

VERIFICATION AND COMPLIANCE

REPORT



GREENFIRE SOLUTIONS

SUPPORTING RENEWABLE ENERGY

FEN DYKE FARM, BARDLING'S DROVE,

SUTTON ST JAMES, SPALDING

PE12 OJN

OCTOBER 2024

Greenfire Solutions

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Version	Date	Description of changes	Person responsible
0.9	13 th June 2024	Initial document for internal discussion and Quality Assurance	DE
1.0	18 th June 2024	Draft document for discussion and agreement with Integrum Renewable Energy Ltd.	MB
2.0	27 th June 2024	Revised draft document for discussion and agreement with Integrum Renewable Energy Ltd.	MB
3.0	6 th September 2024	Revised document to include updated plans and revised guidance from the NFCC on separation distances.	MB
4.0	16 th Oct 2024	Revised document following feedback from Integrum and updated layout plans.	MB

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1 Executive Summary

Greenfire Solutions has been commissioned by Integrum to provide a fire related independent Verification and Compliance Report of the Battery Energy Storage System (BESS) development at Fen Dyke Farm, especially against the National Fire Chiefs Council (NFCC) BESS Guidance.

At the time of writing this report, the pre-planning consultation for this project has been submitted and all discussions in this report are therefore based on this scheme design. The technical specifications associated with the procurement process are yet to be finalised and the procurement process commenced. Therefore, our assessment criteria and the way forward, outlined in this report, are all predicated on this technical specification and procurement process supported by a comprehensive and Detailed Battery Safety Management Plan.

The assessment criteria in this document and the current evidence mapped to the NFCC Guidance shown in *Appendix 3*, provide a framework against which a full evaluation of the fire risks of this BESS site can be undertaken once the design and technical specification and the detailed battery management plan have been completed and the procurement process concluded.

Overall, should the methodology, assessment criteria within this report be implemented, together with the subsequent test results, Greenfire Solutions conclude that the site will comply, where appropriate, with the relevant guidance and regulations and, the potential impacts of fire will be of a sufficiently low level of risk, and, appropriately mitigated.

2 Introduction and Project Commissioning Information

- 2.1 Greenfire Solutions is led by former Senior Officers from the UK Fire and Rescue Service.
- 2.2 Greenfire Solutions work with fire and rescue services across the UK, Local Authorities and private sector clients. We pride ourselves on providing a wide range of high-quality, bespoke, and ethically sound advice and support including:
- Operational Advice and Assurance
 - Fire Safety Strategies including Protection and Prevention
 - Legal Advice in Relation to UK Fire Legislation
 - Liaison with Local Authority Fire and Rescue Services on behalf of Third Parties
 - Liaison with Parish, District and County Councils including Elected Members and Officers on behalf of Third Parties
- 2.3 Since the launch of Greenfire Solutions, we have enjoyed considerable growth, built upon the foundations of a solid reputation for delivering high quality outcomes. We have been working with multiple energy companies helping to shape projects from inception through to delivery on the ground. Our extensive strategic, operational experience of the fire service and local authorities enables Greenfire Solutions to support planners and designers by:
- Reviewing designs and plans to prepare for fire service consultation in line with the new requirements of the Planning Practice Guidance (PPG) which now includes the National Fire Chiefs Council (NFCC) guidance document on Battery Energy Storage Systems and the Health and Safety Guidance for Grid Scale Energy Storage.
 - Providing Scheme Specific Verification and Compliance Reports
 - Generating solutions for site specific challenges
 - Support liaison during engagement with fire and rescue services to create a positive and open collaborative approach
 - Provide challenge and feedback from learning that emerges from national and international incidents to feed into future design
 - Creating bespoke Fire Risk Response and Battery Safety Management Plans
 - Work with other professional institutions and associations such as the National Fire Chiefs Council, Institute of Fire Engineers and the Fire Industry Association
- 2.4 Our focus is to build trusting relationships with our clients to become their preferred partner of choice into the future.

Author

- 2.5 The author of this document is Martin Blunden QFSM MIFireE AIFSM, a former Chief Fire Officer of the UK's largest fire services with over 30 years' experience in the UK Fire and Rescue Service. His career experience also includes roles as the strategic lead for the National Fire Chiefs Council on Health and Safety, National Operational Learning, and the Joint Emergency Services

Interoperability Programme, as well as secondments to UK Government to deliver large elements of various national projects.

Scope of the Verification and Compliance Report

2.6 The Verification and Compliance Report is designed to be a constructive process which is intended to be an assessment of the current planning application documentation outlined below, for the co-located BESS site against material planning considerations related to batteries and fire safety. The report acknowledges the procurement process concerning the exact battery and cabinet type, along with other material fire and safety matters, is to be commenced. Therefore, many of the recommendations can be incorporated into the procurement process. This will ensure full compliance and further safety matters can be engineered and 'built in' to the project. The outcome of this report is to inform and enable third parties to consider the acceptability of the proposal and inform any necessary planning controls. Based on the documentation provided and supported by conversations with the client, the objectives of this report are as follows:

- Determine and evaluate whether the fire risks stated by the applicant (Integrum) are reasonable.
- Assess whether the impacts of a fire at this BESS site are reasonable, including potential fire spread to neighbouring buildings.
- Scrutinise the design of the BESS in terms of fire safety and measures to mitigate fire risks.
- Investigate the potential effects of a fire plume on neighbouring sites.
- Consider the suitability of the assessment to satisfy the relevant planning policy and material considerations in accordance with the NFCC guidance for BESS design.

