (each comprised of 4x BESS Enclosures).

- 7 x Twin MV Skid (each comprised of 2 x Power conversion systems and 1 x MV transformer).
- 1 x Monitoring House.
- 1 x Backup Generator.
- 1 x Intake Substation.
- 1 x Transformer.

3.0 Safety Objectives

3.1 High Level Safety Objective

The primary safety objective across the BESS project is to minimise risk to health and safety of the public, employees, property, and the environment by complying with applicable legal requirements and relevant emerging good practice for grid scale connected battery energy storage systems. These will be distilled into safety requirements that will be included in the requirements for prospective suppliers during the tendering and contracting stage. Compliance with these safety requirements (by the potential suppliers) will be used as part of the safety argument, to demonstrate that '***The risk posed to individuals, the environment and property from the BESS programme of work has been reduced to a level that is Broadly Acceptable or Tolerable and ALARP' as directed by the HSE***. Compliance with the CDM Regulations 2015 will require the following documentation:

- Pre-Construction Information Plan (PCIP).
- Review of Contractor Competency and Prequalification.
- Review of Contractor Construction Phase Plan.
- Registration of the project on HSE UK F10 form.
- Understanding of LSbp Golden Rules (see Appendix B).
- On completion of the BESS installation a competent Health and Safety File is produced by the Principal Contractor for BESS which clearly identifies all Residual Risks.
- A comprehensive set of Operational Manuals and 'As Built' including all Single Line Diagrams and Schematics.
- A Fire Strategy and Emergency Response Plan.

These derived safety requirements will be fundamental to the BESS development and will be used to ensure that all direct and indirect safety requirements for BESS are met and the supplier(s) and installers are safety competent and compliant.

4.0 Legislation and Compliance Requirements

Legislative compliance, specifically safety, for the BESS will be demonstrated by compliance with the UK Health and Safety at Work Act (HSAWA) 1974 and the appropriate underlying legislation that is enacted through the HSAWA. The following current legislation has been determined as applicable to the BESS development:

1. Health and Safety at Work etc. Act 1974 – UKSI1974/0037.
2. Control of Noise at Work Regulations 2005 – UKSI 2005/1643.
3. Control of Substances Hazardous to Health Regulations 2002 – UKSI 2002/2677.
4. Control of Vibration at Work Regulations 2005 – UKSI2005/1093.
5. Electrical Equipment (Safety) Regulations SI 1994/3260.
6. Electro-magnetic Compatibility Regulations SI 2006/3418.
7. Fire Safety Order 2023
8. Fire Safety Act 2021
9. Lifting Operations and Lifting Equipment Regulations 1998 – UKSI1998/2307.
10. Management of Health and Safety at Work Regulations 1999 – UKSI1999/3242.
11. Manual Handling Operations Regulations 1992 – UKSI1992/2793.
12. Personal Protective Equipment Regulations 2002 – UKSI2002/1144.
13. Provision and Use of Work Equipment Regulations 1998 – UKSI1998/2306.
14. Reporting of Injuries, Diseases and Dangerous Occurrences Regulations SI2013/1471.
15. Supply of Machinery (Safety) Regulations 2008 – UKSI2008/1597.
16. Workplace (Health, Safety and Welfare) Regulations 1992 – UKSI1992/3004.
17. Registration, Evaluation, Authorisation & Restriction of Chemicals Regulations (REACH) – 1907/2006.
18. Restriction of Hazardous Substances Directive (RoHS) – 2011/65/EU.
19. Dangerous Substances and Explosive Substances Regulations 2002 - SI 2002/2776.
20. Construction (Design and Management) Regulations - SI 2015/51.
21. Health and Safety (Safety Signs and Signals Regulations 1996)
22. Waste Batteries and Accumulators Regulations 2009.

4.1 Relevant Regulation and Industry Benchmarks

Safety Guidance for the BESS installation will be demonstrated by alignment with prevailing industry guidance, both national and globally. The following industry guidance / best practice has been determined as applicable to this BESS installation:

1. PPG Renewables and Low Carbon Energy, which refers out to.

a. National Fire Chiefs Council (NFCC) Grid Scale Battery Energy Storage System planning – Guidance for FRS.

b. FM Global Property Loss Datasheet 5-33 – Lithium-Ion BESS.

