



**CLEARSTONE
ENERGY**

DARTFORD ENERGY HUB

BATTERY SAFETY STANDARDS

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Clearstone Energy Battery Safety Standards

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Prepared by	Checked by	Verified by	Approved by
RJ Environmental Consultant	Neil Titley Technical Director	Paul Gregory, BST&T	Neil Titley Technical Director

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Prepared for:

Clearstone Energy

Prepared by:

AECOM Limited

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Abbreviations and acronyms

The following technical terms and definitions have been used within this document and will form the basis of understanding.

Table 1: Technical terms and definitions

Term	Definition
ADB	Approved Document B
ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
BAT	Best Available Techniques
BESS	Battery Energy Storage System
BMS	Battery Management System
BSMP	Battery Safety Management Plan
COSHH	Control of Substances Hazardous to Health
DA	Data Analytics
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations 2002
ERP	Emergency Response Plan
FAT	Factory Acceptance Testing
FMEA	Failure Mode and Effects Analysis
HAZOP/HAZID	Hazard and Operability Analysis and Hazard Identification
HGV	Heavy Goods Vehicle
HSE	Health and Safety Executive
IP	Ingress Protection
LCRM	Land Contamination: Risk Management
LFP	Lithium Iron Phosphate (LiFePO ₄)
MSDS	Material Safety Data Sheets
NFPA	National Fire Protection Agency
NMC	Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO ₂)
R&D	Research and Development
SAT	Site Acceptance Testing
SIL	Safety Integrity Level
SME	Subject Matter Expert
UPS	Uninterruptible Power Supply
VESDA	Very Early Smoke Detection by Aspiration

1. Executive Summary

- 1.1.1 *Battery Energy Storage Systems (BESS) are rapidly becoming an integral part of efficient and resilient power systems worldwide. BESS enables energy from sources of renewable generation such as wind and solar to be stored and released during periods of peak demand.*
- 1.1.2 *This Battery Safety Standards document outlines Clearstone Energy's corporate safety commitments for BESS. It considers the latest good practices for battery fire detection and prevention relevant at the time of writing (September 2023).*
- 1.1.3 *Clearstone Energy is committed to developing safe BESS facilities that provide long and dependable operation. The selected BESS technology used will be robust, particularly with regard to safe operation.*
- 1.1.4 *This safety standards document demonstrates the robust processes that will be followed in BESS development from conception through to submission of the planning application. This document also outlines the developer's accountability to consult with the local fire and rescue services and other relevant stakeholders in the vicinity of any proposed BESS development and to incorporate the outcomes of consultation in the design of the facility.*
- 1.1.5 *A summary of the safety provisions which will be committed to in Clearstone Energy's planning applications, and therefore will be followed by the project operator as standard, are listed below:*
- *BESS facilities will be designed and maintained in accordance with the most up to date UK legislation and guidance, good industry practice, and related standards.*
 - *Risk assessments will be carried out for the entire system and elements across the project lifecycle.*
 - *The location of a BESS facility will be chosen to minimise impacts on receptors.*
 - *Separation distances between components will be selected to minimise the chance of fire spread based on best practices.*
 - *Equipment will, where possible, be selected to be fire limiting, such as by selecting transformer oils with low flammability and constructing a fire-resistant BESS enclosure. BESS facilities will be designed with multiple layers of protection to minimise the chances of a fire or thermal runaway.*
 - *All equipment associated with a BESS will be monitored, maintained and operated in accordance with manufacturer standards and requirements.*
 - *24-hour continuous remote monitoring of the BESS facility will be undertaken via a dedicated control facility. The control facility will have the capability to shut the system down should the need arise and will also be responsible for implementing the emergency plan and acting as a point of contact for the emergency services.*
 - *The BESS facility will include integrated fire detection with automated suppression systems to deal with electrical fires. Following industry good practice (e.g., NFPA 855 2023), gas venting will avoid build-up of explosive gases. A site-specific Emergency Response Plan will be developed for each BESS based on best practice measures.*
 - *Communication and engagement with the local fire and rescue services will be carried out early in the project and will continue through the design and construction phases.*

2. Introduction

2.1 Document Overview

- 2.1.1 This Battery Safety Standards document outlines Clearstone Energy's key corporate fire safety provisions for standalone Battery Energy Storage System (BESS) facilities. It includes the measures that will be implemented for fire protection and to reduce fire risk. It summarises the safety-related information requirements and commitments for Clearstone Energy's BESS proposals in the UK. It demonstrates how good industry practice will be applied to reduce risk to life, property and the environment.
- 2.1.2 This document covers Clearstone Energy's commitments up to the point of receipt of planning permission; it also explains how Clearstone Energy will ensure the safety measures presented in this document are delivered by the company carrying out detailed design, procurement, build, operation and maintenance, and decommissioning.
- 2.1.3 Prior to the detailed design of a BESS, a site-specific Battery Safety Management Plan (BSMP) will be prepared, which will be in accordance with this Corporate Battery Safety Standards document. When preparing the BSMP, the latest best practices for battery fire detection and prevention, along with site-specific measures to assure safety will be taken into account, noting that the associated guidance continues to develop both in the UK and worldwide.
- 2.1.4 This document references measures and guidelines valid at the time of writing in September 2023. This document, and subsequent site-specific BSMP's will be reviewed periodically to consider updates or developments in best practice guidance.

2.2 Potential BESS Incident Response

- 2.2.1 The risk of a battery fire or explosion is very low, but this document is provided to ensure good design measures to minimise this risk are embedded in Clearstone Energy's BESS projects. Causes of battery cell failure include issues such as manufacturing defects, overcharging, over-discharging, mechanical damage, overheating, or abuse.
- 2.2.2 BESS hazards for first responders in the unlikely event of a fire depend on the BESS design but are typically defined as: fire, explosion, chemical hazards, and release of atmospheric gases. First responders should wear full PPE, and fire management should not generally be conducted within any exclusion zones identified by the fire and rescue services.
- 2.2.3 Regardless of the type or cause of battery failure, the main potential hazard is a thermal runaway, which is the uncontrollable increase in battery's temperature. This document focuses on the mitigation measures that can be incorporated to reduce fire and explosion risks and manage BESS incident hazards.

