Cranbourne West: Battery Energy Storage System (BESS)

Preliminary Hazard Assessment (PHA)

Macquarie Group Ltd

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Appendices

1 Executive Summary

A potential Battery Energy Storage System (BESS) with an assumed capacity of 200 MW / 400 MWh is proposed at the Cranbourne West site. Due to dangerous goods being present on site, there's a requirement for hazard identification and the determination of appropriate dangerous goods storage and handling, which is the motivation for conducting this PHA. By completing a **Preliminary Hazard Analysis (PHA)** this will outline the design and operational risks with mitigations to be incorporated by Macquarie Group in the planning application for the proposed BESS.

The Lithium-ion battery technology used in the BESS design is considered dangerous goods Class 9 (Miscellaneous) and the expected quantity on site exceeds the placarding, manifest and fire protection system quantity thresholds. As such, the relevant steps for placarding, manifest application, emergency response and fire protection systems must be taken to ensure the regulations are adhered to. Several of the other materials expected to be present on site also require these steps to be taken to adhere to regulations.

Hazards that may pose a potential off-site risk were identified and documented in a Risk Register (refer to Appendix A). The consequence of each of the identified hazards were assessed to determine if the consequences may impact adjacent facilities or sensitive receptors. The following eight (8) hazards were identified pertaining to the BESS, in addition to six (6) environmental hazards:

Hazard	Cause
Arcing or short-circuit	Cable or equipment fault
Battery cell fire hazard	Fire hazard arising from combustible materials used in the storage system
Battery cell thermal hazard	Thermal hazard, due to thermal properties of the system or components Thermal runaway hazard, causing propagation of increasing temperatures, pressure and fire towards neighbouring cells
Explosion hazards	Cooling system failure and/or overcharging of battery causing rapid expansion and confinement of gases
Dropping of battery cell(s) during installation	Faulty equipment or procedure during battery installation
Vandalism damage	Unauthorised access, few staff on site
Transformer arcing / fire /explosion	Insufficient insulating oil maintenance, equipment fault
Live contact with transformer	Insufficient enclosure or barricading around transformer

All identified hazards are manageable through appropriate technical and management safeguards which reduce the residual risk and make it unlikely that a significant risk is posed.

Due to the site location falling in both CFA's and FRV's areas of responsibility, the BESS must be designed to comply with the guidelines under both authorities. Under the CFA guidelines, there's a requirement for hazard identification and the determination of appropriate dangerous goods storage and handling.

The PHA recommends the implementation of appropriate technical safeguards as listed below in the detailed design of the BESS intended to reduce the residual risk such that no identified hazards pose a significant risk:

- Containers and infrastructure for BESS must be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.
- Confirm the cooling system allows the BESS to operate in all temperature conditions expected for the location.
- BESS should be designed to be above the appropriate flood level
- A lightning study for the proposed site should be conducted with the lightning mitigation measures implemented

Additional safeguards during construction and operations are proposed to ensure the risks are managed so far as is reasonably practicable.

- The BESS should be installed correctly and commissioned/tested to ensure safe function, in accordance with *IEC 62619: Safety requirements for secondary lithium cells and batteries, for use in industrial applications.*
- Asset Management Plans and Assurance activities. A comprehensive and regular program of maintenance and inspections, covering the BESS and related infrastructure (i.e. transformers, HVAC, civil structures) to ensure the system is serviced and maintained as per the manufactures requirements.
- Good housekeeping ensuring the BESS is kept free on extraneous materials
- Placarding and labelling compliant with the Dangerous Goods (Storage and Handling) Regulations 2012 and the relevant Australian Standards must be provided.
- Appropriate material (including absorbent, neutralisers, tools and personal protective equipment) for the clean-up of spills must be provided and available on-site.

The following safety management plans should specifically address the BESS and be in place prior to commencement of operation of the BESS:

- Emergency Management Plan including
  - Safe operating conditions for temperature
  - Details of the electrical safety hazards
  - Details of the effects of fire on the battery energy storage system
  - The shut-down procedures if the batteries are involved in fire
  - a plan for partial and full decommissioning of the battery energy storage system in the event of an emergency incident that renders the facility inoperable or unsafe, prior to its anticipated end-of-life
- A Fire Management Plan to minimise fire risks
- Emergency Information Book within the Emergency Information (Manifest) Container; including the following
  - The safe operating conditions (e.g. temperature) of the BESS
  - The details of any emissions or toxic gases, including during a fire,
  - All dangerous goods stored on-site must have a current Safety Data Sheet (SDS).
  - Other manifest requirements as listed in the Dangerous Goods (Storage and Handling) Regulations 2012

2 Introduction

2.1 Project Context

The Cranbourne West BESS project is currently being develop by Macquarie Corporate Holdings Pty Limited (The Proponent), with a desired capacity of 200 MW / 400 MWh and a co-located 220kV/33kV substation. A 220kV HV reticulation will connect the BESS to the existing Cranbourne AusNet terminal station. The installation of the Cranbourne West BESS is aiming to provide a range of valuable functions to the electricity market and network, including:

- Lower electricity prices;
- Energy “time shifting” from times of high supply, e.g. during peak renewable production to periods of high demand; and
- Network support via a range of potential functions including Fast Frequency Response, Reactive Power Support and Voltage Stability.

2.2 Project Description

The BESS comprises 760 Fluence Gridstack™ cubes, complete with CATL lithium iron phosphate batteries (LFP), connected to 76 Power Electronics FP3510K bidirectional Power Conversion Systems (PCS). The cubes are configured into cores and combined with power conversion systems and step-up transformers to create a 200MW / 400MWh array. Each core is connected on the AC side of the inverter to a 7 MVA 33/0.66 KV two winding core transformer at 660 VAC.

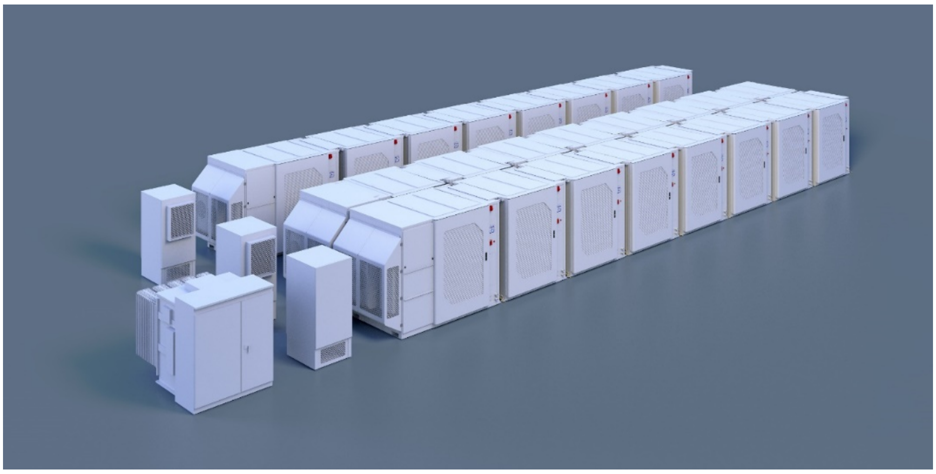

Figure 1: Typical Gridstack™ Core

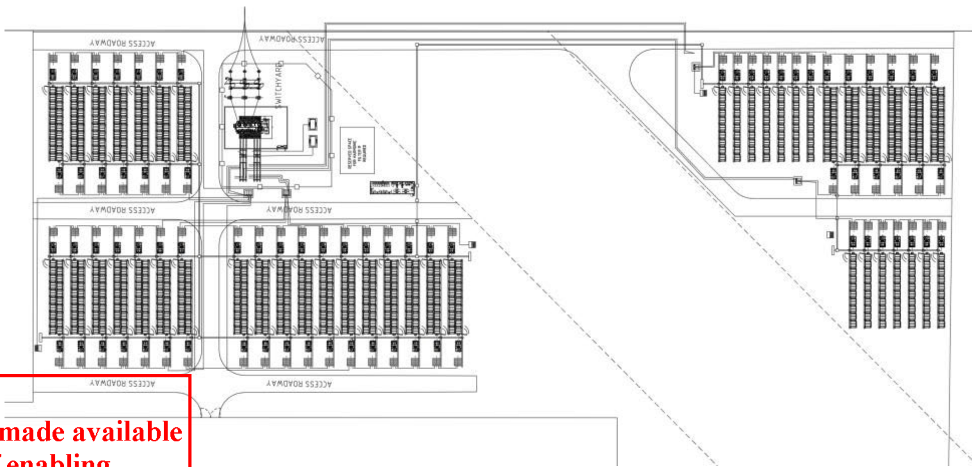

Figure 2: Cranbourne BESS Arrangement

2.3 Site Location

The proposed site location is east of Evans Road in Cranbourne West. The approximate site boundaries are shown in Figure 3 below. This site falls within Fire Rescue Victoria's (FRV) Southern D2 response area and the primary response station is Fire Station 92 [1]. It also falls with the Country Fire Authority's (CFA) District 8 [2] with a CFA fire station located nearby at 10 Arundel Street, Cranbourne.