2. National Fire Protection Association (NFPA) – Energy Storage Systems and Solar Safety, which refers out to:

   a. Underwriters Laboratory (UL)1973 – Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power, and Light Electric Rail Applications.

   b. UL9540A – BESS Test Methods.

   c. UN38.3 – Standard Requirements for Lithium-Ion Battery Production.

3. International Electrotechnical Commission (IEC) 61508 - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES).

4.2 NFCC Guidance

The NFCC Report Grid Scale Battery Energy Storage System Planning – Guidance for FRS [Ref. 4] details the FRS requirements anticipated at BESS installations. The alignment of the proposed project with these guidelines are outlined in Table 6-1 based on the site layout detailed in Figure 6-1.

5.0 Safety Controls and Good Practice

5.1 BESS Procurement

Lightsource bp operates with a stringent prequalification process that leverages the global technological capabilities of the company in the selection of all components. The Applicant is therefore experienced in conducting thorough tendering processes for procuring battery storage equipment and services, working with Tier 1, bankable, suppliers of battery cell manufacturers, inverters, and transformers.

This limits the selection of manufacturers to only those which are approved by Lightsource bp.

Only suppliers and products that conform to ISO 9001, UN38.3, CE, and local regulation, as well as pass both technical and financial auditing will be considered.

Lightsource bp's procurement processes look to inspect manufacturing facilities and periodically monitor production lines. The inspections evaluate production quality documentation and production line process, against pre-defined documentation to verify that the quality requirement is correctly respected and implemented. The following aspects are specifically checked:

- Material management.
- Procurement and supplier management.
- Manufacturing processes.
- Quality system.
- Reliability program.
- Training.

- Corrective action and non-confirming process and process improvements.
- Corporate social responsibility, environmental, health and safety.

Lightsource bp employs a robust quality process at the development and procurement stages that ensures safe and continuous operation.

We require the designs to incorporate the most advanced fire detection and suppression systems, including adhering to the UL9540 and NFPA 855 standards, as well as conform to local and industry standards.

5.2 Design Safety

As a minimum it is anticipated that the BESS supplier and operator will provide a layered protection approach from cell to container to remote monitoring. The envisaged safety control measures and design features under consideration, and those that will be flowed to the prospective suppliers, include:

1. Appropriate battery chemistry selection - balancing energy density requirements against available volume and operating parameters.
2. Cell module level control – consideration of the use of battery technology incorporating Current Interrupt Devices (CID) and Positive Thermal Coefficient (PTC) protection, enabling the cell to disconnect from the battery in the event of cell failure.
3. Implementation in the design of an approved Battery Management System (BMS) and a layered protection system in accordance with UL1973 [Ref. 2] guidelines.
4. Safety certification and qualification to UL9540A [Ref. 3] or equivalent.
5. The ability for 24/7 Remote Monitoring and Control and automated shut-down.
6. Off-gas detection to allow for preventative interaction.
7. Battery chemistry bespoke fire detection and suppression systems (FDSS) fitted to containers.
8. Site Security and Monitoring.
9. At a site and installation level:
   a. The segregation of containers in accordance with the national and international guidance detailed in this report.
   b. The landscaping of land adjacent to and between BESS containers and maintenance of vegetation to provide a natural firebreak.
   c. The provision of suitable and sufficient access / passing points for emergency services.
   d. Communication with local emergency services and the provision of site maps, detailing BESS locations, access points and water sources.

e. Drainage Study and other groundwater studies, Soil Investigations, Ground Resistivity, Hydrology, Roads, and Bridges access assessment. Environmental Impact Assessments, UXO, Existing buildings and services, (All to be included in the PCIP) for contractors.

5.3 Testing

Once chosen, the battery system will be tested in accordance with UL9450A or its successor. UL9540A was developed to address safety concerns identified by the building codes and the fire service in the United States and is considered the global standard for evaluating the propensity of BESS to suffer from thermal propagation at cell, module, rack and enclosure level. The results of all four tests at each level will be made available on request.

5.4 Decommissioning

Disposal activities will be considered at the procurement contract stage and will be included within the BESS safety management process and detailed in the DBSMP. As the programme matures the hazard log will be expanded to cover each phase of product development and installation.

The chosen BESS supplier will be designated as the producer of the battery components and the party placing the battery components on the UK market, and as such has certain obligations in respect of battery disposal pursuant to the Waste Batteries and Accumulators Regulations 2009 (or such equivalent regulations in force at the time of decommissioning).

It is assumed that all components replaced during the defects notification and warranty period will be returned to the manufacturer and recycled.