2.3 Safety Objectives

- 2.3.1 The principal safety objectives that will be incorporated into the design of a standalone BESS are as follows:
 - To minimise the likelihood of a fire or deflagration (overheating until it burns away) event in BESS equipment.
 - To minimise the consequences should an incident occur.
 - To restrict any event to the incident locality, minimise equipment damage, and minimise impacts on any site personnel, first and second responders, local respondents and the environment.
 - To automatically detect and quickly differentiate between electrical fires and thermal runaway incidents.
 - To provide evacuation procedures with appropriate training provided in case of the unlikely event that service personnel are on-site during an incident.

- To ensure that first responders can coordinate incident response at minimum risk to their life and safety.
 - To ensure that fire, smoke and the spread of toxic gases do not significantly harm site operatives, first responders and the local community.
- 2.3.2 The following sections of this document set out the safety standards that would be incorporated into a standalone BESS development, in order to achieve the safety objectives outlined above.

2.4 Relevant guidance, codes and standards

- 2.4.1 There is currently limited UK-specific guidance for BESS facilities and battery safety; however, international good practice has been reviewed and incorporated into this document to create a corporate standard.
- 2.4.2 Clearstone Energy planning policies for BESS standalone projects will ensure the relevant industry practice and standards are followed. It will do this by agreeing a planning condition attached to any consent with the Local Planning Authority requiring a Battery Safety Management Plan in accordance with this corporate standards document or, where one is provided, with the Outline Battery Safety Management Plan submitted with the application. These will be implemented throughout the lifecycle of the project through to completion. It should be noted that many new or revised BESS standards and codes will be released in 2023-24, which the company carrying out the detailed design are expected to take into account.
- 2.4.3 This document considers the recommendations of the following standards and best practice documentation currently used in the UK:
- National Fire Chiefs Council (NFCC) Grid-Scale Battery Energy Storage System planning – Guidance for FRS (2023).
 - National Fire Protection Agency (NFPA) 855 (2023): Standard for the Installation of Stationary Energy Storage Systems.
 - NFPA 68: Standard on Explosion Protection by Deflagration Venting.
 - BS EN 14797 (2006): Explosion venting devices.
 - NFPA 69: Standard on Explosion Prevention Systems.
 - Underwriters Laboratories (UL) 9540A 4th Edition: Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.
 - UL 1642: Standards for Lithium Batteries.
 - UL 1973: Batteries for Use in Stationary and Motive Auxiliary Power Applications.
 - UL 9540 3rd Edition (2023) Standard for Energy Storage Systems and Equipment.
 - EPRI 3002022540 (2021) EPRI BATTERY STORAGE FIRE SAFETY ROADMAP: EPRI's Immediate, Near, and Medium-Term Research Priorities to Minimize Fire Risks for Energy Storage Owners and Operators Around the World.
 - FM DS 5-33 (2023) FM Global Datasheet. Lithium-Ion Battery Energy Storage Systems.
 - United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116: Fire Protection Standard for UK Power Networks Operational Sites, 2016.
 - DNV GL-Recommended Practice-0043: Safety, Operation and Performance of Grid-Connected Energy Storage Systems, 2017.
 - Scottish and Southern Energy TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide, 2019.
 - BS 5839 Part 1 2017: Fire Detection and Fire Alarm Systems for Buildings.
 - BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC-AC.
 - BS EN IEC 62933-2-1 (2018) Electrical Energy Storage (EES) systems. Part 2-1 Unit parameters and testing methods - General Specification.

- BS EN IEC 62933-5-2 (2020) Electrical Energy Storage (EES) systems. Part 5-2 Safety requirements for grid-integrated EES systems. Electrochemical-based systems.

3. Consultation

- 3.1.1 Where BESS facilities are planned to be installed, Clearstone Energy will work closely with the local fire and rescue service (FRS) to provide relevant information on BESS and site design features to inform all necessary hazard and risk analysis studies and assist in the development of comprehensive Risk Management (RM) and Emergency Response Plan (ERP)
- 3.1.2 Preliminary indicative site designs will be shared with the Local Planning Authority and local FRS and any recommendations on the layout design will be considered and incorporated into the scheme design for which planning permission is being sought from the regulator. It is common practice for Local Planning Authorities to impose a planning condition on any issued permission requiring the submission and approval of a detailed safety plan before construction commencing.
- 3.1.3 Clearstone Energy will work with the Local Planning Authority to ensure there is a planning commitment to ensure that consultation will continue with the local FRS throughout the post-planning detailed design stage, to ensure all key stakeholders are satisfied that all mitigation and safety requirements are agreed before construction.

4. BESS Safety Requirements

4.1 BESS procurement and testing

- 4.1.1 Clearstone Energy recognises that robust quality processes are essential for safe, continuous operation in the development and procurement stages. Clearstone Energy only considers and engages with suppliers that conform to relevant standards such as ISO 9001, ISO 14001, OHAS 18001, CE, and local regulations.
- 4.1.2 Clearstone Energy will work with leading global tier-one battery Original Equipment Manufacturers or BESS integrators with requisite expertise in BESS systems and controls and expects any buyers of its sites to act in the same way.
- 4.1.3 A non-exhaustive list of safety standards for the equipment is set out in Table 2. Adherence to these standards provides robust and good industry practice safety protection measures. Clearstone Energy will secure it through an appropriately worded planning condition agreed with the Local Planning Authority.