2.7 The contents of this report have been informed by a series of documents provided to Greenfire Solutions including:

- Layout Plan Detail IRE004-PL-03 rev13 – *Appendix 1*
- Outline Battery Storage Safety Management Plan vers4.0
- AMA-22709-DS-002 (Drainage Strategy)

3 Use of Design Guidance and Standards

- 3.1 Through communication with the client, our understanding is the design and layout of the BESS site has been established through the use of the following industry wide standards, guidance and best practice. Greenfire Solutions have utilised these standards and added comments on their use for due consideration by Integrum to complement the design and technical specification when this is complete, and the procurement process commenced.

NFCC - Grid Scale Battery Energy Storage System planning – Guidance for FRS

- 3.2 National Planning Practice Guidance encourages Local Planning Authorities to consider guidance produced by the National Fire Chiefs Council. The reviewer notes that the use of this guidance for this development is appropriate to reduce the potential fire risk to as low as reasonably practicable. The new Draft NFCC BESS Guidance currently out for consultation, also advocates such an approach. However, the new guidance also emphasises the need for each site/proposal to be viewed independently as technology and engineering design is rapidly advancing which is also therefore improving and increasing the safety of such sites. The new guidance also places further emphasis on the need to strengthen relationships between the applicant and the local FRS as a key stakeholder.

NFPA 855:2023 – Standard for the Installation of Stationary Energy Storage Systems

- 3.3 This is the standard developed by the National Fire Protection Association in the United States and provides a minimum requirement for mitigating the hazards associated with Battery Energy Storage Systems. Due to the paucity of specific UK and European guidance, the use of this standard is appropriate because it (a) addresses the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems, (b) provides guidance for a successful emergency response in the event of a fire, particularly important where a burn policy is adopted and (c), it is widely used within the UK and accepted by many fire and rescue services and planning authorities.

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

- 3.4 At the time of writing and submitting this report, the specific battery product to be used has not been finalised for this site. However, the use and application of this test method and battery certification standard is appropriate due to the comprehensive approach it takes to evaluating and mitigating fire safety hazards of battery systems. Specifically, it helps in understanding how a thermal event can propagate within a battery system; the standard helps in mitigating fire hazards associated with Lithium-ion BESS; it is a recognised global standard used to demonstrate compliance with safety requirements; and, it can be used to determine the fire and explosion protection required for an installation of a BESS, ensuring these sites are equipped to handle potential fire incidents and thereby protecting equipment and personnel. Batteries which have been tested to UL9540A are therefore designed not to spread from a single cell or the module involved. The test shows that a fire does not spread from beyond the battery module (rack).

UL1973 – Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

3.5 This is a safety standard for energy storage systems. It specifies detailed requirements that manufacturers of ESS must meet to qualify for safety certification. UL1973 certification ensures that the ESS system is safe and reliable for use in real-world conditions. The standard includes construction requirements, safety performance tests, and production tests. UL 1973 also outlines a series of safety performance tests for Energy storage solutions, including electrical tests such as an overcharge test, short circuit test, over-discharge protection test, temperature and operating limits check test, imbalanced charging test, dielectric voltage test, continuity test, failure of cooling/thermal stability system test, and working voltage measurements. Of particular relevance to this study, UL 1973 also requires two fire exposure tests: an external fire exposure test and an internal fire exposure test.

NFPA 68 - Standard on Explosion Protection by Deflagration Venting

3.6 This standard provides guidelines for deflagration venting. It evaluates the potential for and consequences of deflagration from thermal runaway events in BESS equipment. This is crucial for designing safer energy storage solutions and mitigating potential explosion hazards.

NFPA 69 – Standard on Explosion Prevention Systems

3.7 This standard provides guidelines for explosion prevention systems. These systems are designed, installed, operated, maintained, and tested to prevent explosions. This ensures that BESS sites are equipped to handle potential explosion incidents, protecting both the equipment and personnel.

3.8 Whilst NFPA 68 and NFPA 69 are U.S. standards, they are recognised globally and can be used to demonstrate compliance with safety requirements in the UK. They are widely used within the UK and accepted by many fire and rescue services and planning authorities. Compliance with these standards can increase confidence among stakeholders, including regulators, insurers, and members of the public, about the safety of a BESS installation.

Battery Design - Fire Safety Provisions

3.9 It is the understanding Greenfire Solutions that the BESS development consists of 6 battery containers with a capacity of 10MW, 3 battery interface cabinets, 8 PCSK inverters, a transformer, and a substation building on the site. The site also contains a solar farm, landscaping, an attenuation pond area, and a 240,000-litre static water supply.