The BESS development will be subject to a decommissioning plan for submission to the Local Authority on request. (Note this is essentially a reverse engineering exercise with a large component on safe disposal of the batteries) to comply with the Waste Batteries and Accumulators Regulations 2009.

Lightsource bp will follow the hierarchy of waste management throughout the life of the Scheme and during construction (subject to monthly reports) as follows:

- Reduce – batteries have a finite life based on several factors, primarily the total number of cycles undertaken. The operation will attempt to manage the degradation by the selection of services and cycling that maximises the overall life. Consideration will be given to supplementation of the equipment or operation at a lower output.

- Recycle – The supplying manufacturer will have obligations under the Waste Batteries and Accumulators Regulations 2009 (as amended) (or such equivalent regulations in force at the time of decommissioning) and will be contractually obliged to offer a recycling service.

- Recovery – The recycling should allow any useful materials to be recovered and re-enter the supply chain.

- Disposal – Any disposal of batteries shall be undertaken in compliance with all applicable Laws and all regulatory requirements, product stewardship, registration disposal and recycling or take back requirement.

5.5 Maintenance

Any hazardous materials used in the BESS development will need to be fully justified and captured in the BESS Hazardous Materials Register, a sub-set of the Bill of Materials (BoM). The register is used to highlight the hazardous materials contained within BESS and provides justification as to why they cannot be eliminated and to highlight exact quantities of hazardous materials that are present to satisfy legislative requirements. The BESS Hazardous Materials Register will be made available to the local emergency services.

The site will be regularly kept free of vegetation, litter, and any combustible materials.

All internal roads will be maintained to a standard suitable for use during usual operation and emergency response.

All required hazard signage, contact information for emergency response and security will be attached to main gates and boundary fencing. (To comply with the Health and Safety (Safety Signs and Signals Regulations 1996)

5.6 Emergency Plans

Prior to construction of the BESS, Emergency Plans and Risk Assessment will be developed that will outline how the operator will respond to incident and accident scenarios at site. This will include the interfaces with external first responder organisations. An onsite fire containment strategy will be incorporated into the overall site drainage design at the detailed design stage.

The Emergency Response Plans will be developed in an iterative manner in parallel to technical safety requirements. This will ensure that the BESS design and Emergency Plans are properly integrated (e.g., that BESS layout ensures access for first responders) and that appropriate information can be provided to first responders (e.g., the type and meaning of external indication on containers) to include in their planning activities.

Note: It is important to note that current guidance states that Lithium battery fires will not be tackled with water other than for the purpose of cooling down and fire prevention to other assets local to the fire.

The Emergency Response Plan will be formed through 2 distinct elements, both of which will be communicated to the FRS on commissioning of the asset, these being:

1. The Risk Management Plan, a distillation of the OBSMP and DBSMP which will include:

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

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

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

d. The fire detection and suppression systems (i.e., bespoke FDSS fitted to BESS containers, off-gas detection systems, enclosure fire rating etc.)

e. Any natural or built infrastructure and on-site processes that may impact or delay effective emergency response.

2. The Emergency Response Plan will be developed and include:

   a. How the FRS will be alerted.

   b. The site layout including infrastructure details, operations, number of personnel, and operating hours. Key points on site such as entrances and availability of hydrants and shut of isolations as identified by What 3 Words Codes for the Local Fire and Rescue Service. This will require consultation and site visits by the FRS.

   c. A site plan depicting key infrastructure, site access points and internal roads.

   d. Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eyewash and shower facilities; spill containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid.

   e. Up-to-date contact details for facility personnel, and any relevant off-site personnel that could provide technical support during an emergency.

   f. A list of any dangerous goods stored on site.

   g. Site evacuation procedures.

   h. Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire and vegetation / flora fire.

6.0 Site Specific Safety

6.1 Siting

The site has been selected due to its minimal environmental constraints, distance from nearby residences and proximity to a viable grid connection. The nearest residential property is approximately 100m from a battery unit.

The northern part is bound by the A525 Ruthin Road to the south and extends northwards towards Higher Berse Road. Coedpoeth lies approximately 120m to the west and New Broughton lies approximately 600m north-west of the site. The site comprises several agricultural fields, primarily used for pasture grazing, bound by a mixture of mature woodland, trees, hedgerows, fencing, agricultural tracks, and roads.

Figure 6-1 illustrates the site layout for the Plas BESS installation.