Figure 3: Proposed BESS Location

2.4 PHA Motivation

Due to the site location falling in both CFA's and FRV's areas of responsibility, compliance with the guidelines under both authorities is required.

The *CFA Guidelines for Renewable Energy Installations* details requirements for the CFA's involvement in assisting in assessing planning permit applications. The Guideline covers the proposed risk assessment methodology and key emergency and safety mitigations required for Renewable Energy installations including BESS that may be potentially hazardous.

The *FRV Guideline 21: Structural Fire Safety/Dangerous Goods Incidents* provides applicants, seeking a report and consent from the Fire Rescue Commissioner, with an understanding of the FRV process for the accommodation of dangerous goods in a building.

Table 1 further expands the required regulatory compliance required in Victoria associated with dangerous goods.

Table 1: Required Regulatory Compliance for the Cranbourne West BESS Site

Regulation / Act	Guideline Requirement	Relevance
Dangerous Goods (Storage and Handling) Regulations 2012	CFA, FRV	Where the facility includes a battery energy storage system, emergency services written advice may be required for sites that contain dangerous goods exceeding the relevant Fire Protection Quantity and for sites that require an Emergency Management Plan. Regulation 26 states that "An occupier of premises where dangerous goods are stored and handled must ensure that any hazard associated with the storage and handling of dangerous goods at the premises is identified, having regard to what the occupier knows or ought reasonably to know about the hazard".
Building Regulations 2018	CFA, FRV	All buildings on site are required to comply with the National Construction Code. Where fire safety matters as listed in the Building Regulations 2018 do not meet the deemed to satisfy provisions of the NCC, the report and consent of the fire authority Chief Officer is required.
Victorian Occupational Health and Safety Act 2004 (OHS Act) Occupational Health and Safety Regulations 2017	CFA	A person who designs a building or structure or part of a building or structure who knows, or ought reasonably to know, that the building or structure or the part of the building or structure is to be used as a workplace must ensure, so far as is reasonably practicable, that it is designed to be safe and without risks to the health of persons using it as a workplace for a purpose for which it was designed.

Due to dangerous goods being present on site, there's a requirement for hazard identification and the determination of appropriate dangerous goods storage and handling, which is the motivation for conducting this PHA. By completing the PHA, an outline of the design and operational risks with mitigations to be incorporated by The Proponent in the planning application for the proposed BESS will be achieved.

3 Methodology

The methodology of this PHA consists of three main tasks:

- **Task 1: Screening Assessment**

  The screening assessment will consider all legislative and planning criteria and determine if the facility triggers any specific screening criteria in relation to the storage and handling of dangerous goods and fire risk. In particular the preliminary screening assessment will be in accordance with *Dangerous Goods (Storage and Handling) Regulations 2012* to determine if the BESS is potentially hazardous through the trigger of any Placarding Quantity, Manifest Quantity or Fire Protection Quantity.

- **Task 2: Preliminary Hazard Analysis**

  WorkSafe Victoria published *A Guide to Risk Control Plans* (June 2017) which outlines the procedure for preparing a risk control plan. The WorkSafe guide is to be applied to the Preliminary Hazard Analysis and will inform a risk assessment table that identifies the nature of risk, its characteristics and the hierarchy of controls. The Preliminary Hazard Analysis will identify and estimate type and quantity of materials (dangerous goods) and will document additional significant hazards that may pose an off-site risk to understand the potential sources of fire, including on-site hazards, off-site hazards and any other operational, financial or strategic risks that could affect the ability of the organisation or operation to meet objectives.

- **Task 3: Recommendations**

Provide technical recommendations for effective emergency and fire management planning to be included in the design of the BESS and Emergency Management Plan, based on the risk reduction measures identified in the study analysis.

3.1 Task 1: Screening Assessment

The methodology to undertake Task 1 for the Cranbourne West BESS includes the following:

- Identify and estimate type and quantity of dangerous goods including any storage, transport, or handling activities.
- Screen the dangerous goods based on the Placarding Quantity, Manifest Quantity or Fire Protection Quantity requirements as outlined in Schedule 2 – Quantities of Dangerous Goods in *Dangerous Goods (Storage and Handling) Regulations 2012*.

3.2 Task 2: Preliminary Hazard Analysis (PHA)

Following the preliminary screening assessment, a PHA should be completed to identify any additional significant hazards that may pose an off-site risk. This further assessment includes additional hazard scenario development and consequence analysis.

WorkSafe Victoria's published guide, *A Guide to Risk Control Plans*, provides a process for preparing PHAs which can be seen in Figure 4 below.