3.10 As previously identified above, the design and technical specification has not been concluded or the procurement process commenced. Therefore, the specific battery storage unit/cabinet has not been selected for the project which is not unusual at such an early stage in the design process. As a result, there is no specific detail or confirmation concerning the exact type of battery unit/cabinet, how they are to be arranged e.g. a cell-module-rack-cabinet arrangement or how many cabinets there will be in each unit.

3.11 The impact of the site layout and arrangement is dependent on the provision of risk mitigation measures and fire safety provisions, which Greenfire Solutions has considered in later sections of

this report. Specific comments on individual components are provided in further sections of this report.

- 3.12 However, through our discussions with the client, it has been confirmed that each battery container will have its own Battery Management System (BMS). This will provide information on the energy capacity, thermal status and detection systems that reports to a controller which is responsible for the management of each battery container. These individual controllers will connect and report to an overall site control unit. This is commonplace across BESS projects and an industry standard approach.
- 3.13 In relation to battery design fire safety provisions for the cabinets/units, to comply with industry best practice, smoke, heat and flammable gas detection systems should be included in the technical specification/requirements of the procurement documentation. This will enable the specific operating parameters of detectors and emergency response for the units to be defined in the Detailed Battery Storage Safety Management Plan.

Assessment Criteria 1: *In the detailed design of the system, Integrum should detail the detection system specification and operation. This should include the specific operating parameters of the detectors, how they are monitored and the response to the detection event e.g. the identification of a potential fault or issue within the system that could lead to a safety hazard, such as thermal runaway and/or, the early identification of gases released by the lithium-ion cells leading to the initiation of suppression measures.*

Fire Protection Barrier

- 3.14 To comply with NFPA 855, fire protection should be provided between the cabinets in the unit to limit thermal runaway and fire spread. Additionally, the outer steel enclosure of each battery cabinet should be designed with a thermal barrier to mitigate fire spread to and from neighbouring battery containers.
- 3.15 As the design and technical specification has not been concluded or the procurement process commenced, the specific battery storage unit/cabinet has not been selected for the project. When the battery containers and chemistry are known, Integrum should assess the possibility of fire spread from BESS to site critical infrastructure. It is, however, noted that the site vegetation border is more than 10m for the BESS units in accordance with the recommendation in the NFCC guidance.
- 3.16 The new Draft NFCC Guidance allows for spacing of 3ft (0.914m) if it can be proven that fire resistant materials will prevent direct flame impingement or radiated heat affecting adjacent BESS and allowing the incident to develop beyond BESS of origin. However, the 0.914m is predicated on the NFPA 855 standard which states separation can be reduced to at least 3 feet or 0.914m between BESS if tests such as UL 9540A shows propagation does not occur.
- 3.17 Greenfire Solutions note that the side-to-side separation between the BESS units is 2.5m and that each pair are arranged back-to-back, as shown in the diagram shown in *Appendix 2*. Greenfire Solutions confirm that, as per NFPA 855:2023 G.9.2.2, the separation distance can be less than 6m if the units have at least a 60min thermal barrier. The separation distances and this design is in

accordance with the updated FM Global Property Loss Prevention Data Sheet 5-33: Lithium-Ion Battery Energy Storage Systems, January 2024 edition, section 2.3.2 and the new draft NFCC Guidance.

Assessment Criteria 2: *In the detailed design of the system, Integrum should identify the specification/duration of the fire protection provided by partitions between battery cabinets and by the enclosure of the battery unit. This should include justification as to why the specification/duration of fire protection is appropriate for the risk.*

Fire Suppression System

- 3.18 As the design and technical specification has not been concluded or the procurement process commenced, to comply with industry best practice, each battery cabinet should be supplied with its own independent fire suppression system - typically a pulsed aerosol system which has demonstrable evidence at being effective at suppressing lithium battery thermal runaway fires.

Assessment Criteria 3: *In the detailed design of the system, Integrum should provide details of the suppression system specification and operation. This should include the specific suppression technology and product, as well as evidence demonstrating that the suppression system will be effective for a lithium-ion battery fire.*

Deflagration Venting and Off-gas Pressure Relief

- 3.19 As the design and technical specification has not been concluded or the procurement process commenced, details are not clear concerning the deflagration venting and off-gas pressure releasing design. The absence of such information is common at this early design stage. To comply with industry best practice, the design of the BESS units should provide sufficient ventilation so that should there be a build-up of flammable gases very early in a thermal runaway event before they accumulate within the enclosure and become an explosion hazard. Greenfire Solutions recommend that each of the battery cabinets is equipped with the following (as a minimum):

- Ventilation for air conditioning system
- Passive pressure relief valve designed to NFPA68 (for deflagration)
- Active exhaust vents, activated to vent gas from the battery cabinet when gas detectors identify a buildup of flammable gas, well below the lower explosive limit, designed to NFPA69 (for explosion prevention).

- 3.20 If the venting within the containers is designed in accordance with NFPA 68 & 69, Greenfire Solutions agree that it would be appropriate at reducing deflagration and overpressure risks.