Table 2: Standards to be applied for equipment

Group Category	Standard	Year	Description
Fire Detection and Alarm	BS EN 54	-	All parts
	BS 5839-1	2017	Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises.
	BS 6266	2011	Fire protection for electronic equipment installations.
	BS EN 60079-29-3	2014	Part 29-3. Gas detectors. Guidance on functional safety of fixed gas detection systems.
Automatic Fire protection	BS 5306-0	2020	Fire protection installations and equipment on premises. Guide for selection, use and application of fixed firefighting systems and other types of fire equipment.
	BS EN 12845	2015	Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance.
	BS EN 14972-1	2020	Fixed firefighting system. Water mist Systems. Design, installation and maintenance.
	FM Global Property Loss Prevention Data Sheet 2-0	2021	Installation guidelines for automatic sprinklers
	United Kingdom Power Networks (UKPN) Engineering Design Standard 07-0116	2016	Fire Protection Standard for UK Power Networks Operational Sites
Battery Safety	UL 1973	2022	Batteries for Use in Stationary and Motive Auxiliary Power Applications
	UL 9540A (4th Edition)	2019	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
	BS EN IEC 62619	2017	Secondary cells and batteries containing alkaline or other non-acid electrolytes. Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

Group Category	Standard	Year	Description
ESS EMC Safety	UN 38.3		UN Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria
	BS EN IEC 62281	2019	Safety of primary and secondary lithium cells and batteries during transport.
	BS EN IEC 61000-4-2	2008	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test.
	BS EN IEC 61000-4-3	2020	Electromagnetic compatibility (EMC). Testing and measurement techniques. Radiated, radio-frequency, electromagnetic field immunity test.
	BS EN IEC 61000-4-4	2012	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrical fast transient/burst immunity test.
	BS EN IEC 61000-4-5	2014	Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
	BS EN IEC 61000-4-6	2023	Electromagnetic compatibility (EMC). Testing and measurement techniques. Immunity to conducted disturbances, induced by radio-frequency fields.
	BS EN IEC 61000-4-8	2009	Electromagnetic compatibility (EMC). Testing and measurement techniques. Power frequency magnetic field immunity test.
	BS EN IEC 61000-6-2	2016	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
	BS EN IEC 61000-6-4	2018	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.
BEES Safety	IEC CISPR 11	2022	Industrial, scientific, and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement. Conducted emissions and Radiated emissions tests.
	NFPA 855	2023	Standard for the Installation of Stationary Energy Storage Systems.
	UL 9540	2023	Standard for Energy Storage Systems and Equipment
	NFPA 70	2023	National Electric Code
	NFPA 68	2018	Standard on Explosion Protection by Deflagration Venting
	BS EN 14797	2007	Explosion venting devices
	NFPA 69	2019	Standard on Explosion Prevention Systems
	BS EN 16009	2011	Flameless Explosion Venting Devices
	BS EN 14373	2021	Explosion Suppression Systems
	CE mark		European conformity - Low voltage and EMC directives
	UKCA mark		UK conformity – Low voltage and EMC directives
	BS EN IEC 62933-2-1	2018	Electrical Energy Storage (EES) systems. Part 2-1 Unit parameters and testing methods - General Specification.
	BS EN IEC 62933-5-1	2020	Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid-integrated EES systems – General specification

Group Category	Standard	Year	Description
	BS EN IEC 62933-5-2	2020	Electrical Energy Storage (EES) systems. Part 5-2: Safety requirements for grid integrated EES systems. Electrochemical-based systems.
	BS EN IEC 61439-1	2020	Low-voltage switchgear and controlgear assemblies – Part 1: General
	BS EN IEC 61439-2	2020	Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies
	BS EN IEC 60364	2009	Low-voltage electrical installations
	FM DS 5-33	2023	FM Global Property Loss Prevention Data Sheets: Electrical Energy Storage Systems
	BS EN IEC 60812	2018	Failure modes and effects analysis (FMEA and FMECA)
	EPRI 3002022540	2021	EPRI BATTERY STORAGE FIRE SAFETY ROADMAP: EPRI's Immediate, Near, and Medium-Term Research Priorities to Minimize Fire Risks for Energy Storage Owners and Operators Around the World
BESS Enclosure Integrity	BS EN IEC 60529	2013	Degree of Protection Provided by Enclosure (IP Code)
	UL 50E	2020	Enclosures for Electrical Equipment, Environmental Considerations.
	BS EN IEC 62262	2002	Degrees of Protection Provided by Enclosure for Electrical Equipment Against External Mechanical Impacts (IK code).
BESS Enclosure wall fire resistance (1 hour minimum)	BS EN 13501-2:2023	2023	Fire classification of construction products and building elements. Classification using data from fire resistance tests, excluding ventilation services
	BS EN 1364-1	2015	Fire resistance tests for non-loadbearing elements: Walls
ESS Seismic integrity (control and switchbox)	IEEE 693	2018	IEEE Recommended Practice for Seismic Design of Substations
	BS EN IEC 60068-3-3	2019	Environmental testing. Supporting documentation and guidance. Seismic test methods for equipment.
PCS standards (common standards)	UL 1741	2021	Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
	IEEE 1547	2018	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.
	CSA C22.2 No. 107.1:16	2021	Power conversion equipment
	BS EN IEC 62109-1	2010	Safety of power converters for use in photovoltaic power systems. General requirements.
	BS EN IEC 62109-2	2011	Safety of power converters for use in photovoltaic power systems. Particular requirements for inverters.
	BS EN IEC 62477-1	2022	Safety requirements for power electronic converter systems and equipment. General.

Group Category	Standard	Year	Description
	BS EN IEC 61000-6-2	2016	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
	BS EN IEC 61000-6-4	2018	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.
	IEC CISPR 11	2022	Industrial, scientific, and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement. Conducted emissions and Radiated emissions tests.
	BS EN IEC 62909-1	2017	Bi-directional grid-connected power converters. General requirements.
	BS EN IEC 62909-2	2019	Bi-directional grid-connected power converters. Interface of GCPC and distributed energy resources.
Fire and Rescue Service	Local Government Association and Water UK	2007	National Guidance Document on the Provision of Water for Firefighting
	National Fire Chiefs Council (NFCC)	2023	National Operational Guidance. Hazard – Fire water run-off
	National Fire Chiefs Council (NFCC)	2023	Grid Scale Battery Energy Storage System planning – Guidance for FRS
Cybersecurity	UL 1741	2021	Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
	UL 2941	2023	Outline of Investigation for Cybersecurity of Distributed Energy and Inverter-Based Resources
	BS EN IEC 62433	2021	Security of Industrial Automation and Control Systems (IACS)
	IEEE 1547.3	2023	Guide for Cybersecurity of Distributed Energy Resources (DER) interconnection with Electric Power Systems (EPS)
	IEEE 1815	2012	Standard for EPS Communications-Distributed Network Protocol (DNP3)

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

4.2 Safe BESS Design

- 4.2.1 BESS facilities promoted by Clearstone Energy will be designed to address prevailing industry standards and good practices at the time of design and implementation. BESS system and components must be certified to UL 9540 (2023) standards.
- 4.2.2 NFPA 855 (2023) currently provides the most comprehensive guidelines for BESS design and site installation specifications. BESS design structural integrity will be demonstrated through full-scale fire and explosion testing or by integrating NFPA 69 (explosion prevention) and NFPA 68 (Explosion protection through deflagration venting) features.
- 4.2.3 In addition to this, good practice guidance for electrical sites within the UK will be consulted with regard to the proposed site layout and separation distances for the transformers and inverters.