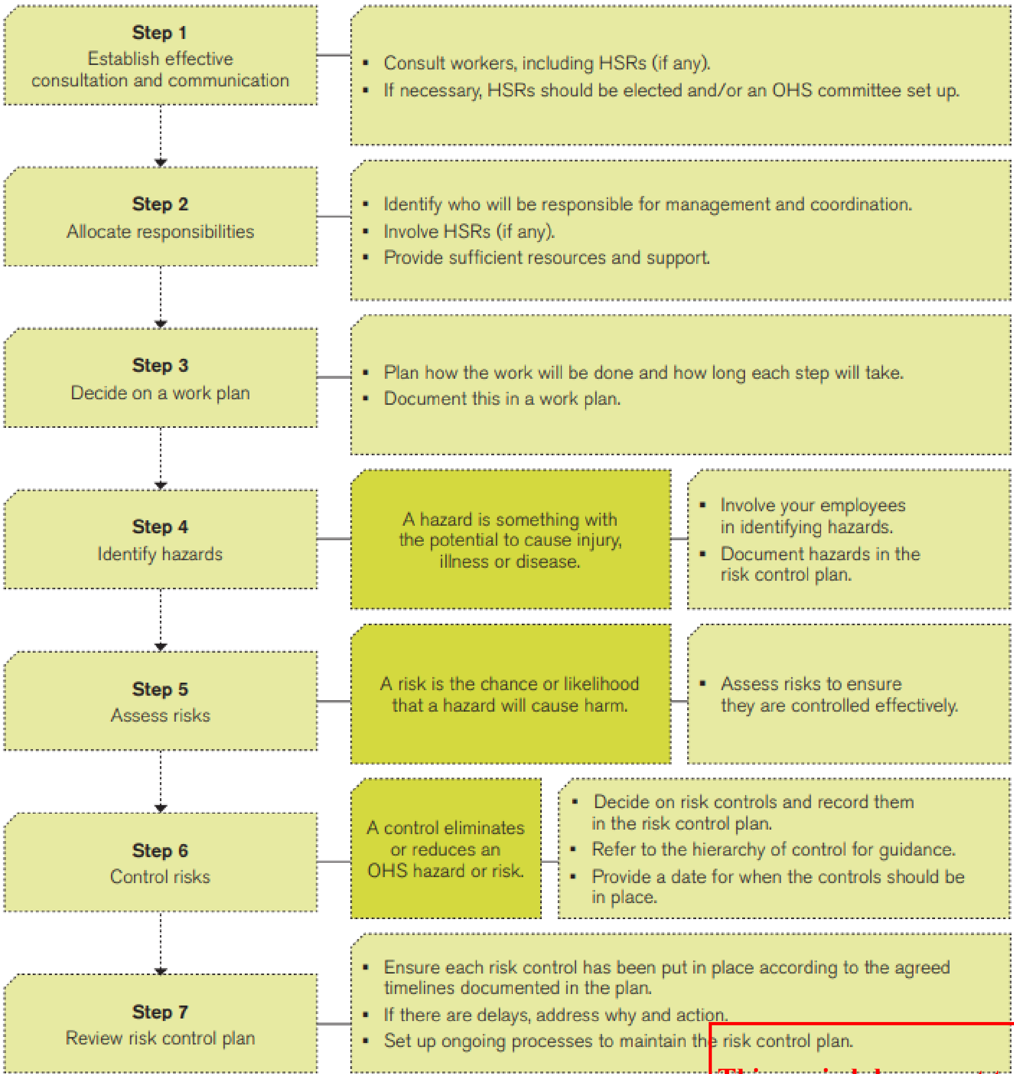

Figure 4: Risk Control Plan Preparation Guide

The methodology for Task 2 includes:

- Identify key client contact and other stakeholders for consultation and communication to the risk assessment.
- Identify and estimate type and quantity of materials (dangerous goods) including any storage, transport or handling activities.
- Identify additional significant hazards that may pose an off-site risk to understand the potential sources of fire including on-site hazards (e.g. electrical faults, operational faults, chemical releases, operational practices/processes, animal management); off-site hazards (e.g. bushfire, grassfire, storm, lightning, flood), and any other operational, financial or strategic risks that could affect the ability of the organisation or operation to meet objectives.
- Document these key hazards associated with the operation of BESS through the development of a risk assessment table by identifying the nature of risk and its characteristics and identifying controls for risks based on the hierarchy of controls, and industry good practice.
- Assess the consequences of each identified hazard and determine where consequences may impact adjacent facilities or sensitive receptors. Screen out those hazards with no significant impacts and carry forward only those hazards identified to have a possible impact on adjacent sites or sensitive receptors.
- Assess the frequency of those hazards carried forward from the consequence assessment.
- Assess the risk by evaluating the consequence and frequency analysis for those hazards identified to have an off-site or significant impact.
- Determine if the facility is potentially hazardous and document any proposed mitigation measures.

For this assessment, it is assumed that a qualitative assessment will be appropriate to assess the potential impacts to neighbouring land uses. The assumption is based on the expected types and quantities chemicals stored and handled at the facility, relatively non-sensitive surrounding land used and understanding that The Proponent has implemented appropriate technical safeguards and will have a safety and risk management system in place that is organisation-wide, supported by organisational management at all levels, underpinned by organisational policy, and integrated into organisational decision-making.

Risk assessment is a continuous process and the preliminary hazard analysis risk assessment will need to be continuously reviewed and updated through each of the project stages.

3.3 Task 3: Recommendations

Recommendations will be developed, and appropriate mitigation measures will be identified based on the risk reduction measures identified in the hazard analysis. Mitigation measures will be used to inform the Emergency Management Plan and will be drawn from Australian standards and guidelines such as *Guidelines for Renewable Energy Installations, AS/NZS 5139-2019: Electrical installations – Safety of battery systems for use with power conversion equipment,* and *AS 1940-2017: The storage and handling of flammable and combustible liquids*. These recommendations will also include the additional requirements for BESS as listed under the applicable regulatory considerations.

4 Screening Assessment

Task 1 of the assessment involves a preliminary risk screening as per the *Dangerous Goods (Storage and Handling) Regulations 2012*. In Schedule 2 of the Regulations it states the allowable quantities of dangerous goods to avoid a potentially hazardous scenario.

This section identifies the types and quantities of dangerous goods that may be associated with the proposed BESS development, screen them against regulatory thresholds, and identify any outstanding hazards which pose significant off-site risks based on the site location.

4.1 Hazardous Materials

Table 2 below displays the allowable quantities outlined in Schedule 2 of the Dangerous Goods (Storage and Handling) Regulations 2012 for a lithium-ion battery. Where the Placarding Quantities are exceeded, a "HAZCHEM" outer warning placard is required to be displayed at the entrance road for vehicles and every rail entrance (if applicable). Where the Manifest Quantities are exceeded, the Authority must be notified of the presence of the dangerous goods and a manifest of dangerous goods must be kept on the premises in a place where it is easily accessible to the emergency services authority. Where the Fire Protection Quantities are exceeded, a fire protection system for the premises must be established with regard to written advice from the emergency services authority.

Lithium-ion batteries fall under ADG Class 9: Miscellaneous Dangerous Goods, and for a 400MWh battery the total quantity of dangerous goods was estimated to be approximately 2,666 tonnes. The principal hazard presented by lithium-ion batteries is not a particular hazardous material such as lithium, but rather the potential for thermal runaway effects under certain conditions, leading to fire and explosion hazards [3]; risks and mitigation measures for lithium-ion batteries are discussed further in Section 5.

Table 2: Battery energy storage systems hazardous materials

Hazardous Material	UN Number	ADG Class / Packing Group	Estimated Quantity	Dangerous Goods Quantity Requirements			Threshold Exceeded?
				Placarding Quantity	Manifest Quantity	Fire Protection Quantity	
Lithium-ion: Overall thermal overload hazard	3480	9 (Misc) / PG II	2,666 tonnes	1000 kg or L	10 000 kg or L	20 000 kg or L	Yes – Fire Protection Quantity

The following table is a list of non-battery hazardous materials which are expected to be present in various quantities on site and may be part of adjacent infrastructure (e.g. transformers) to the BESS. In cases where the packing group is ambiguous, the worst-case scenario will be assumed.

Table 3: Other possible hazardous materials

Hazardous Material and Purpose	UN Number	ADG Class / Packing Group	Estimated Quantity	Dangerous Goods Quantity Requirements			Threshold Exceeded?
				Placarding Quantity	Manifest Quantity	Fire Protection Quantity	
Petrol: Fuel for minor maintenance machinery	1203	3 (Flammable Liquids) / PG II	< 100 L	250 kg or L	2500 kg or L	10 000 kg or L	No
Diesel: Fuel for minor maintenance machinery	1202	N/A: C1 Combustible Liquid. Treated as 3 / PG III if stored with Petrol	< 100 L	1000 kg or L	10 000 kg or L	20 000 kg or L	No
Pesticides: Weed and pest control	2588	6.1 (Toxic Substances) / PG I	<100kg	50 kg or L	500 kg or L	2000 kg or L	Yes – Placarding Quantity

Transformer Oil: Transformer coil insulation	Various	9 (Misc) / PG II	>1000 L ≤2000 L for Core Transformer & Auxiliary Transformer >60 000 L for Power Transformer	5000 kg or L	10 000 kg or L	20 000 kg or L	Yes – Fire Protection Quantity
Miscellaneous cleaning chemicals: Various minor maintenance activities (e.g. cleaning)	Various	5.1 and 8 / PG I	<100kg	50 kg or L	500 kg or L	2000 kg or L	Yes – Placarding Quantity

The largest delivery of dangerous goods will be during construction and commissioning when the batteries are delivered. There is no significant ongoing transport of hazardous materials to site as part of the operational requirements of the BESS.

5 Preliminary Hazard Analysis

5.1 Hazard Identification

All potential significant hazards that may pose a risk to the BESS or an off-site risk were identified and documented in a Risk Register (refer to Appendix A). The consequence of each of the identified hazards were assessed to determine if the consequences may potentially impact off-site adjacent facilities or sensitive receptors.

5.1.1 Natural Hazards

There are several potential natural hazards which pose a risk to the BESS. These hazards covering extreme temperatures, bushfires, seismic activity, lightning, wind and flooding are covered in the Risk Register located in Appendix A.