Assessment Criteria 4: *In the detailed design of the system, Integrum should provide details of design methodology for the deflagration vents and explosion prevention measures that comply with NFPA 68 and 69. The detail should include the location, size and operating pressures/methodology for each vent and the calculations made for the specification of each vent.*

4 Planning Application Information

- 4.1 The NFCC have produced a guidance document for BESS sites to aid the design for the fire service and their provisions. This is guidance intended for fire and rescue services only. The guidance provides high-level information and design provisions that should be discussed/provided to support the fire safety design of the systems and site layout. Greenfire Solutions considers reference and use of this document is appropriate at benchmarking the initial design. A high-level checklist summary of the against this guidance is detailed in *Appendix 3. Please note – this is not a checklist which incorporates any aspects of the new Draft NFCC Guidance which has recently been out for consultation.*
- 4.2 BESS installations commonly use standard electrical cables with appropriate solid insulation ratings to meet operational and safety requirements. In our discussions with Integrum, we understand that these cables will be selected on their insulation properties, current carrying capacity, and environmental suitability for the specific application on this site and will not be fluid filled.
- 4.3 As highlighted within other sections of this review it is noted that there is lack of detail in the design of the battery units and type for a planning application at this stage. This is because the design and technical specification has not yet been concluded or the procurement process commenced.
- 4.4 Therefore, whilst there are a number of areas of the NFCC report where this site does **not yet** comply (due to a lack of detail as mentioned throughout this report), the assessment criteria that we have used in this report are predicated on a technical specification and a procurement process which, through a comprehensive and detailed Battery Management Safety Plan, will assure that, where appropriate, the scheme **will** adhere to the relevant regulations.
- 4.5 The DBSMP will be prepared to ensure that safety risks related to this proposed BESS site are understood, accounted for, and mitigated as far as practicable, in agreement with relevant consultees, prior to construction commencing. Following the adoption of the measures set out in the BSMP, the risk of a fire occurring from the BESS will be reduced and, if a fire did occur, the risk of it spreading to the point where it became a major incident will be reduced to an acceptable level.

5 Fire Spread Analysis

- 5.1 It is important to ascertain the fire safety implications of a battery container fire on adjacent containers, buildings or sites. This will enable evaluation of the received thermal radiation, visibility of the smoke plume, and toxicity of hydrogen fluoride. An appropriate methodology to gauge the impact of a BESS fire and ensure fire safety for neighbouring sites or buildings can be achieved using a 3D Computational Fluid Dynamics (CFD) model or similar. Such a model can simulate a worst-case Battery Energy Storage System (BESS) fire event, and the subsequent assessment of the fire's byproducts in comparison with the critical tenability criteria.
- 5.2 The model should incorporate the dimensions of the worst-case battery fire event and prevailing wind conditions (with the assumption that the wind is moving towards the side of the site where the nearest buildings are located). The model should accurately represent the anticipated behaviour of the smoke plume and the radiative heat flux emitted. The critical tenability criteria, which are based on literature regarding impairment thresholds and critical levels for potential fire spread, should also be determined.

Model Scenarios

- 5.3 To understand the impact of a fire event to neighbouring units is assessed, Greenfire Solutions recommend that, as a minimum, the following three possible fire scenarios, including the worst-case event, should be considered:
 - 1. A single battery cabinet (rack) is on fire, and this does not spread.
 - 2. Fire spreads to all battery cabinets in a battery container.
 - 3. Unit to unit fire spread.
- 5.4 Scenario 2 can be defined as the worst-case scenario, where all fire protection measures have failed, and the battery cabinets have not performed as per testing under UL9540A conditions.
- 5.5 Scenario 3 which will help validate the planning assumption that a fire in a single BESS unit is the most likely scenario as it will identify the kW/m² of heat radiated from the unit on fire and determine whether this exceeds the failure criteria of the steel enclosure of the unit and therefore the likelihood of it failing.
- 5.6 A scenario where fire spreads to several battery cabinets within a unit is not considered a necessary test if the battery cabinets have been certified to UL9540A if this is chosen as the unit level specification for this project.
- 5.7 For there to be verification of the modelling, peak heat release rate and fire growth rate of the fire modelled in each scenario must be recorded. In addition to this, confirmation of the time, in seconds, for a cell to release off-gas (which directly affects the fire size and burning behaviour,

with a longer time reducing the burning rate) will be available once the detailed design and specification of the system has been completed.

- 5.8 It is necessary to model the escalation of failure from cell to cell and the resulting burning rate over time to accurately represent the failure propagation event within the battery racks. However, as discussed above, the propagated thermal release from the thermal runaway of each rack or scenario will be possible when the detailed design and specification of the system has been completed. At this stage it will be possible to fully evaluate the impact of the off-gas release rate in terms of thermal radiation.
- 5.9 The chosen manufacturer should be asked to provide details of the UL9540A test data to validate assumption of gas composition that can be used in modelling, once the procurement process has concluded and the detailed design and specification of the system has been completed.
- 5.10 A typical BESS fire has a generic composition of off-gas and fire products of 30% hydrogen, 40% hydrocarbons(propane), 15% carbon monoxide, and 10% carbon dioxide. This could be considered as the normal baseline for use in the CPD modelling.
- 5.11 For evaluating the toxicity impact of a battery fire event, it's essential to use the model to examine the production of hydrogen fluoride, given its low threshold and abundance. The threshold for hydrogen fluoride used in the assessment should be set at 30ppm.
- 5.12 The models should include the wind speed variable (average and extreme) as well as the direction towards the area of highest fire spread risk, using an accredited source.