- 4.2.4 Safety Certifications and mitigation features typically found within battery module design, which Clearstone Energy will commit to in its proposed BESS facilities, include:
- Internal fuses.
 - Liquid cooling system.
 - Active Thermal Management System.
 - Overcharge safety device.
 - Internal passive protection products.
 - Venting systems and gas channels.
 - Thermal or multi-sensor monitoring devices.
- 4.2.5 Cell certified to UL 1973 and tested to UL 9540A unit or installation level for BESS designs.
- 4.2.6 Module design will be certified to UL 1973 and tested to UL 9540A unit or installation level for BESS designs.

4.3 BESS Siting and Layout

- 4.3.1 Renewable energy facilities will be located in low-risk environments wherever possible. The selection of the locations for BESS areas will be based on a number of factors including wider environmental conditions and other potential sources of fire hazards in the surrounding area. Distances from BESS areas to residential areas / commercial properties will be carefully considered to minimise operational or incident impacts on receptors.
- 4.3.2 The layout of the BESS should provide adequate separation between enclosures, additional ESS (Energy Storage System) equipment, and other key site structures and infrastructure. The UK National Fire Chiefs Council (NFCC) 'Grid Scale Battery Energy Storage System planning – Guidance for FRS (2023)' should be followed at an indicative design stage, which comprises:
- To protect BESS enclosures from exterior risks, they shall be provided with impact protection to prevent damage to battery enclosures by vehicles or construction equipment, and use Damage Limiting Construction (DLC) techniques.
 - NFCC guidelines state a minimum separation distance of 6m is required between BESS enclosures and ESS equipment. This exceeds the NFPA 855 (2023) guidelines of 3.06m, considered safe practice if sufficient UL 9540A testing and/or 3rd Party Fire and Explosion testing heat flux data has validated that closer spacing does not increase explosion risks or fire propagation risk.
 - NFCC guidelines allow reduced separation distances if suitable design features can be introduced. If reducing distances, a clear, evidence-based case for the reduction should be shown in the detailed design phase and supported by testing data. Therefore, the requirements set by NFPA 855 (3.06m) can be used at the indicative site design stage where a definitive BESS system has not been selected, subject to validation in the detailed design phase.
 - Separation distance between the BESS enclosures and site boundaries should be 25 m but can be located closer if a full risk assessment is conducted and/or mitigation features are integrated.
 - Areas within 10 m of BESS enclosures should be cleared of combustible vegetation. Where this is not feasible a full risk assessment should be conducted, and mitigation features applied if required by the FRS. Any other vegetation on site should be kept in a condition such that they do not increase the risk of fire on site. Areas with wildfire risk or vegetation that would result in significant size fires should be factored into this assessment and additional cleared distances maintained as required.
 - BESS enclosures must have an internal fire resistance rating of at least one hour (according to NFPA 855 and FM Global Datasheet 5-33).
 - BESS areas shall be designed to integrate fire hydrants and/or static water tanks for firefighting, dependent on available water supply. Water tanks should be located at

least 10 m from the nearest BESS enclosure. Water access points, whether hydrants or tank connections, will be located in consultation with the local FRS to provide redundancy and safe operating distances for firefighters with 30 – 50 m, which is considered an optimal safe distance.

- Tanks and water outlets should be clearly labelled with appropriate signage and marked on site plans. Additionally, to avoid any mechanical damage, outlets and hard suction points must be safeguarded with bollards.

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

4.4 BESS Enclosures

4.4.1 The BESS enclosure shall be installed by a certified and qualified installer. The BESS enclosure will be UL9540 certificated. Ingress protection testing of BESS enclosures is conducted under UL9540 and/or IEC62933-5-2 certification of any BESS system. Typical BESS enclosure ingress protection levels are IP55 / NEMA 3R or IP66 / NEMA 4. IEC Factory Acceptance Testing (FAT) or an independent manufacturing audit will be carried out to ensure the supplied BESS enclosures comply with the requisite certified ingress protection levels.

4.4.2 Ingress Protection² (IP) ratings of BESS containers will be shared with the FRS at the detailed design stage so that risks associated with boundary cooling can be understood and implemented into the Emergency Response Plan. Potential boundary cooling water ingress points such as HVAC systems and deflagration vents will be considered as part of an incident response strategy.

4.5 BESS Fire Detection and Suppression

4.5.1 It is unlikely that a fire event will occur, but good international practice requires the incorporation of fire detection and suppression systems to minimise the risk of an incident and the consequences of any incident should one occur.

4.5.2 As a preventative measure, battery modules will integrate liquid cooling systems with automated fail-safe operation.

4.5.3 The BESS fire and gas detection system will comply with NFPA 855 (2023) and NFPA 69. This means that smoke, fire and gas detection equipment will be installed. New BESS multi-sensor equipment in development which measures combinations of air temperature, hydrogen, volatile organic compounds, overpressure, shock and vibration, and moisture ingress will also be considered if fully tested with the BESS design. The gas detection systems will have external BESS beacon and audible alert facility. The final fire detection design will be validated by an independent Fire Protection Engineer under the responsibility of the Operations, Engineering and Maintenance Contractor prior to construction, and will be approved by the FRS.

4.5.4 The BESS fire suppression system will conform to NFPA 855 (2023) guidelines, and the suppression system will be tested to UL 9540A latest standard or significant scale 3rd Party fire and explosion testing. Fire suppression system performance will be benchmarked against free burn testing. An independent Fire Protection Engineer specialising in BESS will be contracted by the Operations, Engineering and Maintenance Contractor to review all UL 9540A test results and any additional fire and explosion test data which has been provided and validate the suppression system design.