5.1.2 Lithium-ion Hazards

Referring to DNV's recommended practice for the *Safety, Operation and Performance of Grid-Connected Energy Storage Systems* [3], the primary consideration for Lithium-ion batteries is for adequate cooling and management of temperature excursions. In most cases, the temperature of the lithium-ion batteries should not be higher than 70°C to prevent thermal runaway, which causes propagation of increasing temperatures, pressures, and fire towards neighbouring cells. Similarly, the temperature of the lithium-ion batteries in most cases should not drop below 0°C to prevent lithium plating around the anode during charging which can cause internal shorts. Although the choice of anode-cathode chemistry can result in different thermal stability and volatility, all lithium-ion batteries are flammable when exposed to fire. Lithium-ion fires are a unique class of fire and may result in emissions of large volumes of toxic or combustible gases, which need to be managed accordingly. These hazards are described in the Risk Register located in Appendix A:

5.1.3 Transformer Hazards

Access to equipment, safe operation and maintenance, safe personal egress, equipment clearance, electrical safety, and fire system safety all need to be considered for transformer installations. *AS2067:2016 Substations and high voltage installations exceeding 1 kV a.c.* outlines the risks and safety measures for these hazards [4]. Contact with live parts, arc flashing and transformer fires are the most common hazards associated with transformers.

The origins of fire hazards relating to transformers are typically categorised as one of the following:

- Plant and equipment containing combustible insulating liquids may rupture due to internal failure; there may be an explosion and ignition may occur with a serious fire risk.
- Plant and equipment without combustible insulating liquids may rupture due to internal failure; there may be an explosion and modest fire risk.
- Other plant and equipment such as cables, batteries, and drainage pipes may catch fire and spread the fire.

This hazard is further described in the Risk Register located in Appendix A:

5.2 Risk Assessment Matrices

The risk matrices set out in Table 5, Table 6 and Table 7 below were used to complete a qualitative risk assessment of the hazards identified in Section 5.1. Consistent with standard risk assessment methodology the risk rating for a given hazard is a product of frequency and consequence of their occurrence. As such, the estimated consequence for each hazard carried forward due to posing significant off-site risk was first assessed (Table 5), followed by an assessment of their estimated frequency of occurrence (Table 6). Finally, the overall current risk rating was then calculated taking frequency and consequence as inputs (Table 7).

Table 4: Hazard Consequence Assessment Matrix

Consequence	***People***	***Property***	***Environment***	***Community***
A - Catastrophic	Single or multiple fatality	Virtual complete loss of plant or system	Permanent / irreversible widespread ecological damage not able to be remediated	Outrage by a sizeable community or many communities. Riots.
B - Major	Disabling injury or illness i.e. amputation and/or permanent loss of bodily function, or any kind of permanent health impact	Extensive damage to plant or system	Extensive ecological damage, lengthy remediation process	Community/NGO legal actions. Pickets, demonstrations.
C - Moderate	Any Lost Time Incident (LTI), i.e. an illness or injury resulting in one or more consecutive days or shifts off work	Significant damage to plant or system	Substantial ecological damage but able to be remediated	Persistent formal community complaints. Formal complaints to politicians or comparable representatives.
D - Minor	A medical treatment case (MTC) / or restricted work case (RWC)	Damages impact on budget and program	Localised ecological damage, easily remediated	Formal complaints from local Community complaints locally
E - Incidental	First Aid case, or an injury or illness not requiring treatment	Minor damage to plant or system	Negligible ecological damage, may not require remediation	No Informal community complaints &/or negative comments / views.

Table 5: Hazard Likelihood Assessment Matrix

Probability	*Descriptor*	*Likelihood*	*Industry Incidences*
5 - Almost Certain	The threat is expected to be realised.	90% < Likelihood ≤ 100%	Common incident
4 - Likely	The threat is likely to be realised.	5% < Likelihood ≤ 90%	Several incidents nationally
3 - Possible	The threat may be realised.	1% < Likelihood ≤ 5%	One or a few incidents nationally
2 - Unlikely	The threat is not expected to be realised.	0.1% < Likelihood ≤ 1%	No known national incidents. One or a few incidents in comparable international operating regimes.
1 - Rare	The threat may be realised in reasonably foreseeable but exceptional circumstances.	0% < Likelihood ≤ 0.1%	No known incidents in comparable international operating regimes.

Table 6: Risk Rating Matrix

		Likelihood				
		1 - Rare	***2 - Unlikely***	***3 - Possible***	***4 - Likely***	***5 - Almost Certain***
Consequence	***A - Catastrophic***	High	Critical	Critical	Critical	Critical
	B - Major	High	High	Critical	Critical	Critical
	C - Moderate	Medium	Medium	High	High	Critical
	D - Minor	Low	Low	Medium	High	High
	E - Incidental	Low	Low	Low	Medium	Medium

5.3 Risk Register Results

The risk register identified eight (8) different hazards associated with the BESS and associated infrastructure of which six (6) were identified to have potential off-site risks. All BESS and associated infrastructure hazards received an initial risk rating of 'High' or 'Critical' as detailed in Appendix A. After the application of the current technical and design controls, the residual risk ratings were all reduced. All hazards were rated again as unlikely to pose significant risk, with all potential risks mitigated.

Table 7: BESS Hazards identified in risk register

Hazard	Cause	Off-Site Risk Potential	Residual Off-Site Risk
Arcing or short-circuit	Cable or equipment fault	Unlikely	Unlikely

Hazard	Cause	Potential for Off-site risk	Residual Off-Site Risk
Battery cell fire hazard	Fire hazard arising from combustible materials used in the storage system	Potential	Unlikely
Battery cell thermal hazard	Thermal hazard, due to thermal properties of the system or components Thermal runaway hazard, causing propagation of increasing temperatures, pressure and fire towards neighbouring cells	Potential	Unlikely
Explosion hazards	Cooling system failure and/or overcharging of battery causing rapid expansion and confinement of gases	Potential	Unlikely
Dropping of battery cell(s) during installation	Faulty equipment or procedure during battery installation	Unlikely	Unlikely
Vandalism damage	Unauthorised access, few staff on site	Potential	Unlikely
Transformer arcing / fire /explosion	Insufficient insulating oil maintenance, equipment fault	Potential	Unlikely
Live contact with transformer	Insufficient enclosure or barricading around transformer	Potential	Unlikely

For the full Risk Register, including the likelihood and consequence analysis for both current and residual risks for all hazards, refer to Appendix A.

The risk assessment detailed above has shown that, whilst there is potential for major consequences, implementation of risk controls will make these consequences unlikely, particularly for off-site effects. The current and recommended technical and management safeguards set out in Section 5.4 below are intended to reduce the residual risk such that no identified hazards pose a significant risk. Additional safeguards during construction and operations were proposed to ensure the risks are managed so far as is reasonably practicable.

5.4 Technical Safeguards

There are several international standards which govern the best practice design and installation of BESS. The current and recommended technical safeguards for the proposed BESS outlined in the following sub-sections will reduce the residual risk such that no identified hazards pose a significant risk.

5.4.1 Natural Hazards Safeguards

It is anticipated that no natural hazards will impact the BESS to pose a significant off-site risk once appropriate controls, as set out in Table 4 above, are designed and implemented.

Table 8: Natural hazards

Hazard	Description
Extreme Temperatures	The temperature data at the Cranbourne Botanic Gardens weather station from 1990-2020 were as follows: mean annual maxima and minima were 25.7ºC in February and 6.2ºC in July respectively, whilst the highest and lowest temperatures in the past 30 years were 46ºC and -2.5ºC [5]. The Fluence Gridstack™ cubes are designed to operate in the standard temperature range of -30ºC to 45ºC, but this can vary depending on the cooling system [6]. The cooling system should be selected to ensure the system can operate at the highest historical temperature of 46ºC, including a temperature buffer of 1.5-2ºC to account for the likely effects of global warming.