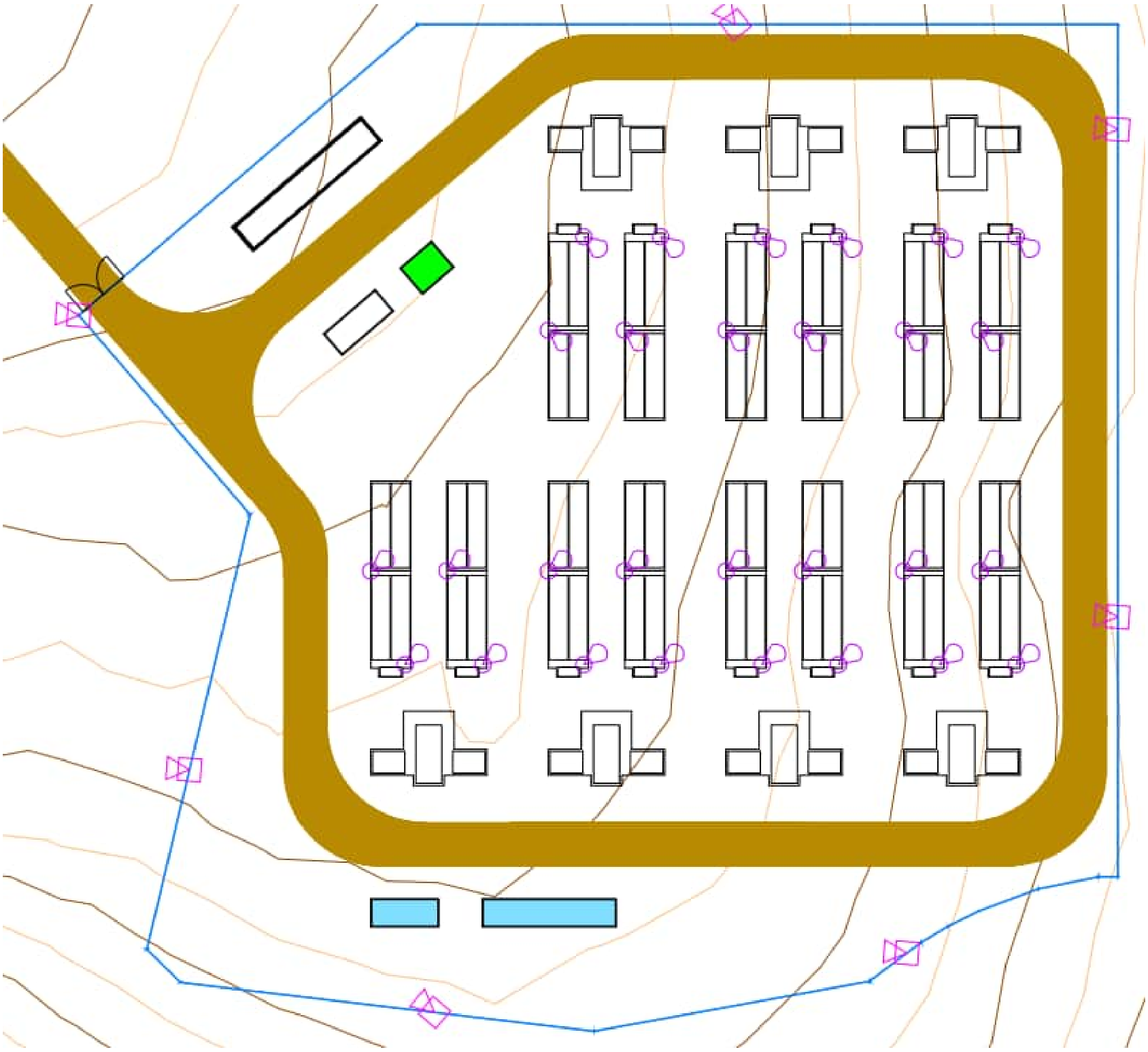

Figure 6-1 – Plas Energy Storage Site Layout

Any planting as part of the landscaping plan will sit a minimum of 10m from any BESS container.

There are no public footpaths or rights of way within the BESS boundary.

Analysis within the Transport Survey of the local road network has shown that the site is accessible to emergency response vehicles. Furthermore, new external and external access tracks proposed on site are suitable for emergency response vehicles, proving space for manoeuvring and a circular service road.