Assessment Criteria 5: *Once the procurement process has concluded and the chosen supplier is confirmed, using an appropriate methodology, Integrum should ascertain the fire safety implications of a battery container fire on adjacent buildings or sites, and evaluate the received thermal radiation, visibility of the smoke plume, and toxicity of hydrogen fluoride.*

6 Fire Service Liaison, Response and Recovery

6.1 To promote transparency and joint understanding with the fire and rescue service, and to support their understanding and mitigation of risk, it is recommended that regular liaison routinely takes place as required through the published Planning Guidance. Such communication should be consistent and include pre-planning; site commissioning; site operations; and site decommissioning. Information that is useful and should be provided to the fire and rescue service includes:

- Background information about the Client and Design Team as well as their expertise with BESS projects.
- How the site design complies with the current NFCC Guidance on BESS sites.
- The background to the use of the NFPA 855 standard.
- Separation distances between battery units
- Thermal Runaway mitigations and the use of UL 9540A.
- An understanding of the preferred/chosen battery chemistry e.g. Lithium Iron Phosphate.
- An understanding of the battery management system (BMS) and thermal detection system response.
- The mitigations and measures for the flammable gas build up risk from thermal runaway of the battery.
- Knowledge of the deflagration venting or off-gas pressure relief provisions to mitigate the risk of deflagration which will inform the fire service's response to a BESS fire.
- An Outline and Detailed Battery Safety Management Plan
- The detection, fire and gas suppression systems designed for use with BESS units.
- A Site-Specific Emergency Response Plan
- A Site-Specific Information Risk Information Pack

Assessment Criteria 6: ***Integrum should share the above details with the fire and rescue service and agree an appropriate communications approach.***

6.2 The Layout Plan Detail at *Appendix 1*, shows that the fire and rescues service will be provided with an emergency water supply via an onsite tank which has a minimum capacity of providing 228,000 litres (1,900L/min for at least 120 minutes). This tank will be sited at least 10m from any BESS container and will be connected and pumped to any affected BESS unit via a fire service appliance. Greenfire Solutions agrees that this is an appropriate supply of water and meets the NFCC guidance on BESS sites.

6.3 From the information provided to Greenfire Solutions by Integrum to date, there is limited evidence to support fire and rescue service access to the site and whether this complies with Approved Document B5 in terms of distance between kerbs, turning circles, access routes around the site including a swept path analysis. A single access road is shown on the scheme design. Whilst

the NFCC Guidance suggest two access routes, Greenfire Solutions acknowledge that is this a small site (10MW) so one access road may be operationally acceptable to the fire and rescue service.

Assessment Criteria 7: ***As part of the planning application, Integrum should provide details of the vehicle access path around the site and confirm that the design, construction and maintenance of the road are suitable for fire service vehicles.***

Emergency, Environmental and Recovery Plan

- 6.4 Greenfire Solutions has not had sight of an emergency, environmental or recovery plan of the BESS in the unlikely event of a fire on this site. This is a common situation at this early stage of a scheme design. However, through our discussions with Integrum, it is currently proposed that the onsite fire containment strategy will be incorporated into the overall site drainage design which is permeable grade 3 compound for the BESS and attenuation having the capacity for 1:100+40 for CC and the NFCC recommended water tank capacity. This should be confirmed through appropriate liaison with the fire and rescue service and planning authority.
- 6.5 Although the design and technical specification has not been concluded or the procurement process commenced, Greenfire Solutions expect that in the unlikely event of a fire, the affected unit will be left to burn out, whilst water may be used for boundary cooling to ensure any fire does not spread further. This operational stance is now commonplace within the industry and is supported by many fire and rescue services. Consequently, the runoff generated is unlikely to create a contamination risk. It is our understanding that runoff used boundary cooling will be initially intercepted by the gravel surfacing from where it will be conveyed by gravity to the attenuation area and held for testing via a penstock or similar prior to release or tanking off site for treatment. Greenfire Solutions recommend consideration is given to lining the battery storage compounds at the site to prevent any discharge of potentially polluted water during a fire event to groundwater receptors.
- 6.6 Without being able to review the detail of the proposed design of the fire containment strategy, Greenfire Solutions cannot yet confirm whether this meets the environmental requirements. Any likely implications of water runoff and environmental concerns should be reviewed by a competent person and in conjunction with discussions with the Environment Agency.