Bushfires	The proposed BESS location is in a designated Bushfire Prone Area [7]. A fire management plan and fire mitigation measures should be implemented to reduce the potential consequences in accordance with the Fire Management Plan. A 10m asset protection zone is planned to be incorporated around the BESS location [8].
Seismic activity	The project is not located in a severe seismic activity zone, according to Geoscience Australia. According to the National Seismic Hazard Assessment 2018, the peak ground acceleration for a 10% exceedance in 50 years of mean hazard levels is 0.2-0.3 m/s^2 [9]. This is considered light seismic activity with potential damage highly unlikely. Risk of seismic activity is assumed to be minimal.
Flooding	No preliminary flooding assessment has been undertaken yet for the proposed project site. However, 14% of the City of Casey, containing Cranbourne West, is at risk of flooding and 16 floods have occurred in the past 100 years [10]. The location of the BESS should be designed to be above the appropriate flooding level.
Lightning	There has been approximately 68 recorded lightning strikes within a 30km radius of Cranbourne West in the last 30 years, however the last recorded lightning strike was in 2001 [11]. Regardless, a lightning study for the proposed site should be conducted with the lightning mitigation measures implemented.
Wind	Cranbourne West is located within the A5 Wind Region, which has an ultimate design wind speed of 147.6km/h for a Terrain Category 2 [12]. The BESS has been designed in accordance with *AS/NZS 1170.2:2011 Structural design actions Wind actions* [12].

5.4.2 Lithium-ion Battery Safeguards

Management of operating temperature is the primary consideration in the design and installation of Lithium-ion battery systems, given that fire and runaway thermal overload are the primary hazard with these systems [3]. The below requirements are outlined in the CFA Renewable Energy Installation Guidelines to mitigate the thermal and fire hazards associated with BESS. Refer to Appendix B for the Cranbourne BESS Safety and Fire Risk Report detailing the Safety in Design elements incorporated into Fluence's BESS design [8].

- The primary reference Standard is *IEC 62619 Safety Requirements for Secondary Lithium Cells and Batteries, for use In Industrial Applications* [13]. This Standard describes protection measures against all major hazards identified in this PHA, and provides safety requirements for the installation, use, maintenance, and disposal of Lithium-ion batteries. The BESS and its components comply with and have been certified to this standard.
- Design of the Lithium-ion BESS should consist of modular, insulated battery cells and the container should be kept free of extraneous and combustible materials to mitigate the risk of fire or thermal overload spreading to multiple battery cells. The Fluence Gridstack Cube BESS is a modular design with a lockable door.
- Wiring must be closed, and cables for battery energy storage systems must be buried, except where required to be above-ground for grid connection. This has been implemented in the layout.
- Appropriate cooling systems should be designed and installed to keep the Lithium-ion BESS within a safe operating temperature range and to manage the potential release of toxic or combustible gases. This is achieved through the Fluence Gridstack Cube BESS design.

- A fire protection system should be designed and installed to mitigate the consequences of a fire or thermal runaway hazard event. A lithium-ion battery fire presents multiple hazards including fire damage to buildings and personnel, gas release, chemical damage and reactions, and hazardous material contamination. The Fluence Gridstack Cube BESS design includes a fire detection and suppression system.
- Containers/infrastructure for battery energy storage systems must be clear of vegetation, including grass, for at least ten (10) metres on all sides. CFA requires non-combustible mulch such as crushed rock or mineral earth within this ten (10) metre area. The system is contained within the site boundaries inclusive of the 10 metre asset protection zone along the eastern boundary.
- Containers/infrastructure for BESS must be located so as to be directly accessible to emergency responders through provision of a suitable access road. The plant layout has multiple access roads.
- Containers and infrastructure for BESS must be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.
- The BESS facility will be surrounded by a 1.8-2.4m chain wire security fence and may include three strands of barbed wire on bent fence posts [14].

5.4.3 Transformer Safeguards

AS2067:2016 Substations and high voltage installations exceeding 1 kV a.c. outlines the risks and safety measures for primary hazards presented by transformers which includes live contact, arc flashes, and fire and explosion [4]. The BESS (including transformer) is designed in line with and complies to this standard [8]. All transformers have separation distances away from other transformers, control rooms and office complexes that exceed the required distances in the standard. Details of the requirements for this standard is listed below

- Protection against live contact of a transformer is generally achieved with the following mitigation measures:
  - Protection by enclosure.
  - Protection by barrier.
  - Protection by obstacle.
  - Protection by placing out of reach.
- Protection against arc faults between transformers and other equipment or people is generally achieved with the following mitigation measures:
  - Protection against operating error through:
    - load break switches;
    - short-circuit rated fault-making switches;
    - interlocking devices; or
    - non-interchangeable key locks.
  - Operating aisles as short, high and wide as possible.
  - Solid covers as an enclosure or protective barrier.
  - Equipment tested to withstand internal arc fault.
  - Arc products to be directed away from operating personnel and vented outside the building if necessary.
  - Use of current-limiting devices.
  - Very short tripping time.
  - Operating of the plant from a safe distance.

- Prevention of re-energisation by use of manually resettable devices which detect internal equipment faults and which incorporate pressure relief and provide external indication.

- To mitigate the risks associated with a transformer fire, the following steps should be followed:
  - Minimise the risk of a fire starting.
    - The transformer specification should consider insulation levels, operating temperatures, cooling systems, protection systems, operation (including the effect of prolonged overloading) and maintenance practices.
  - Minimise the risk of transformer failure developing into an oil fire.
    - Consideration should be given to insulating liquid type, tank strength, low explosion risk bushings, and pressure relief.
  - Minimise the impact of a transformer fire on the environment, other assets, and humans.
- If a transformer failure has developed into a transformer fire, the following control measures should be in place to minimise the damage resulting from the fire:
  - Minimise risk of loss of life and injury to humans by –
    - providing adequate clearance around transformers, particularly those with sound enclosures;
    - providing adequate access for firefighting equipment; and
    - providing adequate egress routes.
- Minimise the risk of the fire spreading or causing damage to adjacent transformers, control building, structures and other items of plant and equipment. Fire damage can be minimised by –
  - Providing passive protection systems in the form of; adequate separation distances, fire barriers, constructing buildings of fire resisting materials; and
  - Providing active suppression systems such as deluge, water mist, or gas flooding.
- Minimise contamination and damage to the environment by provision of oil containment systems and bunding.

5.4.4 Summary Design Recommendations

- The location of the BESS should be designed to be above the appropriate flooding level.
- A lightning study for the proposed site should be conducted with the lightning mitigation measures implemented.
- Confirm the cooling system allows the BESS to operate in all temperature conditions expected for the location.
- Containers and infrastructure for BESS must be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.

5.5 Safety Management System

The following recommendations are provided for the safety management systems which will govern the BESS at Cranbourne West:

5.5.1 Operational and Maintenance Recommendations

- The BESS should be installed correctly and commissioned/tested to ensure safe function, in accordance with *IEC 62619: Safety requirements for secondary lithium cells and batteries, for use in industrial applications.*

- Asset Management Plans and Assurance activities. A comprehensive and regular program of maintenance and inspections, covering the BESS and related infrastructure (i.e. transformers, HVAC, civil structures) to ensure the system is serviced and maintained as per the manufactures requirements.
- Good housekeeping ensuring the BESS is kept free of extraneous materials
- Placarding and labelling compliant with the Dangerous Goods (Storage and Handling) Regulations 2012 and the relevant Australian Standards must be provided.
- Appropriate material (including absorbent, neutralisers, tools and personal protective equipment) for the clean-up of spills must be provided and available on-site.