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

² Ingress Protection (IP) rating grade the resistance of an enclosure against the intrusion of solids or liquids.

- 4.5.6 Each BESS enclosure integrating water or aqueous fire suppression systems will be provided with a sump and drain valve to allow extraction of contaminated fire water and / or electrolyte spill without having to open the door of the container and will prevent contamination of surrounding environment with the extracted liquid being taken off site for treatment. The sump construction will be designed to allow for chemical resistance of electrolyte which may be released from a battery fire and have capacity to hold the total volume of electrolyte plus a 10% safety factor. The sump will encompass the entire floor area of the BESS container with mesh grating type floor to allow spilled electrolyte to drain without pooling near other racks, other designs proven capable to protect against electrolyte spills will be permissible, i.e. separate fire water drainage and electrolyte spill systems.
- 4.5.7 A post-incident recovery plan shall be developed that addresses the potential for reignition of BESS battery systems, as well as removal and disposal of damaged equipment. A fire watch will be present until all potentially damaged BESS equipment batteries are removed from the area following a fire event. The water supply for suppression systems and / or firefighting will be replenished as quickly as feasible.
- 4.5.8 Energy Storage Management System / Battery Management Systems (ESMS / BMS) controls will follow NFPA 855 (2023) recommendations (new IEC and IEEE standards are being drafted). Battery system data analytics will be integrated into ESMS / BMS systems & controls which reduces Thermal Runaway risks. Data Analytics can also be used to predict accurate End-of-Life timeframes and provide operator maintenance alerts.
- 4.5.9 Other measures to minimise the risk of a fire event that could be incorporated include:
- Any ventilation and gas extraction system shall also be designed to exhaust flames and gases safely outside in case of fire inside the BESS enclosure, without compromising the safety of first responders. The ventilation system shall be provided with suitable ember protection to prevent embers from penetrating BESS enclosures (HVAC, gas exhaust, deflagration panels).
 - At a minimum a BESS ventilation system will comply with NFPA 855 (2023) / NFPA 69 guidelines which require the prevention of a dangerous build-up of explosive gases (25% LEL). The gas exhaust / ventilation system must have redundancy and can be separate to any HVAC system providing climate control. Heating and cooling of the battery modules will be provided by an independent liquid cooling system which is separate to any HVAC system providing climate control for the BESS enclosure. When mechanical ventilation is required to maintain concentrations below the required limits, it shall be interlocked, so that the system shuts down upon failure of the ventilation system.
 - Where emergency ventilation is used to mitigate an explosion hazard, the disconnect for the ventilation system should be clearly marked to notify personnel or first responders to not disconnect the power supply to the ventilation system during an evolving incident.
 - The BESS enclosure will be designed to withstand overpressures generated by the battery system during thermal runaway. An explosion prevention system to NFPA 69 standards and / or explosion protection system to NFPA 68 and EN 14797 standards will be integrated. If BESS design only integrates explosion protection systems i.e. deflagration panels, then performance must be validated through BESS free burn testing and requisite pressure testing required by NFPA and EN standards. Further, the BESS enclosure will have completed UL 9540A unit and / or installation testing or large-scale 3rd Party Fire & Explosion testing without pressure waves occurring or shrapnel being ejected. An independent Fire Protection Engineer specialising in BESS will review all UL 9540A test results and any additional fire and explosion test data which has been provided.
 - Inclusion of a BESS Emergency Stop system – both remote and local.
 - BESS local manual gas exhaust mechanism for first responders (separate to BESS enclosure) should be installed.

4.6 Safe BESS Transportation and Construction

- 4.6.1 The installation of BESS will be subject to prerequisites such as a contractor emergency protocol detailing the actions to be taken in an emergency, including a construction emergency response plan that would be coordinated with the relevant stakeholders and emergency services. In addition, installation would not take place until practical provisions were completed.
- 4.6.2 The transportation of the system from the factory will be a combination of sea and land freight. The system is certified for transportation in all potential environmental conditions. The equipment will be certified for transport to UN 38.3 Transportation and will be managed in accordance with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2019 and the UK guidance on the transport of dangerous goods 'Moving dangerous goods, Guidance' website.
- 4.6.3 The appointed Contractor will ensure the transported BESS equipment will be prepopulated with batteries and will have undergone Factory Acceptance Testing (FAT) to IEC 62933-5-2 standards. Site Acceptance Tests (SAT) will follow IEC 62933-5-2 and IEEE 2962 (in development) standards and protocols.
- 4.6.4 By following a logical sequence of works with each step being built upon the preceding one, the system can be safely assembled without risk and all mitigation against issues can be implemented before the next step occurs.

4.7 Safe BESS Operation

- 4.7.1 BESS facilities will preferably be monitored and managed closely by a remote facility.
- 4.7.2 Staff will be fully trained and familiar with the BESS technologies and will have responsibility for alerting the local FRS and will be responsible for connecting the FRS with BESS incident Subject Matter Experts (SMEs).
- 4.7.3 The 24/7 remote control facility will also be responsible for monitoring the security of the BESS site, monitoring and detection systems will be repurposed in an emergency to support first responders. NFPA 855 (2023) defines minimum monitoring and control standards.
- 4.7.4 The 24/7 control facilities will have the capability to immediately shut the system down should the need arise. It will also be responsible for implementing the emergency plan, acting as a point of contact to the emergency services.
- 4.7.5 In some circumstances it will be necessary to discharge the batteries to enable the first / second responders to deal with the incident. This capability could be potentially achieved through the remote facility (24/7). The precise methodology in this regard will be agreed in the Emergency Response Plan once the detailed design of the BESS is known. This will be prepared in conjunction with the relevant fire services and is secured through this document.
- 4.7.6 Signage should be installed in a suitable and visible location on the outside of BESS units identifying the presence of a BESS system. Signage as per NFCC guidelines will also include details of:
 - Relevant hazards posed i.e., the presence of High Voltage DC Electrical Systems is a risk, and their location should be identified.
 - The type of technology associated with the BESS.
 - Any suppression system fitted.
 - 24/7 Emergency Contact Information.
 - Signs on the exterior of a building or enclosure will be sized such that at least one sign is legible at night at a distance of 30 m or from the site boundary, whichever is closer.

