PRELIMINARY HAZARD ANALYSIS

Battery Energy Storage System (BESS)

Laceby BESS

[Snow Rd and Wangaratta Kilfeera Road LACEBY Victoria 3678]

Client:	ANZA Power
Project Reference:	AP PHA-2026
Prepared by:	AusSafe Consulting
Document Status:	ISSUED
Revision:	Rev A
Date:	04 July 2026

Executive Summary

Background

ANZA Power (AP) has engaged AusSafe Consulting (AusSafe) to prepare this Preliminary Hazard Analysis (PHA) for the proposed Laceby Battery Energy Storage System (BESS), to be located at the corner of Wangaratta Kilfeera Road and Snow Road, Laceby, Victoria. The Project comprises 44 × BYD MC Cube-T ESS containers with a combined rated capacity of approximately 70.8 MW / 283.2 MWh, co-located with an existing solar farm.

This PHA has been prepared in accordance with Hazardous Industry Planning Advisory Papers (HIPAP) No. 4 – Risk Criteria for Land Use Safety Planning and No. 6 – Guideline for Hazard Analysis (DoP, 2011), consistent with the multi-level risk assessment approach adopted for BESS facilities nationally, to inform the Project's planning approval process in Victoria.

Conclusions

A hazard identification (HAZID) exercise was undertaken for the Laceby BESS to identify potential hazards associated with site operations, materials storage and the surrounding environment (Appendix A). Ten hazard areas were assessed, from which scenarios with potential for onsite or offsite consequence were carried forward for risk assessment (Section 10).

Scenarios were screened qualitatively; transformer bund fire and transformer explosion (following an electrical surge) were carried forward for quantitative consequence modelling using Gexcon EFFECTS (Section 9). All assessed scenarios were rated LOW risk, except for transformer explosion (surge), rated MEDIUM. The assessment demonstrates no unacceptable offsite impacts, subject to the recommendations in Section 11.

On this basis, the Project is considered potentially hazardous but permissible within the current land use zoning, subject to implementation of the design safeguards and critical controls identified in this report, including confirmation of the fire engineering design basis (detection, isolation and ventilation-based controls, with no active fire suppression installed) with the Country Fire Authority (CFA) prior to finalisation.

Key Recommendations Summary

- BESS containers (BYD MC Cube-T ESS) to be designed, supplied and tested in accordance with UL 9540A, with test data made available to the certifying authority as required.
- BESS containers to be installed at the manufacturer's minimum separation clearances and in accordance with UL 9540A data, to be confirmed at detailed design.
- Confirm at detailed design that vent/fan covers on BESS containers to be constructed of non-combustible metal, with battery packs not located directly beneath ventilation openings.
- All transformers to be bunded (self-bunded skid or dedicated concrete bund) to contain oil releases.
- A detailed HAZOP and safety-in-design review to be undertaken during detailed design.
- Consult with relevant authorities and determine if a Fire Safety Study is required for the BESS compound.
- Site access roads, firefighting water supply infrastructure and firebreak dimensions to be finalised and confirmed against the CFA Design Guidelines at detailed design.
- The Dangerous Goods Manifest is to be notified to WorkSafe Victoria and kept accessible to the CFA, given Manifest and Placard Quantity thresholds are exceeded (Section 4.4).
- Consider frequency analysis for explosion overpressure in later design stages and confirm assumptions in the final hazard analysis.
- Formally confirm safety management system (SMS) elements assumed in Section 6.0 and ensure site-specific O&M Health Safety Management Plan, prior to commissioning.

Acronym and Abbreviations

Acronym/ Abbreviation	Description
ADG	Australian Dangerous Goods Code
AEGL	Acute Exposure Guideline Level
AP	ANZA Power
APZ	Asset Protection Zone
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
BAL	Bushfire Attack Level
BESS	Battery Energy Storage System
BMS	Battery Management System
CFA	Country Fire Authority
CSA	Canadian Standards Association
AC	Alternating Current
DC	Direct Current
DG	Dangerous Goods
EES	Electrical Energy Storage
EIS	Environmental Impact Statement
ELF	Extremely Low Frequency
EMF	Electric and Magnetic Fields
ERPG	Emergency Response Planning Guideline
FACP	Fire Alarm Control Panel
FRV	Fire Rescue Victoria
GVM	Gross Vehicle Mass
Ha	Hectare
HAZID	Hazard Identification
HAZOP	Hazard and Operability Study
HF	Hydrogen Fluoride
HIPAP	Hazardous Industry Planning Advisory Paper
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz

ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDLH	Immediately Dangerous to Life and Health
IP	Ingress Protection
Km	Kilometres
kV	Kilovolt
kW	Kilowatt
kW/m²	Kilowatts per square metre
LFP	Lithium Iron Phosphate ($LiFePO_4$)
MLRA	Multi-Level Risk Assessment
MV	Medium Voltage
MW	Megawatt
MWh	Megawatt hour(s)
NFPA	National Fire Protection Association
NMC	Nickel Manganese Cobalt
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
OHS/WHS	Occupational / Work Health and Safety
PCS	Power Conversion System
PHA	Preliminary Hazard Analysis
RPRR	Rapid Pressure Rise Relay
SCADA	Supervisory Control and Data Acquisition
SFAIRP	So Far As Is Reasonably Practicable
SOC	State of Charge
STEL	Short Term Exposure Limit
T	Tesla (SI unit of magnetic flux density)
TNT	Trinitrotoluene
UL	Underwriters Laboratories
UN	United Nations
UPS	Uninterruptible Power Supply
VBB	Victorian Big Battery
WorkSafe	WorkSafe Victoria

Key Definitions

Item	Description
Bowtie Analysis	A structured risk analysis technique mapping the pathway from threats (causes) through a central top event to consequences, with prevention barriers on the threat side and mitigation barriers on the consequence side.
Consequence	Outcome or impact of a hazardous incident, including the potential for escalation.
Critical Control	A control whose failure alone could lead to a major consequence; subject to formal verification and ongoing assurance.
Fire Protection Quantity	The quantity of a dangerous good above which specific fire protection systems are required under the Dangerous Goods (Storage and Handling) Regulations 2022 (Vic).
Hazard	Potential for harm
Likelihood	The chance of a specific event or outcome occurring, expressed qualitatively (e.g. Highly Unlikely, Remote) in this assessment.
Major Hazard Facility (MHF)	A facility required to notify and manage risks under Schedule 14 of the Occupational Health and Safety Regulations 2017 (Vic) due to the type and quantity of hazardous materials present.
Manifest Quantity	The quantity of a dangerous good above which a manifest must be prepared, notified to WorkSafe Victoria and kept accessible on site under the Dangerous Goods (Storage and Handling) Regulations 2022 (Vic).
Off-site	Areas extending beyond the Project site boundary.
Onsite	Areas within the Project site boundary.
Placard Quantity	The quantity of a dangerous good above which hazard warning placards must be displayed at the site and container entrances under the Dangerous Goods (Storage and Handling) Regulations 2022 (Vic).
Project	Laceby Battery Energy Storage System.
Proponent	ANZA Power
Risk	The likelihood of a specified undesired event occurring within a specified period or in specified circumstances; may be either a frequency or a probability depending on circumstances.
Sensitive Receptor	A person, place or use (e.g. a residence) that may be adversely affected by an incident at the Project and is considered in assessing offsite consequences.
SFAIRP (So Far As Is Reasonably Practicable)	A risk has been reduced SFAIRP when the cost of further risk reduction is grossly disproportionate to the benefit gained — the duty standard under Victoria's Occupational Health and Safety Act 2004.
Thermal Runaway	An uncontrolled, self-sustaining exothermic reaction within a battery cell that generates heat, gas and potentially fire faster than it can be dissipated.

1.0 Introduction, Scope and Background

AusSafe Consulting (AusSafe) was engaged by ANZA Power (AP) to prepare a Preliminary Hazard Analysis (PHA) for the Laceby Battery Energy Storage System (BESS) proposed at Wangaratta Kilfeera Road LACEBY Victoria.

The Laceby project is a hybrid solar (81MW DC PV Array/ 60MW AC Capacity) and-BESS facility with a rated capacity of 283MWh. The BESS will connect to a planned 66KV grid connection and will provide grid-scale energy storage and firming services to the market.

The solar farm component of the project has received prior approval. A PHA is needed to support the BESS component Development Application and Approval.

The PHA been performed in accordance with HIPAP No. 4 and HIPAP No. 6. This report outlines the PHA findings.