Assessment Criteria 8: ***In the detailed design of the system, Integrum should provide details of the emergency, environmental and recovery plan, including the mitigation measures for loss of containment and potential environmental damage in the event of a failure.***

7 Conclusion

- 7.1 As stated throughout this document, the design and technical specification has not been concluded or the procurement process commenced. This is common at this early stage of a scheme design and planning process. To fully evaluate all the fire risks, the collective fire safety approach and design of BESS containers and site will need to be provided in detail. Such additional information would enable Greenfire Solutions to fully assess the fire safety measures collectively, as part of the entire BESS safety strategy, e.g. determining whether the internal fire protection between cabinets is acceptable at limiting fire spread to other cabinets or the fire suppression system used is suitable for these style of battery cabinets.
- 7.2 The assessment criteria in this document and the current evidence mapped to the NFCC Guidance shown in *Appendix 3*, provide a framework against which a full evaluation of the fire risks of this BESS site can be undertaken once the design and technical specification and the detailed battery management plan have been completed and the procurement process concluded.
- 7.3 Overall, should the methodology, assessment criteria within this report be implemented, together with the subsequent test results, Greenfire Solutions conclude that the site will comply, where appropriate with the relevant guidance and regulations and, the potential impacts of fire will be of a sufficiently low level of risk, and, appropriately mitigated.
- 7.4 The following is a summary of our assessment criteria. They are predicated on a technical specification and a procurement process that, once completed and supported through a comprehensive and Detailed Battery Safety Management Plan, will assure that this scheme complies with the relevant guidance and regulations:

Assessment Criteria 1: *In the detailed design of the system, Integrum should detail the detection system specification and operation. This should include the specific operating parameters of the detectors, how they are monitored and the response to the detection event e.g. the identification of a potential fault or issue within the system that could lead to a safety hazard, such as thermal runaway and/or, the early identification of gases released by the lithium-ion cells leading to the initiation of suppression measures.*

Assessment Criteria 2: *In the detailed design of the system, Integrum should identify the specification/duration of the fire protection provided by partitions between battery cabinets and by the enclosure of the battery unit. This should include justification as to why the specification/duration of fire protection is appropriate for the risk.*

Assessment Criteria 3: *In the detailed design of the system, Integrum should provide details of the suppression system specification and operation. This should include the specific suppression technology and product, as well as evidence demonstrating that the suppression system will be effective for a lithium-ion battery fire.*

Assessment Criteria 4: *In the detailed design of the system, Integrum should provide details of design methodology for the deflagration vents and explosion prevention measures that comply with NFPA 68 and 69. The detail should include the location, size and operating pressures/methodology for each vent and the calculations made for the specification of each vent.*

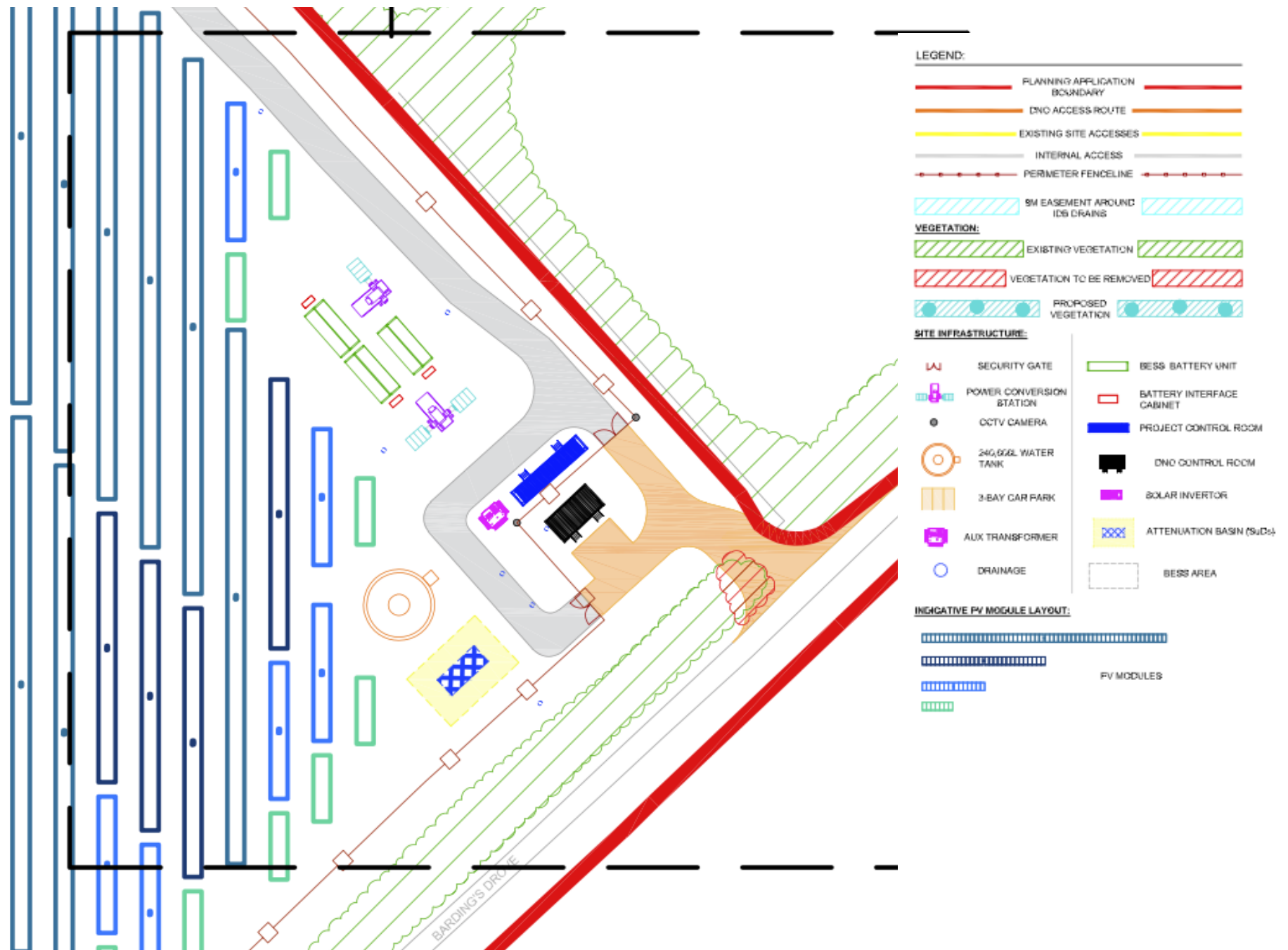
Assessment Criteria 5: *Once the procurement process has concluded and the chosen supplier is confirmed, using an appropriate methodology, Integrum should ascertain the fire safety implications of a battery container fire on adjacent buildings or sites, and evaluate the received thermal radiation, visibility of the smoke plume, and toxicity of hydrogen fluoride. This could be undertaken as part of a wider Environmental Impact Analysis.*