6.2 Security

During construction, the site will be secured with temporary fencing, CCTV and in-person security. During operation, a 2m high palisade fence and security cameras will be in place that are remotely monitored 24/7.

6.3 Fire and Rescue Service

The North Wales Fire and Rescue Service (NWFRS) is the regional FRS for the Plas site:

1. **Consultation.** Discussion with the NWFRS on the initial layout, installation and safety measures took place 19th October 2023. NWFRS input was instrumental in subsequent design changes and improvements to the site layout and installation. This preliminary consultation with the NWFRS established that the emergency response is anticipated to be focused on preservation of life and public safety. Given the rural location of the Project and highly restricted access to the Project site, there is a low chance of personnel being found in direct harm from a fire event within the battery compound during normal operation. The primary response would likely involve quenching of the surrounding land and containers to mitigate the risk of a fire event spreading between battery blocks. Further consultation with the NWFRS is anticipated and feedback on this OBSMP and compliance with the NFCC recommendations will be sought.

2. **Water Supply**. The Applicant has identified a hydrant near the Project which is privately owned by Hafren Dyfrdwy (a North and mid Wales Water Company). Discussion with Hafren Dyfrdwy have yet to be entered into but subject to further consultation with the NWFRS this is considered a possible supply of water in the event of a fire.

3. **NFCC Guidance Compliance.** The NFCC has provided guidance to regional FRS regarding grid scale BESS and planning. This NFCC Guidance [Ref. 4] has been distilled into the 14 key salient recommendations arising from the guidance and is presented at Table 6-1, this details the site layout and compliance status reflecting the NFCC guidance.

Ser	NFCC Recommendation	Site Status	Options / Comments
1	Access - Minimum of 2 separate access points to the site	**Compliant**	Access to the site containing the BESS is possible from the South via the Plas Buckley Road (accessed via the B5098) at the junction near St Mary's Plas Power Church and from the North via the A525 in the direction of Coedpoeth.
2	Roads/hard standing capable of accommodating fire service vehicles in all weather conditions. As such there should be no extremes of grade	**Compliant**	Immediate access road is 5.5m wide and BESS service roads are 4.5m wide. Site-wide – OS Map indicates no significant gradient on the access to the site or at the site. All site service roads are suitable for HGVs, given the need to locate the ISO containers and other installations using transporters of a similar size and weight to that used by the FRS.
3	A perimeter road or roads with passing places suitable for fire service vehicles	**Compliant**	Service road leads to site area housing BESS with several points in which to pass or turn
4	Road networks on sites must enable unobstructed access to all areas of the facility	**Compliant**	Service roads run centrally through the site providing access to all BESS and other site infrastructure.
5	Turning circles, passing places etc. size to be advised by FRS depending on fleet	**TBC**	The preliminary site layout will need to be consulted on with NWFRS for their comments and input.
6	Distance from BESS units to occupied buildings & site boundaries. Initial min distance of 25m	**Compliant with caveats**	Site containing BESS is 25m distant from occupied buildings (less site buildings) Site containing BESS is closer than 25m to site boundaries. Reduction of distances may be possible in areas of lower risk is stated in the NFCC Guidance.

Ser	NFCC Recommendation	Site Status	Options / Comments
7	Access between BESS unit – minimum of 6 metres suggested. If reducing distances, a clear, evidence based, case for the reduction should be shown.	**Compliant subject to confirmation**	The suggested 6m separation is based on a 2017 Issue of the FM Global Loss and Prevention Datasheet 5-33 (footnote 9 in the NFCC Guidance refers). This datasheet was revised in July 2023 and now details the following: 1. For containerized LIB-ESS comprised of lithium iron phosphate (LFP) cells, provide aisle separation of at least 5 ft (1.5 m) on sides that contain access panels, doors, or deflagration vents. 2. For containerized LIB-ESS comprised of lithium nickel manganese cobalt (NMC) cells where wall construction is unknown or has an ASTM E119 rating less than 1 hour, provide aisle separation of at least 13 ft (4.0 m) on sides that contain access panels, doors, or deflagration vents. For containerized NMC LIB-ESS where wall construction is documented as having at least a 1-hour rating in accordance with ASTM E119, aisle separation of at least 8 ft (2.4 m) is acceptable. From the site layout the BESS Containers are end-to-end and side-to-side in blocks of 4. Fire and Heat Flux models to be provided by BESS Manufacturer that demonstrates that propagation between containers is not possible when final technology is selected.
8	Site Conditions – areas within 10m of BESS Units should be cleared of combustible vegetation	**Compliant**	BESS and other installations will be positioned on concrete plinths and the land between laid out to hardcore with a gravel cover. No trees are present within 10m of BESS units, the Ecology and Landscape Plan refer.
9	Water Supplies	**Compliant with caveats**	Other than the reservoir to the North of the Site an additional water supply, a hydrant near the Project, which is privately owned by Hafren Dyfrdwy, has been identified as a possible secondary source. Discussion with Hafren Dyfrdwy have yet to be entered into but subject to further consultation with the NWFRS this is considered a possible supply of water in the event of a fire.
10	Signage	**Compliant**	Signage to be positioned at the entrance to the site boundary on the bridleway, and at the fence line of the site. Signage to be confirmed through design process.
11	Emergency Plans	**Compliant**	Future iteration of the OBSMP to DBSMP will roll up the Emergency Response Plan, outlining who and how the FRS will be alerted, facility description, number of operatives, detailed site plan etc.
12	Environmental Impacts	Compliant	An Environmental Impact Assessment has been conducted for the Plas Site.