5.5.2 Safety Management Plans Recommendations

The following safety management plans should specifically address the BESS and be in place prior to commencement of operation of the BESS:

- Emergency Management Plan including
  - Safe operating conditions for temperature
  - Details of the electrical safety hazards
  - Details of the effects of fire on the battery energy storage system
  - The shut-down procedures if the batteries are involved in fire
  - a plan for partial and full decommissioning of the battery energy storage system in the event of an emergency incident that renders the facility inoperable or unsafe, prior to its anticipated end-of-life
- A Fire Management Plan to minimise fire risks
- Emergency Information Book within the Emergency Information (Manifest) Container; including the following
  - The safe operating conditions (e.g. temperature) of the BESS
  - The details of any emissions or toxic gases, including during a fire,
  - All dangerous goods stored on-site must have a current Safety Data Sheet (SDS).
  - Other manifest requirements as listed in the Dangerous Goods (Storage and Handling) Regulations 2012

6 Conclusion and Recommendations

A potential Battery Energy Storage System (BESS) with a desired capacity of 200 MW / 400 MWh is proposed at the Cranbourne West site. The Lithium-ion BESS and potentially dangerous goods expected to be present on site were subjected to a preliminary risk screening in accordance with CFA and FRV's guidelines.

The preliminary risk screening process concluded that the quantity of lithium-ion batteries expected to be present on site exceeds the placarding, manifest and fire protection system quantities. This means the necessary steps need to be taken to adhere to the regulations for this potentially dangerous good. Several of the other materials expected to be present on site also require steps to be taken to adhere to the required regulations.

Subsequent hazard identification and the PHA were conducted in accordance with WorkSafe Victoria's published guide: *A Guide to Risk Control Plans.* The process identified eight (8) hazards associated with the BESS and associated equipment, of which six (6) potential hazards had potentially significant off-site risks. All identified hazards are manageable through appropriate technical and management safeguards which reduce the residual risk to a manageable level, and make it unlikely that a significant off-site risk is posed

Following the PHA process it was determined that, subject to the implementation of recommended risk mitigation, technical and safety measures, the proposed BESS at Cranbourne West will not constitute a hazardous industry. The PHA recommends that the following appropriate technical safeguards as per the CFA Guidelines are implemented in the detailed design of the BESS:

- Containers and infrastructure for BESS must be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.
- Confirm the cooling system allows the BESS to operate in all temperature conditions expected for the location.
- BESS should be designed to be above the appropriate flood level
- A lightning study for the proposed site should be conducted with the lightning mitigation measures implemented

Additional safeguards during construction and operations are proposed to ensure the risks are managed so far as is reasonably practicable.

- The BESS should be installed correctly and commissioned/tested to ensure safe function, in accordance with *IEC 62619: Safety requirements for secondary lithium cells and batteries, for use in industrial applications.*
- Asset Management Plans and Assurance activities. A comprehensive and regular program of maintenance and inspections, covering the BESS and related infrastructure (i.e. transformers, HVAC, civil structures) to ensure the system is serviced and maintained as per the manufactures requirements.
- Good housekeeping ensuring the BESS is kept free on extraneous materials
- Placarding and labelling compliant with the Dangerous Goods (Storage and Handling) Regulations 2012 and the relevant Australian Standards must be provided.
- Appropriate material (including absorbent, neutralisers, tools and personal protective equipment) for the clean-up of spills must be provided and available on-site.

The following safety management plans should specifically address the BESS and be in place prior to commencement of operation of the BESS:

- Emergency Management Plan including
  - Safe operating conditions for temperature
  - Details of the electrical safety hazards
  - Details of the effects of fire on the battery energy storage system
  - The shut-down procedures if the batteries are involved in fire
  - a plan for partial and full decommissioning of the battery energy storage system in the event of an emergency incident that renders the facility inoperable or unsafe, prior to its anticipated end-of-life
- A Fire Management Plan to minimise fire risks
- Emergency Information Book within the Emergency Information (Manifest) Container; including the following
  - The safe operating conditions (e.g. temperature) of the BESS
  - The details of any emissions or toxic gases, including during a fire,
  - All dangerous goods stored on-site must have a current Safety Data Sheet (SDS).
  - Other manifest requirements as listed in the Dangerous Goods (Storage and Handling) Regulations 2012

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Appendix A: Hazard Identification Table / Risk Register

No.	Component	Hazard	Cause	Consequence	Current Risk			Does the hazard pose a potential off-site significant risk?	Current Controls - Technical / Design	Residual Risk			Proposed Controls- Safety Management	Does the hazard pose a potential off-site significant risk?
					Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating		
1	Natural Hazard	Grass or scrub fire	Bushfire	Damage to BESS; Significant environmental damage	3 - Possible	B - Major	Critical	Potential	- 10m asset protection zone incorporated	2 - Unlikely	B - Major	High	- A Fire Management Plan with appropriate mitigations to minimise risks	Unlikely
2	Natural Hazard	Battery fire hazard	Extreme Temperatures	Injury due to burns or smoke/chemical inhalation; Damage/destruction of battery cell	2 - Unlikely	B - Major	High	Potential	- BESS is designed to operate between -30°C to 45°C, however the historical maximum temperature reached was 46°C.	1 - Rare	B - Major	High	- Implement a cooling system that allows the BESS to operate in all temperature conditions expected for the location	Unlikely
3	Natural Hazard	Battery external damage	Excessive wind	Damage to battery casings, cells and other infrastructure	1 - Rare	C - Moderate	Medium	Unlikely	- The site is located in an A5 wind region which is considered "normal". - The BESS has been designed in accordance with AS/NZS 1170.2	1 - Rare	C - Moderate	Medium		Unlikely
4	Natural Hazard	Battery external damage	Seismic activity	Damage to battery casings, cells and other infrastructure	1 - Rare	B - Major	High	Unlikely	Not a seismic area	1 - Rare	B - Major	High		Unlikely
5	Natural Hazard	Battery external damage	Flooding	Damage to battery casings, cells and other infrastructure	1 - Rare	B - Major	High	Unlikely		1 - Rare	B - Major	High	- BESS should be designed to be above the appropriate flood level	Unlikely
6	Natural Hazard	Battery fire hazard	Lightning strike	Injury due to burns or smoke/chemical inhalation; Damage/destruction of battery cell	3 - Possible	B - Major	Critical	Potential	-BESS facility has two large powerlines running overhead. No BESS equipment is located underneath the power lines.	3 - Possible	B - Major	Critical	- Lightning study conducted and lightning mitigation measures implemented	Unlikely

					Current Risk					Residual Risk				
No.	Component	Hazard	Cause	Consequence	Likelihood	Consequence	Risk Rating	Does the hazard pose a potential off-site significant risk?	Current Controls - Technical / Design	Likelihood	Consequence	Risk Rating	Proposed Controls- Safety Management	Does the hazard pose a potential off-site significant risk?
7	Lithium-ion Battery	Arcing or short-circuit	Cable or equipment fault	Electrocution resulting in injury or fatality	1 - Rare	A - Catastrophic	High	Unlikely - electrical shock hazard affecting public						
8	Lithium-ion Battery	Battery cell fire hazard	Fire hazard arising from combustible materials used in the storage system	Injury due to burns or smoke/chemical inhalation; Damage/destruction of battery cell	2 - Unlikely	B - Major	High	Potential	-Battery systems modular and compartmentalised to minimise damage - Batteries and associated balance of plant certified and designed to Australian standards - Battery Management System provides functional safety of electronic safety-related systems certified to IEC61508 - BESS design location sufficient distance from other infrastructure. - Fire risk evaluation conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure - Fire detection and suppression system included in the BESS design - Emergency Shutdown incorporated into BESS design - Containers/infrastructure for BESS located to be directly accessible to emergency responders	1 - Rare	C - Moderate	Medium	- Safety system maintenance, testing and inspections - Safety Management Plans - Containers and infrastructure for BESS should be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.	Unlikely
9	Lithium-ion Battery	Battery cell thermal hazard	Thermal hazard, due to thermal properties of the system or components Thermal runaway hazard, causing propagation of increasing temperatures, pressure and fire towards neighbouring cells	Injury due to burns or smoke/chemical inhalation; Damage/destruction of battery cell	2 - Unlikely	B - Major	High	Potential	-Battery systems modular and compartmentalised to minimise damage - Batteries and associated balance of plant certified and designed to Australian standards - Battery Management System provides functional safety of electronic safety-related systems certified to IEC61508 - BESS design location sufficient distance from other infrastructure. - Fire risk evaluation conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure - Fire detection and suppression system included in the BESS design- Containers/infrastructure for BESS should be located so as to be directly accessible to emergency responders - Emergency Shutdown incorporated into BESS design	1 - Rare	C - Moderate	Medium	- Safety system maintenance, testing and inspections - Safety Management Plans - Containers and infrastructure for BESS should be provided with appropriate spill containment (bunding or otherwise) that includes provision for management of fire water runoff.	Unlikely