The key objectives of this PHA are to:

- Complete a PHA in accordance with HIPAP No. 6 – Guideline for Hazard Analysis.
- Assess results against the criteria in HIPAP No. 4 – Risk Criteria for Land Use Safety Planning.
- Demonstrate compliance with relevant codes, standards and regulations (WHS and DG)
- Address any specific requirements or recommendations for BESS hazard management

The scope of work encompasses a PHA study for the Laceby BESS including hazard identification; consequence analysis; preliminary risk assessment activity, identification of risk controls; recommendations and reporting.

2.0 Methodology

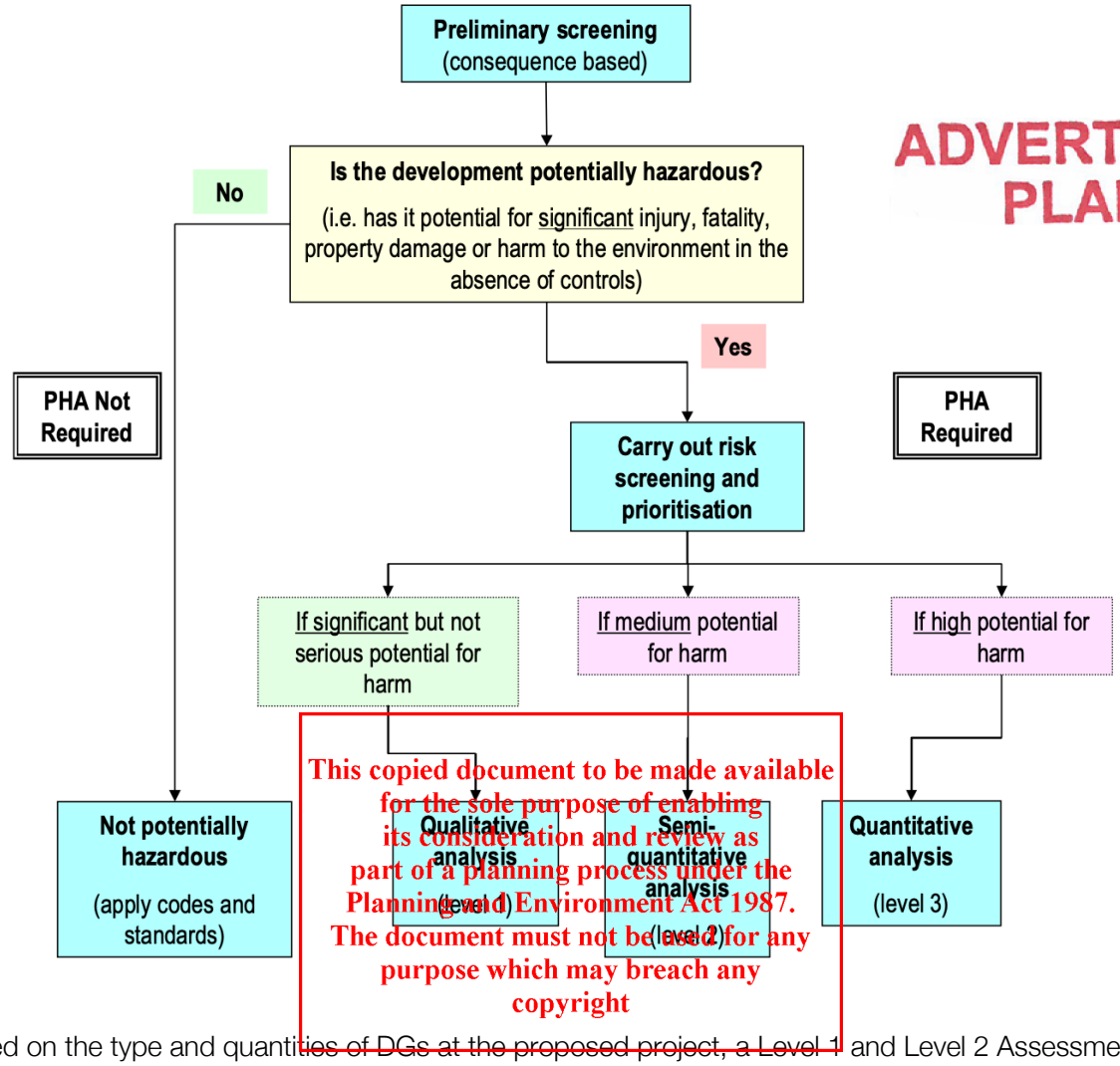
2.1 Multi-Level Risk Assessment Approach

The multi-level risk assessment approach (DoP, 2011) published by NSW DPHI is used to determine the appropriate level of risk assessment. The approach considers the developments location, the quantity and type of Dangerous Goods (DGs) stored and used, and the project's technical and safety management controls.