Ser	NFCC Recommendation	Site Status	Options / Comments
13	System design, construction, testing and decommissioning	**Compliant with caveats**	Several of the elements under this aspect of the NFCC Guidance will be contained in the OBSMP, however details of the actual BESS chemistry, rack layout, suppression systems, detection, decommissioning will only be in the DBSMP as and when the decision on what is being used has been determined. The need to determine the Make and Model of the BESS prior to planning consent has been agreed at several appeals not to be a condition.
14	Deflagration Prevention and venting	**Compliant with caveats**	Elements of this requirement will be flowed to prospective BESS suppliers, but the actual design adopted will only be identifiable at the point at which the decision is made as to what BESS to be procured. It is acknowledged that deflagration venting is most effective when fitted to the roof of the BESS Units, as such deflecting blast upwards and away from FRS personnel. This requirement will be flowed to prospective BESS suppliers.

Table 6-1 – NFCC FRS Requirements X-Ref to Plas BESS

7.0 Conclusions and Recommendations

7.1 Conclusions

This is the initial OBSMP for the Proposed Development and as such the identification of potential hazards, causes and controls is limited to the concept stage, i.e., the BESS concept design and the initial proof of design artefact. Therefore, several controls have been identified are also conceptual and subject to technological assessment, as such no ALARP statements can yet be formulated.

All the control measures identified thus far are founded on good practice and based on previous knowledge of BESS systems in use and other associated products using Lithium-Ion electrical storage technology or similar. These mitigations may in some instances require further development and ratification as the programme progresses. Upon successful implementation, and with suitable evidence available to validate effectiveness, reassessment can be conducted with the aim to consider the reduced level of risk.

It is concluded that, as far as reasonably practicable and for this planning stage of the Proposed Development, that currently foreseeable hazards associated with the equipment have been identified, and these will be developed and managed with prospective suppliers during the tendering, contracting and construction stages. These hazards will be actively managed throughout the life of the installation and added to as necessary as the BESS Project develops and will be reported on regularly.

This OBSMP has been developed using existing knowledge of the BESS capability and leans heavily on the subject matter expertise that ARC have in this technological domain. Further development of the BESS design will provide more detailed information that will enhance future safety analysis and management, where further understanding of the hazards and development of mitigations can be undertaken to reduce the potential level of risk posed by BESS.

7.2 Recommendations

It is recommended that the BESS safety management and criteria (for assessment and analysis) as defined in this OBSMP, is adhered to throughout the BESS project lifecycle to ensure that safety management is developed as the programme progresses and remains valid through the life of the BESS capability.

It is recommended that to maintain an acceptable level of residual risk, that all the identified control measures are assessed as the design matures to elicit; applicability, feasibility and the potential amelioration afforded. At this juncture of the programme, it is not possible to declare ALARP, however successful implementation of the proposed framework for safety management presented in this OBSMP will provide the necessary arguments and supporting evidence to make such a claim.