Assessment Criteria 6: *Integrum should share the above details with the fire and rescue service and agree an appropriate communications approach.*

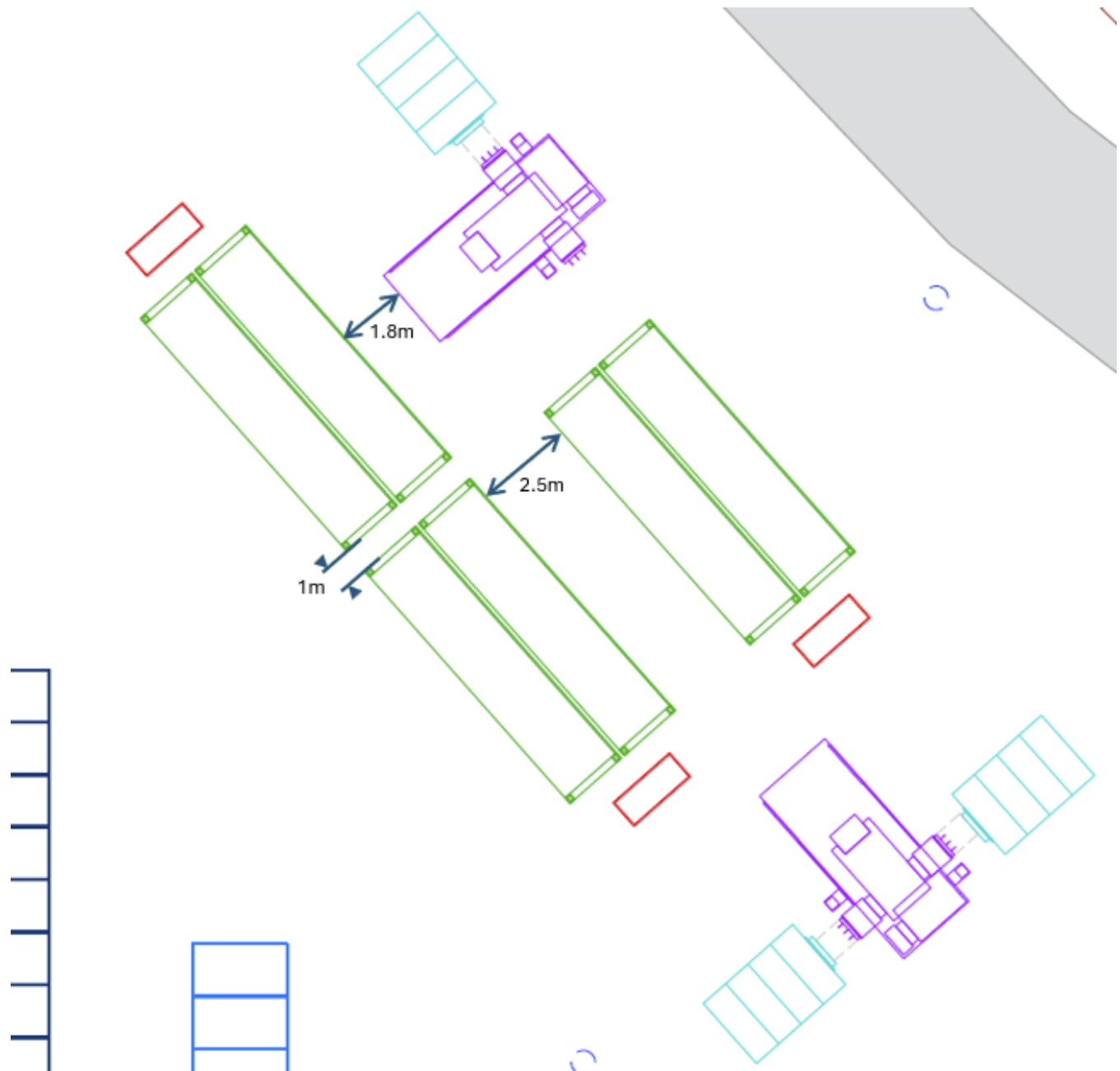
Assessment Criteria 7: *As part of the planning application, Integrum should provide details of the vehicle access path around the site and confirm that the design, construction and maintenance of the road are suitable for fire service vehicles.*