There are three levels of potential assessment show in Table 2-1 and presented schematically below.

Table 2-1: Level of Assessment – PHA

Level	Type of Analysis	Appropriate If:
1	Qualitative	No major off-site consequences and societal risk is negligible.
2	Partially Quantitative	Off-site consequences but with low frequency of occurrence.
3	Quantitative	Where Levels 1 and 2 are exceeded.



Based on the type and quantities of DGs at the proposed project, a Level 1 and Level 2 Assessment was selected for this site. This took into consideration a rural location and with nearest sensitive receptor >500. In addition, LFP battery chemistry with low fire propagation potential, support a qualitative Level 1 and 2 assessment.

2.2 Risk Assessment Study Approach

The methodology used for the PHA aligns with a staged process outlined in HIPAP No. 6:

- Hazard Analysis: A detailed hazard identification was conducted for site facilities and operations, documented using the word diagram format. Each incident was assessed for potential offsite impact.
- Consequence Analysis: For incidents with potential offsite impact, consequence analysis modelled impact distances and compared results against HIPAP No. 4 criteria (4.7 kW/m² for injury; 7 kPa for explosion; 23 kW/m² for property damage).
- Frequency Analysis: Where a simple consequence solution was not evident, initiating event frequency and safeguard reliability is recommended for assessment in a final hazard analysis.
- Risk Assessment and Reduction: Consequence and frequency results were combined and compared to HIPAP No. 4 risk criteria. Risk reduction recommendations were made where criteria were approached or exceeded.
- Reporting: Draft issued for review; final incorporating comments submitted to the regulatory authority.

2.3 Consequence Screening Criteria

The following consequence criteria (HIPAP No. 4) were used to screen incidents for further analysis:

- Fire Impacts: Incidents generating ≥4.7 kW/m² at the site boundary are carried forward for further assessment.
- Explosion Overpressure: Incidents generating ≥7 kPa at the site boundary are carried forward.
- Toxicity: Assessed against Emergency Response Planning Guidelines (ERPG) levels.
- Property Damage / Incident Propagation: Incidents generating ≥23 kW/m² or ≥14 kPa at the site boundary are prioritised for assessment of propagation risk.
- Societal Risk: Assessed where there is significant intensification of population near the project. Given the low population density context of most BESS facilities, societal risk is typically negligible.

3.0 Site and Project Description

3.1 Site Location

The Site is located at the Corner of Wangaratta Kilfeera Road and Snow Road in LACEBY Victoria 3678. This site is approximately 6km NE of Glenrowan and 2.5km S/SW of Wangaratta Airport. Surrounding properties are predominantly agricultural and does not have a bushfire management overlay. The closest sensitive receptor (residential) is approximately 500m from the BESS infrastructure.