No.	Component	Hazard	Cause	Consequence	Current Risk: Likelihood	Current Risk: Consequence	Current Risk: Risk Rating	Does the hazard pose a potential off-site significant risk?	Current Controls - Technical / Design	Residual Risk: Likelihood	Residual Risk: Consequence	Residual Risk: Risk Rating	Proposed Controls- Safety Management	Does the hazard pose a potential off-site significant risk?
10	Lithium-ion Battery	Explosion hazards	Cooling system failure and/or overcharging of battery causing rapid expansion and confinement of gases	Injuries or fatalities Damage/destruction of battery cell	2 - Unlikely	A - Catastrophic	Critical	Potential	- Batteries and associated balance of plant certified to relevant international standards (e.g. UL1642, UL1741, UL1973, UL9540). - BESS installed sufficient distance from infrastructure and people. - Deflagration panels compliant with NFPA 68 are used to direct the force of any internal pressure upwards. - Emergency Shutdown incorporated into BESS design - Containers/infrastructure for BESS located so as to be directly accessible to emergency responders	1 - Rare	A - Catastrophic	High	- Safety system maintenance, testing and inspections - Safety Management Plans.	Unlikely
11	Lithium-ion Battery	Dropping of battery cell(s) during installation	Faulty equipment or procedure during battery installation	Injury Damage to battery cell	2 - Unlikely	B - Major	High	Unlikely - single unit cell						
12	Lithium-ion Battery	Vandalism damage	Unauthorised access, few staff on site	Damage to battery cell and/or other infrastructure Electrolyte emission Electrocution resulting in injury or fatality	2 - Unlikely	A - Catastrophic	Critical	Potential	- BESS and auxiliary equipment to be surrounded by 1.8-2.4m chain wire security fencing, locked gates and other security measures as necessary (e.g. CCTVs, barbed wire)	1 - Rare	A - Catastrophic	High	- Regular and appropriate operations and maintenance covering inspections of the facilities as well as continuous remote monitoring	Unlikely
13	Transformer	Transformer arcing / fire /explosion	Insufficient insulating oil maintenance, equipment fault	Electrocution causing injury or fatality Damage to transformer Ignition source for BESS fire	2 - Unlikely	A - Catastrophic	Critical	Potential	- Transformers have been designed to AS2067:2016 - Sufficient separation between transformers and the BESS, other transformers, and structures. - Core transformers are self bunded - Fire modelling to be conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure	1 - Rare	A - Catastrophic	High	- Maintain transformer as per OEM recommended regime, including regular insulation and function testing	Unlikely
14	Transformer	Live contact with transformer	Insufficient enclosure or barricading around transformer	Electrocution causing injury or fatality	2 - Unlikely	A - Catastrophic	Critical	Potential	- Transformers have been designed to AS2067:2016 - Transformer surrounded by 1.8-2.4m chain wire security fencing, locked gates and other security measures as necessary (e.g. CCTVs, barbed wire)	1 - Rare	A - Catastrophic	High	- Maintain transformer as per OEM recommended regime, including regular insulation and function testing	Unlikely

Appendix B: Fluence Cranbourne BESS Safety and Fire Risk Report

Cranbourne BESS Safety and Fire Risk

4/05/21

Document Control Number: FE-0001- SFR
Revision Number: 1
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Author: Steve McCaffrey________________________

Approval: ____________________________________

Revision History

Date	Revision Number	Pages Affected

Table of Contents

1 System Overview

1.1 Fluence Battery Energy Storage System

The Fluence Battery Energy Storage System (BESS) comprises the latest generation Gridstack™ cube complete with CATL lithium iron phosphate battery (LFP). The cubes are configured into cores and combined with power conversion systems and step-up transformers to create an array.

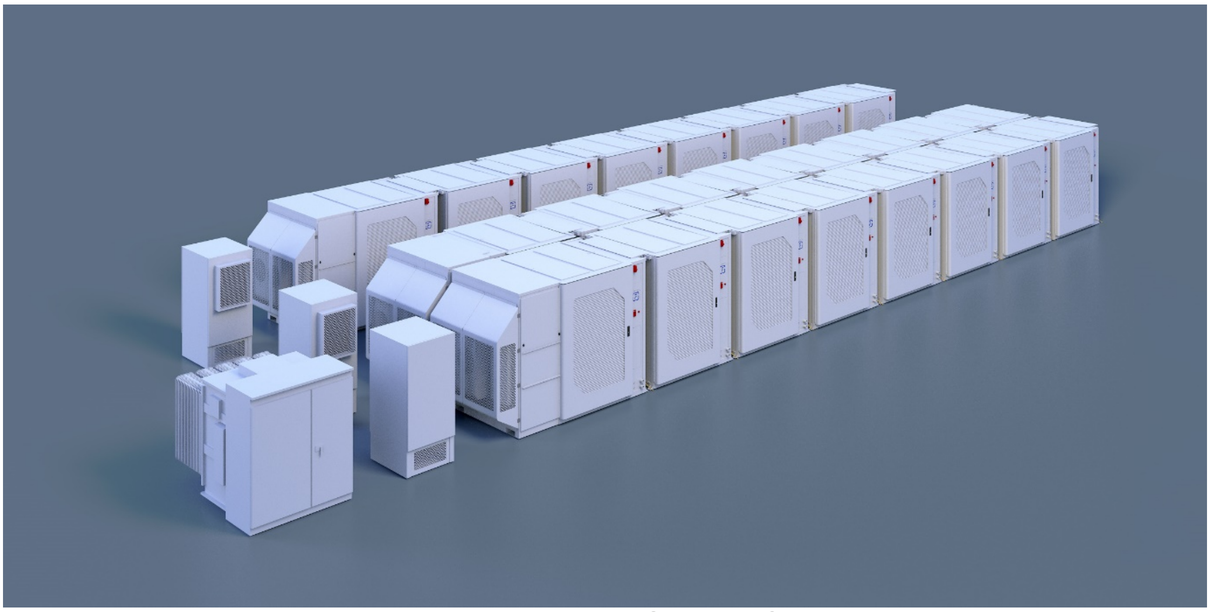

Figure 5: Typical Gridstack™ Core

2 System Configuration

2.1 Site Arrangement

The system consists of 760 Fluence Gridstack™ cubes, complete with CATL lithium iron phosphate batteries (LFP), connected to 76 Power Electronics FP3510K bidirectional Power Conversion Systems (PCS). Each inverter (PCS) and cube configuration constitutes a Core. Each core is connected on the AC side of the inverter to a 3.5MVA 33/0.66 KV two winding core transformer at the 660-volt ac level. The system is arranged so that there are 76 cores in a 200MW / 400MWh array.

Consideration and incorporation of a 10 m asset protection zone (APZ) from the eastern boundary has been included in the design.