4.8 BESS Site Security

- 4.8.1 The site security profile will be assessed by an on-call team with dedicated service level agreement in place with input from all local key safety stakeholders. The package of security measures will be agreed with this stakeholder group.
- 4.8.2 Where practical and required by the local FRS or risk assessment, BESS areas will have security fencing with a minimum of two points of ingress / egress for first responders and clearly signed, with incident emergency response contact details, clear identification of BESS site hazards, details of any site access arrangements, such as key codes, provided to the FRS.
- 4.8.3 BESS sites will also have Thermal Imaging Cameras to alert and locate on site fire risks and integrate HD CCTV with video analytics to alert and respond to unauthorised site access.

4.9 Maintenance

- 4.9.1 BESS facilities will be maintained and operated by skilled personnel ensuring that the system is in optimal condition and that all parts of the system are fully serviced and fully functional.
- 4.9.2 Routine maintenance will be undertaken on the BESS equipment every 6-12 months depending on the risk profile of equipment. This typically consists of a major maintenance period and a minor maintenance period. This will encompass all BESS and supporting equipment supplied by the Original Equipment Manufacturer including the fire system. Minor maintenance is typically a visual inspection and rectification of any accumulated noncritical defects.
- 4.9.3 All maintenance will be undertaken in a carefully controlled manner following the site-specific safety rules.
- 4.9.4 During operation of the BESS facility, all works on the site will be controlled under safe systems of work. This will mean all work is risk assessed to protect both personnel and equipment. Therefore, safety systems such as fire systems will not be stopped or taken out of service without appropriate mitigation, following the system being made safe so far as reasonably practicable, and only for the minimum time required to undertake any specific maintenance tasks.

5. Firefighting

5.1 Fire Service Guidance

- 5.1.1 Guidance for the Fire Service for dealing with electrical apparatus is contained in the Fire Service Manual Volume 2 Fire Service Operations – Electricity.
- 5.1.2 The Fire Service Manual stipulates that it is essential to ensure, on arrival, that the apparatus is electrically isolated and safe to approach. This should be carried out remotely and confirmed safe by the operator before being approached.
- 5.1.3 In the event of a fire, the battery system and the transformers serving the BESS will be automatically electrically isolated when a fire is detected within a container. However, the batteries within the enclosures will still hold the charge in the event of a fire, even after the electrical system is isolated.
- 5.1.4 In order to determine the volume storage of external water supplies for firefighting, NFCC guidance will be used which states provisional firefighting supplies “*should be capable of delivering no less than 1,900 litres per minute for at least 2 hours.*” The local FRS will be able to view the selected BESS system fire test data and an independent Fire Protection Engineer will validate the final water supply requirements. Clearstone will not select a BESS design likely to require direct FRS firefighting engagement.
- 5.1.5 If BESS site restrictions limit the volume of water that can be stored on site, the requirements set out in NFPA 1142 (Standard on Water Supplies for Suburban and Rural Firefighting) could be used in consultation with the local FRS, during the indicative planning stage, to set out the minimum water supply for fighting a BESS fire.
- 5.1.6 Water volumes required for BESS suppression are established during free burn tests by BESS OEMs and the formula ultimately considers the number of BESS enclosures on site and water is commonly stored in above ground tanks. Formula example: $WS_{min} = VStot \text{ OHC (CC) } * 1.5$
 - WS_{min} = Minimum water supply in litres
 - VStot = Total volume of structure in metres³
 - OHC = Occupancy hazard classification number
 - CC = Classification of construction
- 5.1.7 If a dedicated automatic water-based system is provided within each BESS container this will be designed to control or fully suppress a fire, without the intervention of the FRS.
- 5.1.8 If the BESS system is designed to safely burn out to remove the risk of stranded energy in the battery systems, then full scale free burn testing will have been conducted to demonstrate that loss will be safely limited to one container without the intervention of the FRS.
- 5.1.9 Clearstone Energy will ensure engagement with the local FRS has been undertaken for a standalone BESS and will require the design team to continue this engagement throughout the design, installation, and commissioning phases of the project.
- 5.1.10 Site and BESS design principles and ERP content will ensure that the FRS are expected to employ a defensive strategy i.e., only boundary cooling should be employed for cooling of adjacent BESS or associated supporting equipment.

5.2 Fire Service Access

- 5.2.1 UK National Fire Chiefs Council BESS planning guidance stipulates that suitable facilities for safely accessing and egressing the site should be provided. Designs should be developed in

close liaison with the local FRS as specific requirements may apply due to variations in vehicles and equipment. This should include:

- Roads/hard standing capable of accommodating fire service vehicles in all weather conditions. As such there will be no extremes of grade.
- A perimeter road or roads with passing places suitable for fire service vehicles.
- At least 2 separate access points to the site to account for opposite wind conditions / direction. If a BESS site is not able to accommodate this facility due to topographic limitations, then alternative site-specific ingress / egress arrangements will be agreed with the local FRS.
- Road networks on sites will enable unobstructed access to all areas of the facility.
- Turning circles, passing places etc size to be advised by FRS depending on the nature and size of the expected fleet.
- Turning facilities will be provided in any dead-end access route that is longer than 20m.
- The minimum proposed access road width to reach a BESS facility will be a minimum of 4m.
- If FRS observation areas are incorporated into the site design, they must be more than 30 m from the nearest BESS enclosure (upwind).
- Any water storage tanks designed to be used for firefighting must be located at least 10 m away from any BESS enclosure. They must be clearly marked with appropriate signage. They must be easily accessible to FRS vehicles and their siting should be considered as part of a risk assessed approach that considers potential fire development/impacts. Outlets and connections should be agreed with the local FRS. Any outlets and hard suction points should be protected from mechanical damage (e.g., through use of bollards).