8.0 References

1. Reducing Risk, Protecting People (HSE Publications) - https://www.hse.gov.uk/risk/theory/r2p2.pdf.

2. UL1973 – Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power, and Light Electric Rail Applications.

3. UL9540A – BESS Test Methods.

4. NFCC Grid Scale Battery Energy Storage System Planning – Guidance for FRS dated Nov 2022.

5. Client HSE Management System

Appendix A

FAQs

Ser	Question	Answer
1	How does a BESS work?	A BESS generally employs Li-Ion technology, but other technologies are available, to temporarily store electrical energy, very much in the same manner as a mobile phone or laptop battery, but on a much bigger scale. The energy can be stored and released when demand on the National Grid is high and assists in balancing out variations in demand. BESS can be connected to a PV Solar Farm and store energy throughout the day for release in the evening and in this mode of operation is a green renewable energy. An alternative use for BESS is to store electrical energy generated by energy suppliers during period of low demand and releasing in periods of high demand, thus balancing out variation on the National Grid. This mode of operation allows energy suppliers to operate their power station in a more economical manner and assists in reducing the carbon-footprint of the power suppliers. Two different primary Lithium-Ion battery chemistries (the elements that form the energy storage parts of the batteries) are used in BESSs, these being: ○ **Lithium iron phosphate (LFP)** - LFP batteries are possibly the best types of batteries for BESSs. They provide cleaner energy since LFPs use iron, which is a relatively green resource compared to cobalt and nickel. Iron is also cheaper and more available than many other resources, helping reduce costs. The overall production cost is lower as well. LFP batteries have a lower power density, but this characteristic is less important for energy storage systems than it is for Electric Vehicles (EVs), as BESS can occupy larger spaces without concern. LFP batteries are also safer because thermal runaways are less likely, and they have a higher life cycle (between 2,000 and 5,000 cycles) than most other Li-ion battery technologies. ○ **Lithium Nickel Manganese Cobalt (NMC)** - NMC batteries feature both strong energy and power density, and they are relatively safe compared to other types of lithium-ion batteries when it comes to thermal runaways. However, they offer a significantly lower number of life cycles compared to LFP batteries, generally between 1,000 and 2,000 cycles.

Ser	Question	Answer
		NMC batteries also require cobalt and nickel, which are more expensive and harmful to the environment. There is also significant concern about shortages in these minerals, which can significantly impact both cost and availability.
2	How safe is a BESS?	The Department for Energy Security and Net Zero (DESNZ), promulgates on a regular basis the Renewable Energy Planning Database. From the quarterly extract (dated July 2023 and published 8 August 2023) the data has been filtered for BESS installations in the UK and the following salient points are deduced: 1. As of July 2023, there are 100 BESS sites in operation across the UK. 2. The total energy capable of being stored is estimated at 1580MW (1.58GW). 3. Since 2006 BESS have operated for approximately 4.8 million hours (data details 4,729,560 hours) which is equivalent to 540 years of operation. 4. There has currently been only one reported UK BESS fire that required FRS attendance, this occurred at Carnegie Road, Liverpool in Sept 2020. 5. This equates to 2.11E-07 (0.000000211) failures per hour (fph) for BESS fires in the UK. 6. Given the HSE R2P2 Guidance [Ref. 1] of 1.0E-06 fph as being a 'societally acceptable' safety rate, the level achieved by UK BESS is 10 times better than HSE guidance. Noting that to date nobody in the UK has been killed in a BESS incident. BESS are designed to industry specific guidelines and subject to UK legislation.
3	How is the BESS temperature controlled?	The Lithium-Ion batteries are housing in an ISO type container which is fitted with an Environmental Control Unit (ECU). The ECU maintains the temperature and humidity within the container, allowing the Lithium-Ion batteries to operate within the optimum temperature range. The temperature of individual Lithium-Ion cells in each battery is monitored by the battery management system (BMS) and is reported back to the Container level BMS which adjusts the internal temperature in response. Should the ECU develop a fault the container will isolate charge and discharge to the batteries until the fault has been rectified. All faults to the BESS are remotely fed to a centralised Control Room.
4	What is Thermal Runaway?	Thermal Runaway (TR) is the term used to describe an internal short-circuit in one of the battery cells that can lead to cell over-pressure and the venting of combustible gases. Should this gas ignite then the cell will increase in over-pressure and