Assessment Criteria 8: *In the detailed design of the system, Integrum should provide details of the emergency, environmental and recovery plan, including the mitigation measures for loss of containment and potential environmental damage in the event of a failure.*

Appendix 1 – Proposed Site Layout



Appendix 2 – Battery Container Spacing



Appendix 3 – NFCC Checklist Summary

NFCC Area	Specific Item	Compliance	GREENFIRE SOLUTIONS Comment
System design & construction	Battery chemistry	Not yet	The exact battery technology will be defined in detailed design.
	Battery form factor	Not yet	The exact battery technology will be defined in detailed design.
	Type of BESS	Yes	The selected BESS type will be containerised units.
	Number of BESS containers/cabinets	Yes	The number of BESS containers are described in the application.
	Size/capacity of each BESS unit	Partially	The size/capacity of each BESS unit will be defined in detailed design.
	How the BESS units will be laid out relative to one another	Yes	The layout of the BESS units is shown.
	A diagram/plan of the site	Yes	A layout diagram of the site is provided.
	Evidence that site geography has been taken into account (e.g. prevailing winds)	Not yet	The CFD analysis for fire spread has considered wind conditions.
	Access to, and within, the site for FRS assets	Not yet	Fire service response consultation has not yet taken place.
	Details of any fire resisting design features	Not yet	The exact detail of the fire resisting enclosures of the units will be defined in detailed design when a specific product is chosen.
	Smoke or fire detection systems	Not yet	The exact detail of smoke and fire detection systems in the units will be defined in detailed design when a specific product is chosen.
	Temperature management systems	Not yet	The exact detail of the temperature management systems in the units will be defined in detailed design when a specific product is chosen.
	Ventilation systems	Not yet	The exact detail of the ventilation systems in the units will be defined in detailed design when a specific product is chosen.
	Exhaust systems	Not yet	The exact detail of the exhaust systems in the units will be defined in detailed design when a specific product is chosen.
	Deflagration venting systems	Not yet	The exact detail of deflagration venting systems in the units will be defined in detailed design when a specific product is chosen.

	Identification of surrounding communities, sites and infrastructure that may be impacted as a result of the incident	Not yet	No analysis has been undertaken at this time.
Testing	Results of tests (e.g. UL9540A)	Not yet	No specific UL9540A test data has been provided as the exact battery chemistry has not yet been defined.
	Fire suppression systems	Not yet	The exact nature of the fire suppression systems will be defined in the detailed design when a specific product is chosen.
Design	Rack layout and setup	Not yet	No specific rack layout and setup information has been provided as the exact battery product has not yet been selected.
	Thermal barriers and insulation	Not yet	No specific thermal barriers and insulation have been defined as the exact battery product has not yet been selected.
	Container layout and access arrangements	Partially	The plan details contained layout and highlight access arrangements.
Detection and Monitoring	Detection provision within units	Not yet	The exact detail of smoke/fire/gas detection systems in the units will be defined in detailed design when a specific product is chosen.
Suppression Systems	Choice of suppression system	Not yet	The exact detail of the suppression system in the units will be defined in detailed design when a specific product is chosen.
Deflagration Prevention and Venting	Analysis of required deflagration protection	Not yet	As the specific battery product has not been selected, no deflagration analysis has been carried out at this stage of the design.
Access	Site access	Partially	There appears to be a perimeter road around each BESS area. Informal liaison with Lincolnshire FRS has taken place to date concerning acceptance.
	Spacing between units	Not yet	The distance between units is less than the 6m recommended by the NFCC. Further analysis is required to demonstrate the likelihood of fire spread between units.
	Site conditions	Yes	The development appears to have vegetation outside 10m of the BESS units.

	Distance to boundary	Yes	The distance to any adjacent sites is more than 25m.
Water Supplies	Sufficient water supply	Yes	On-site water tanks providing at least 228,000 litres.
	Water tank location	Yes	Site layout shows the water tank will be located at least 10m from the BESS units.
Signage	Sufficient signage	Not yet	No details of the signage have been provided at this stage of design. The signage proposals will be developed as part of the detailed design.
Emergency Plans	Risk Management Plan	Not yet	No specific risk management plan has been provided at this stage of design. However, it is noted that general principles are contained within the Outline BSMMP.
	Emergency Response Plan	Not yet	No specific emergency response plan has been provided at this stage of design. However, it is noted that general principles are contained within the outline Outline BSMMP.
	Environmental impacts	Not yet	No specific emergency response plan has been provided at this stage of design. However, it is noted that general principles are contained within the outline Outline BSMMP.
	Recovery	Not yet	No specific emergency response plan has been provided at this stage of design. However, it is noted that general principles are contained within the outline Outline BSMMP.