5.3 Emergency Planning

- 5.3.1 BESS facilities will have a robust and validated Emergency Response Plan (ERP), developed in consultation with the local FRS.
- 5.3.2 NFPA 855 (2023) defines basic operation H&S protocols for all BESS site designs which will be incorporated into the ERP:
- The ERP will consider measures to protect any features within 30.5 m of the BESS. This is a typical safe exclusion zone in the unlikely event of a fire or overheating.
 - The ERP will establish measures for a building evacuation area 200 feet / 61 m from the BESS.
- 5.3.3 Some example BESS and site design information which will be included in the Battery Fire Safety Management Plan and will be shared with the FRS to establish a risk profile for first responders, are listed below:
- Battery chemistry integrated into BESS – can provide fire and explosive risk profile.
 - Battery form factor (cylindrical, pouch, prismatic).
 - Battery energy Wh / KWh – confirmation of new vs second life cells.
 - Battery module cooling system details (e.g., liquid cooling design, air cooling design) – cooling system capability assessment to stop or reduce battery cell thermal runaway propagation.
 - Battery module vent or gas exhaust specifications.
 - Battery module KWh energy + number of cells contained in the module + battery circuitry details (number of cells in series vs number of cells in parallel).
 - Direct suppression system details – module or rack level integration.

- Rack design – number of modules and KWh energy, spacing between modules, passive protection features, gas exhaust features, electrical isolation functions, heat or thermal runaway sensor integration, etc.
- Rack configuration – spacing to adjacent racks, number of racks in BESS, spacing to walls, doors, gas vents and roof.
- Type of BESS design e.g., container or cabinet, gas exhaust / ventilation features, deflagration vent design features, BESS enclosure level fire protection & suppression system details (proof of testing with BESS design + test data), additional fire or explosion protection features i.e., thermal barriers.
- ESMS / BMS data monitoring capabilities and incident response integration capacity.
- Number of BESS containers/cabinets on site.
- Size and MWh capacity of each BESS unit.
- BESS and ESS equipment spacing; spacing to other equipment, boundaries, vegetation, roads or access routes, fire hydrants / water tanks, site building structures, etc.
- Access routes, observation points, turning areas, FRS equipment & assets, water supply locations and capacity, drainage, and water capture design.
- Definition and frequency of BESS equipment testing and maintenance requirements.
- Digital provision of safety information and procedures must be provided to site operatives, first responders and Subject Matter Experts (SMEs) during BESS incident response – hard copy printed materials must be available onsite (location agreed with FRS). As a minimum content should include:
 - Digital emergency response plans.
 - Remote emergency shutoff procedures.
 - SDS / Hazardous material documentation.
 - Maps or design drawings.
- Gas detection capabilities; could include multi-sensor data metrics e.g., Carbon Dioxide (CO₂), Carbon Monoxide (CO), Hydrogen (H₂), VOC off gas and overpressure and local temperatures.
- Fire protection system data e.g., temperature, alarming, suppression status, etc. – establish discharge warrantee clauses, emergency BESS venting procedures, discharge times, impact on ventilation and detection systems, etc.
- ERP training drills for site operatives + FRS engagement (site familiarisation + training drills) and SME engagement (fire protection experts or battery experts)
- Other documentation as required by specific BESS project i.e., local response stipulations, contact information for nominated response personnel, community contacts, etc.

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

- How the fire service will be alerted and incident communications & monitoring capabilities.
- Facility description, including infrastructure details, operations, number of personnel, and operating hours.
- Site plan depicting key infrastructure:
 - Site access points, internal roads, agreed access routes, observation points, turning areas, etc.
- Firefighting facilities (water tanks, pumps, booster systems, fire hydrants, fire hose reels etc).
- Water supply locations & capacity.

- Drainage and water capture design & locations.
 - 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.
 - Up-to-date contact details for facility personnel, and any relevant off-site personnel that could provide technical support during an emergency.
 - A list of dangerous goods stored on site.
 - Site evacuation procedures.
 - Site operation Emergency Management protocols - 4 phases: discovery, initial response / notification, incident actions, resolution & post incident actions / responses.
 - Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire, wildfires, impacts on local respondents, impacts on transport infrastructure.
 - The operator will develop a post-incident recovery plan that addresses the potential for reignition of the BESS and de-energizing the system, as well as removal and disposal of damaged equipment.
- 5.3.5 A Risk Management Plan shall be developed post consent at detailed design stage which, as a minimum, provides advice in relation to potential emergency response implications including:
- The hazards and risks at and to the facility and their proposed management.
 - Any safety issues for firefighters responding to emergencies at the facility.
 - Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems. Establish response times and site arrival protocols.
 - The adequacy of proposed fire detection and suppression systems e.g., water supply on-site.
 - Natural and built infrastructure and on-site processes that may impact or delay effective emergency response i.e., firefighting water runoff capture.

5.4 Fire and Rescue Service (FRS) Engagement and Consultation

- 5.4.1 It is not anticipated that firefighting techniques will require direct hose streams or spray directly on battery systems and will be limited to boundary cooling of adjacent BESS units and supporting equipment to prevent the fire from spreading. This strategy will be finalised with the local FRS and be clearly communicated in the ERP.
- 5.4.2 Clearstone Energy will work closely with the FRS to provide all necessary information regarding the installation of BESS facilities, including site design features, to facilitate hazard and risk analysis studies. Clearstone Energy will also assist in developing comprehensive Risk Management (RM) and Emergency Response Plans (ERP).
- 5.4.3 Clearstone Energy should contact local FRS before submitting the application. Discussions on site design and FRS requirements must be established promptly.
- 5.4.4 Preliminary site designs will be shared with the local FRS for feedback. Any recommendations will be considered and incorporated into the proposed scheme's concept design, which will be submitted for planning consent.
- 5.4.5 Throughout the submission. post-consent and detailed design stage stages, consultation with the local FRS will continue to ensure all key stakeholders are satisfied with agreed mitigation and safety requirements prior to construction.