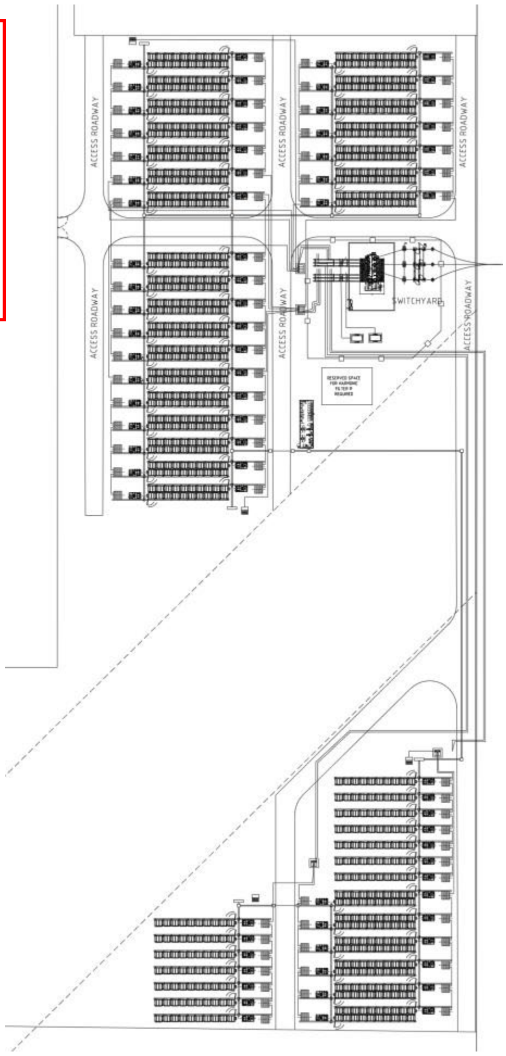

Figure 6: Cranbourne BESS Arrangement

2.2 Safety in Design

Safety is paramount in Fluences design. Access to equipment, safe operation and maintenance, safe personal egress, equipment clearance, electrical safety, and fire system safety are all considered during the design phase.

The system layout considers the requirement for safe egress of personal, providing more than 600mm clearance all open panel and cube open door position. The Cubes are place 2.9 meters between cores to enable safe access for lifting equipment.

Core transformers are arranged to comply with the AS2067:2016 Substations and high voltage installations exceeding 1 kV a.c. The transformers require a minimum clearance of 3 meters separation from transformer to transformer and between transformer and non-combustible buildings and structures that are not integrated into the associated core equipment. The layout provides 5 meters clearance for adjacent transformers and 10 meters from transformer to the control room and 10 meters from the office facility and the nearest core transformer. Table 6.1 of AS2067 lists the minimum clearance requirement as 3 meters.

The auxiliary transformer exceeds the compliant clearances with more than 21 meters to the control room and only requiring 3 meters.

The power transformer also exceeds the compliant clearances with more than 30 meters to the control room and as stated in the table below requires more 23 meters.

The AS2067 table below details the required transformer clearances. As both the control room and office complex will be made from non-combustible material Horizontal separation G1 to other transformers or non-combustible surfaces applies.

TABLE 6.1

CLEARANCES FOR OUTDOOR TRANSFORMERS

Transformer type	Liquid volume	Clearances to other transformers or equipment	Clearances to buildings		
		Horizontal separation G_1 to other transformers or non-combustible surfaces	Horizontal clearance G_2 to combustible surfaces	Horizontal clearance G_3 to 2 hour fire resistant surfaces of buildings	Vertical extent G_4 for 2 hour fire resistant surfaces of buildings
	L	m	m	m	m
Oil-insulated transformers (O)	100 ≤1000	1	6	1	4.5
	>1000 ≤2000	3	7.5	1.5	7.5
	>2000 ≤20 000	5	10	4.5	15
	>20 000 ≤45 000	10	20	7.5	30
	>45 000 ≤60 000	15	30	7.5	30
	>60 000	23	30	7.5	30
Less combustible liquid-insulated transformers (K) without enhanced protection	100 ≤1000	1	6	1	4.5
	>1000 ≤38 000	1.5	7.5	1.5	7.5
	>38 000	4.5	15	4.5	15
Less combustible liquid-insulated transformers (K) with enhanced protection (refer to Note 1)	Clearance G_1 to other transformers or building surfaces				Vertical extent G_4 for 2 hour fire resistant surfaces of buildings
	Horizontal m				Vertical m
	0.9				1.5
Dry-type transformers (A) Fire behaviour class F_0	1.5				3.0

Figure 7: AS2067 Table 6.1

The system is designed in line with and compiles to all relevant Australian Standards including but not limited to:

AS/NZS 3000:2018, Electrical installations (Wiring Rules)

AS 2067:2016 Substations and high voltage installations exceeding 1 kV a.c.

AS/NZS 5000.1:2005 (R2017) Electric cables - Polymeric insulated For working voltages up to and including 0.6/1 (1.2) kV

AS/NZS 60076.1:2014. (IEC **60076**-1:2011 Ed. 3.0, MOD). Australian/New Zealand Standard. Power transformers

AS 62271.1-2012 High-voltage switchgear and control gear Common specifications

AS/NZS 1429.1:2000 Electric cables - Polymeric insulated for working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV

AS / NZS **7000**:2016 Overhead Line Design

AS 1154.1-2009 (R2019) Insulator and conductor fittings for overhead power lines Performance, material, general requirements and dimensions

AS 1824.2-1995 **Insulation coordination** (phase-to-earth and phase-to-phase, above 1 kV) Application guide

AS/NZS 1170.2:2011 (R2016) Structural design actions Wind actions

AS 60044.5-2004 Instrument transformers - Capacitor voltage transformers

AS 1307.2-1996 (R2015) Surge arresters Metal-oxide surge arresters without gaps for a.c. systems

AS 1746-1991 Conductors - Bare overhead - Hard-drawn copper

AS 4777.2-2005 Grid connection of energy systems via inverters, Part 2: Inverter requirements

In addition to the Australian Standards the system and its components also comply with and are certified to:

UL1642 Standard for Safety of Lithium Batteries

UL1973 Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications

UL9540 Energy Storage Systems and Equipment

UL9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

UL1741 Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources

UN 38.3 Certification for Lithium Batteries

IEC 62619:2017 Safety Requirements for Secondary Lithium Cells and Batteries, for use In Industrial Applications

IEC 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems

NFPA885 Standard for the Installation of Stationary Energy Storage Systems

3 Gridstack™ Safety Systems

Fluence provides fully integrated industry-leading safety at all levels of our energy storage systems from Cell to the full System.

Battery Cell

- All cells are certified to UL1642 and IEC62619

Battery Module

- All modules are compliant with UL1973, IEC62619, and UN38.3

Battery Racks

- All racks are compliant with UL1973 and IEC62619
- BMS provides functional safety of electronic safety-related systems certified to IEC61508

Battery Container – Fluence Cube

- Certified UL9540 and 9540A
- Safety features include emergency shutdown, fire detection and suppression, gas detection (carbon monoxide), deflagration panels, lockable disconnect switch, Open Door Sensor, Gas Spring Damper, and Sliding Door Lock.

Battery System

- UL 1741 compliance
- Integrated ground fault protection and safety features for battery faults including overvoltage, overcurrent, and over temperature.

Fluence OS controller software communicates with the battery management system for an additional level of protection beyond OEM BMS logic.

Fluence OS continuously monitors, detects, and alerts operators to potential anomalies in the system. Potential problems are isolated and flagged for immediate attention, including alerts to Fluence 24/7 monitoring staff

1. Battery Management System (BMS)
2. Fast Stop (F-Stop)
3. Incipient Gas Detection: Carbon Monoxide
4. Fire Detection and Suppression System
5. Deflagration Panels
6. Lockable Disconnect Switch
7. Open Door Sensor
8. Gas Spring Damper
9. Sliding Door Lock

Figure 8: Fluence Gridstack™ Cube Safety Features

4 Core Transformer Protection

The core transformers are self-bunded pad mounted type, inclusive of advanced protection. The inclusion of Ring Main Units incorporated into the transformer construction provides remote disconnection and independent transformer protection and enables advanced transformer monitoring and predictive failure detection.

5 Conclusion

The Fluence BESS inbuilt safety features, connection asset design, protection system integration, and SCADA monitoring, incorporates Safety in Design elements with global standards. The system is easily contained within the site boundaries inclusive of the 10 m asset protection zone (APZ) along the eastern boundary.

The clearances and equipment separation exceed all minimum requirements and the system is unrestricted within the site limits.

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Bringing ideas to life