Ser	Question	Answer
		the resulting fire will be self-sustaining until all the material in the cell is expended. Short-circuits in cells are generally a result of: 1. Cell penetration by a foreign object (not usually an issue for a BESS as the batteries are housed in sturdy containers). 2. Impurities in the electrolyte (deposited during the manufacturing process), which over time can lead to the formation if dendrites (electrolytic crystals) which puncture the membrane isolating the anode and cathode – this can, but not always result in a short-circuit and TR. Dendrite formation was a common problem in early Nickel Manganese Cobalt (NMC) battery chemistries but is not prevalent in Lithium Ferrous Phosphate (LFP) and emerging battery chemistries. 3. Over-temperature in the cell because of: a. Over-charging (which is controlled by 2 separate BMS – battery and rack). b. High ambient temperature – controlled by the ECU.
5	How can Thermal Runaway be controlled?	TR is not always inevitable, and the nature of the cell design is such that early warning signs of a stressed cell can be detected by the BMS. Initial signs of cell degradation are an increase in the time it takes the cells to reach full charge (maximum voltage) and a decrease in the time it takes to discharge. These indicators are picked up by the BMS and if persistent the BMS will isolate (prevent charge and discharge) to the battery and inform the centralised Control Room. In turn an engineer will be dispatched to remove the battery and replace it with a serviceable item. If these indicators are not present, and the cell enters early stages of short-circuit the over-pressure in the cell will result in the venting of off-gas which is detected by the off-gas detectors built into the container. This will result in the container disabling the charge and discharge (the act of charging and discharging the batteries generates heat, which is what we want to avoid) and setting the ECU to maximum volume setting. This has a twofold effect, it clears the container of combustible gas and cools the internals, taking the energy out of the cells (Lithium-Ion like other batteries do not perform well in low temperature conditions).

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Ser	Question	Answer
6	How is a BESS fire controlled and suppressed?	If the TR is not controlled and spreads, known as Thermal Runaway Propagation (TRP) the fire detection and suppression system (FDSS) will activate. There are currently two types of FDSS that are used in BESS: gaseous systems and aerosol systems. Each system has advantages and disadvantages: 1. Aerosol systems are better in terms of extinguishing the fire and benefit against gaseous systems, which generally supress the fire by reducing the level of oxygen in the container. 2. Gaseous systems are instantaneous in operation, the gas being kept under pressure in bottles. Aerosol, by the nature of the deployment as a fine mist, take a little longer to reach all areas of the container. 3. Aersol system generally require a more complex and intricate delivery system to reach all areas of the container. 4. Gaseous system requires a sealed environment in which to operate. As such if the container is opened and oxygen reintroduced it can lead to the fire reigniting. 5. Various FDSS aerosols (also known as aqueous) and gaseous systems are available, and they use a variety of aerosol solutions.
7	Can water be used to extinguish a Lithium-Ion fire?	The use of water to extinguish a BESS fire has some drawbacks and disadvantages over bespoke FDSS aerosol mediums, these being: 1. The high conductivity of water may cause short circuiting of cells presenting collateral damage risk and increase the spread of the fire internal in the BESS. 2. A high volume of water is required to cool the cells below the critical temperature to prevent TR propagation, this results in a high volume of fire water run-off and a potential environmental impact. 3. The application of water on a BESS fire increases the generation of gases such as CO, H2 and HF. Applying water causes incomplete combustion of organic substances inside the battery resulting in production of CO rather than CO2; when water is applied, H2 is released that, without combustion, can react with phosphorus pentafluoride, if present in free form, to produce gaseous HF. 4. Due to the design of the batteries and racks (in which they are contained), the inability of water to cool the cell interiors may result in re-ignition of a fire once the water application is halted.

Ser	Question	Answer
8	What are the environmental consequences of a BESS fire?	In the event of a BESS fire several chemicals in gaseous form can be released and the composition and concentration of the plume (also refer to as the vapour cloud) is dependent on the chemistry in use, the design and components of the BESS and the magnitude of the fire. Amongst the general gases released are Carbon Monoxide (CO), Hydrogen Fluoride (HF), Oxygen and Hydrogen. The only UK BESS fire (Carnegie Road, Liverpool – Sept 2020) was monitored and the resultant composition of the plume determined as being negligible in toxic gas concentration.
9	How is the BESS site secured?	BESS Site are secured through fences / walls and are monitored remotely via CCTV. Warning signs along the fence indicate the presence of electrical storage facilities within the site.
10	How is the serviceability of the BESS assured?	The Health and Usage data for each BESS is remoted to a centralise Control Room and the serviceability of each battery determined on an hour-to-hour basis. Given that the batteries have a finite number of cycles over a given period it is envisaged that the batteries will be renewed several times in the 40-year life of the site.

Appendix B

Client LSbp Golden Rules