- 5.4.6 During the detailed design stage, information about the BESS will be provided as early as possible. This will allow for an initial assessment of the BESS, along with appropriate evidence to support any claims made on its performance, and with the necessary installation standards cited. The FRS will be provided with this information.
- 5.4.7 Such information should also be made available to FRSs for inclusion in their Site-Specific Risk Information (SSRI) records (in most cases there is a lead designated FRS station for incident response). UK legislation sets the requirement for site-specific assessment. Collating and disseminating SSRI involves several FRS tasks:
- a) Selecting premises to be inspected.
 - b) Assessing the nature and magnitude of the risk.
 - c) Considering a proportionate response.
 - d) Recording significant findings.
 - e) Making sure information is available in a usable form.
 - f) A site-specific assessment takes account of current legislation on inspection information and includes information on pre planning firefighting tactics.
- 5.4.8 A fire water management plan should include the containment, monitoring, and disposal of contaminated fire water. Infrastructure shall be provided for the containment and management of contaminated fire water runoff from BESS. This can include bunding, sumps, and purpose-built impervious retention facilities. All process water used in the system shall be prevented from contaminating potable water sources in accordance with local regulations through the use of check valves or other means as part of the system design.
- 5.4.9 The FRS will be consulted to determine the location, volume storage, and flowrate of firewater. This may be required for each group of BESS (this can vary significantly depending on BESS locations and site topography).
- 5.4.10 Sites located in flood zones would have details of flood protection or mitigation measures.
- 5.4.11 Trapped water may be reused as a potential source of firefighting water. This follows the management plan process as detailed in "Protocol for the disposal of contaminated water and associated wastes at incidents 2018."

6. Pre-construction Risk Assessment and Hazard Mitigation Requirements

- 6.1.1 The detailed design phase of individual BESS sites will consider the lifecycle of the battery system from installation to decommissioning. At the detailed design stage, risk assessment tools will be utilised together with detailed consequence modelling to provide a comprehensive site operations and emergency response safety audit.
- 6.1.2 The battery system mitigation measures adopted in a final Battery Fire Safety Management Plan, will reflect the latest BESS safety codes and standards applicable at that stage. Mitigation measures will be discussed and coordinated with local FRS.
- 6.1.3 A Failure Modes and Effects Analysis (FMEA) of the BESS will be conducted to lay the foundation for predictive maintenance requirements and complement the fault indicator capabilities of the BMS data analytics system.
- 6.1.4 Comprehensive Hazard Mitigation Analysis (HMA) will be conducted by a BESS specialist independent Fire Protection Engineer following NFPA 855 (2023) guidelines and recommendations.
- 6.1.5 Additional risk assessments likely to be conducted at the detailed design stage are Fire Risk Analysis (FRA), Explosion Risk Analysis (ERA), Hazard and Operability Analysis (HAZOP). BESS 3rd Party risk analysis is sometimes automatically provided by Tier one BESS manufacturers and / or BESS integrators.
- 6.1.6 If the BESS system supplied differs from the specification considered for risk assessments and consequence modelling, then a full safety audit will be repeated for the new BESS system specification. These studies will be completed and signed off before construction commences.

7. Conclusion

- 7.1.1 To conclude, Clearstone Energy is committed to developing safe BESS facilities that will provide long and dependable operation. The selected BESS technology used will be robust, particularly with regard to safe operation.
- 7.1.2 This safety standards document demonstrates the robust processes that will be followed in BESS development. This document also outlines the accountability of the developer to consult with the local FRS and other relevant stakeholders in the vicinity of any proposed BESS development and to incorporate the outcomes of consultation in the design of the facility.
- 7.1.3 Safety is at the forefront of Clearstone Energy's battery storage projects and will be inherent in the overall design, minimising the risk of a fire or explosion event occurring, and reducing the impact of such an event should it occur.

8. References

- Ref 1 DNV (2017) GL-Recommended Practice-0043: Safety, Operation and Performance of Grid Connected Energy Storage Systems.
- Ref 2 Lithium-ion Battery Storage (Fire Safety and Environmental Permits) Bill 2022-23; First Reading (2022) Hansard.
- Ref 3 Scottish and Southern Energy (2019) TG-PS-777: Limitation of Fire Risk in Substations, Technical Guide.
- Ref 4 Water UK (2018) Protocol for the disposal of contaminated water and associated wastes at incidents (Jointly issued by Water UK, Environment Agency, NIEA, Natural Resources Wales, DWI, Fera, Defra's CBRN Recovery Team, NFCC National Resilience).
- Ref 5 British Standard (2017) BS 5839-1:2017 Fire Detection and Fire Alarm Systems for Buildings.
- Ref 6 Regulatory Reform (2005) The Regulatory Reform (Fire Safety) Order 2005.
- Ref 7 BSI Standards Publication (2021) BS EN IEC 61936, Power installations exceeding 1 kV AC and 1,5 kV DC – AC.
- Ref 8 UL Standard (2020) UL9540A Energy Storage Systems and Equipment.
- Ref 9 NFPA (2023) NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.
- Ref 10 UK Statutory Instrument (2002) The Dangerous Substances and Explosive Atmospheres Regulations 2002.
- Ref 11 International Standards Organisation (2015) ISO9001:2015 Quality Management Systems – Requirements.
- Ref 12 United Nations (2015), Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (UN 38.3).
- Ref 13 Fire and Emergency Planning Directorate (1998) Fire Service Manual Volume 2: Fire Service Operations, Electricity.
- Ref 14 United Kingdom Power Networks (UKPN) (2016) Engineering Design Standard 07-0116: Fire Protection Standard for UK Power Networks Operational Sites.
- Ref 15 HM Government (2019) The Building Regulations 2010, Fire Safety – Approved Document Volume 2: Buildings other than dwellings. (Incorporating 2020 amendments).
- Ref 16 United Nations (2021) Agreement Concerning the International Carriage of Dangerous Goods by Road.
- Ref 17 Richard Chitty (2014) External fire spread: building separation and boundary distances (BR 187 2nd edition).
- Ref 18 HSE (2002) The Dangerous Substances and Explosive Atmospheres Regulations 2002.
- Ref 19 Environment Agency (2021) Land contamination risk management (LCRM) Stage 1-3.
- Ref 20 BSI British Standard (2017) BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice.
- Ref 21 International Society of Automation (2018) ISA62443 Security of Industrial Automation and Control Systems.
- Ref 22 UK Statutory Instruments (2009) The Waste Batteries and Accumulators Regulations 2009.
- Ref 23 HSE (2017) Operation Guidance document OG86 Cyber Security for Industrial Automation and Control Systems (IACS).
- Ref 24 M. Rosen (2021) ESIC Energy Storage Reference Fire Hazard Mitigation Analysis