Figure 3-1: Site Location

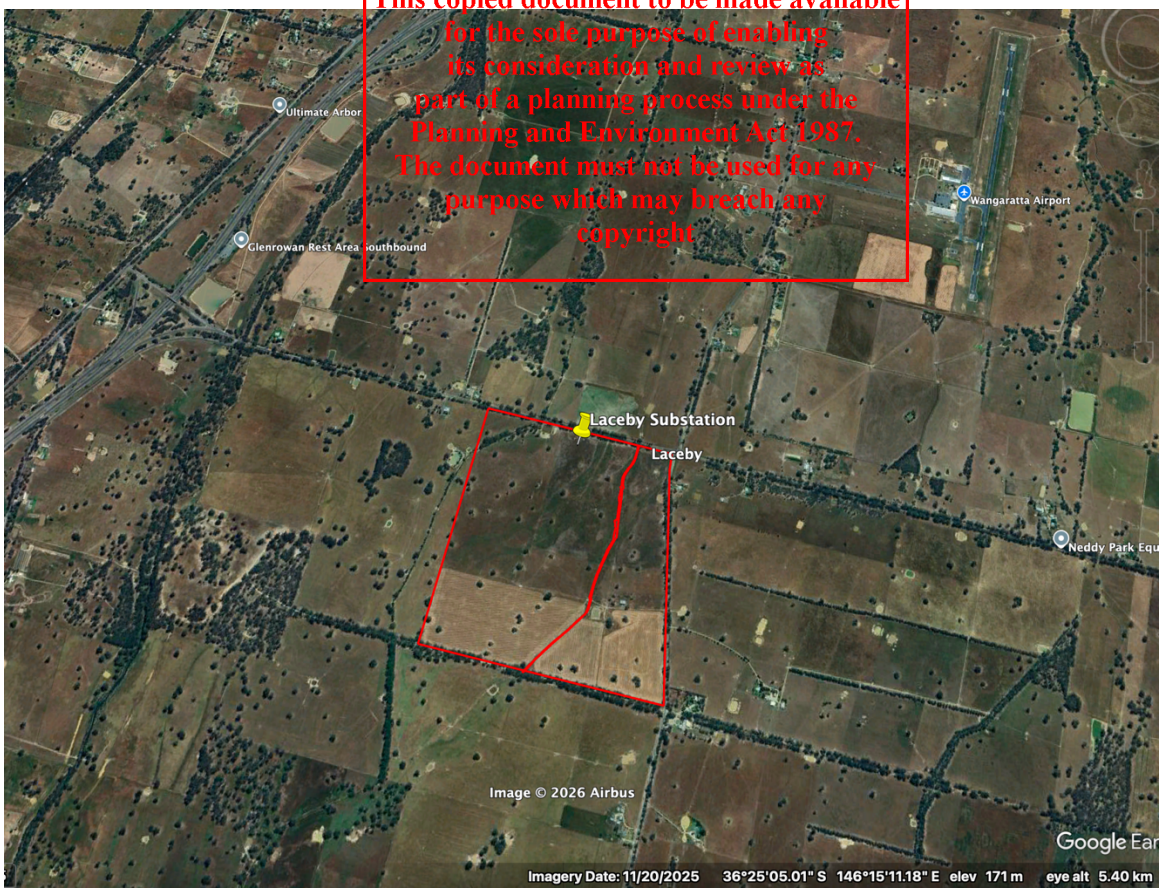
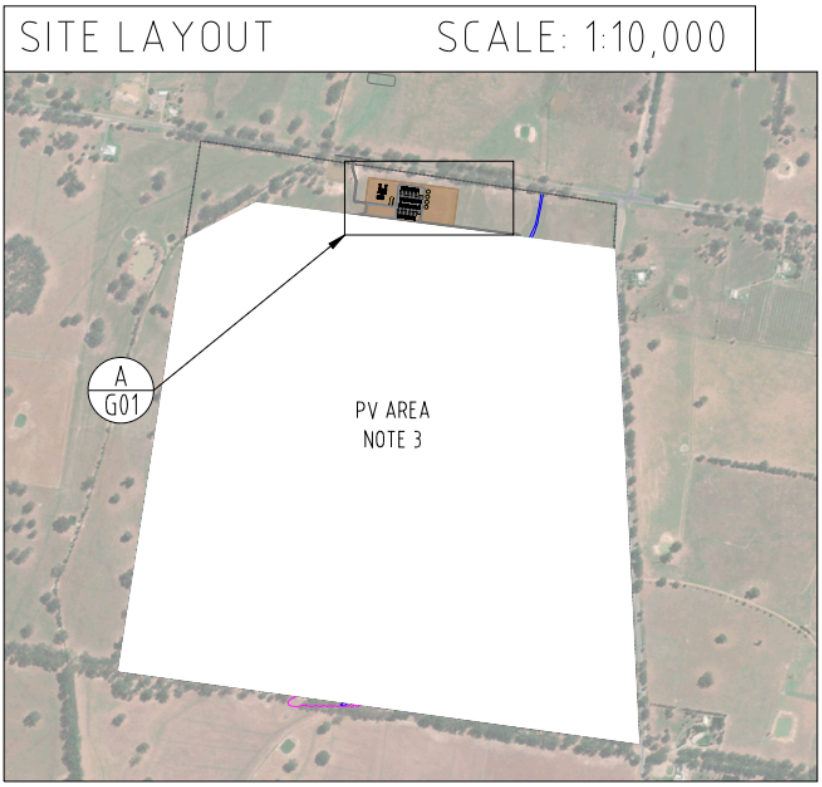


Figure 3-2 A&B: Site Layout

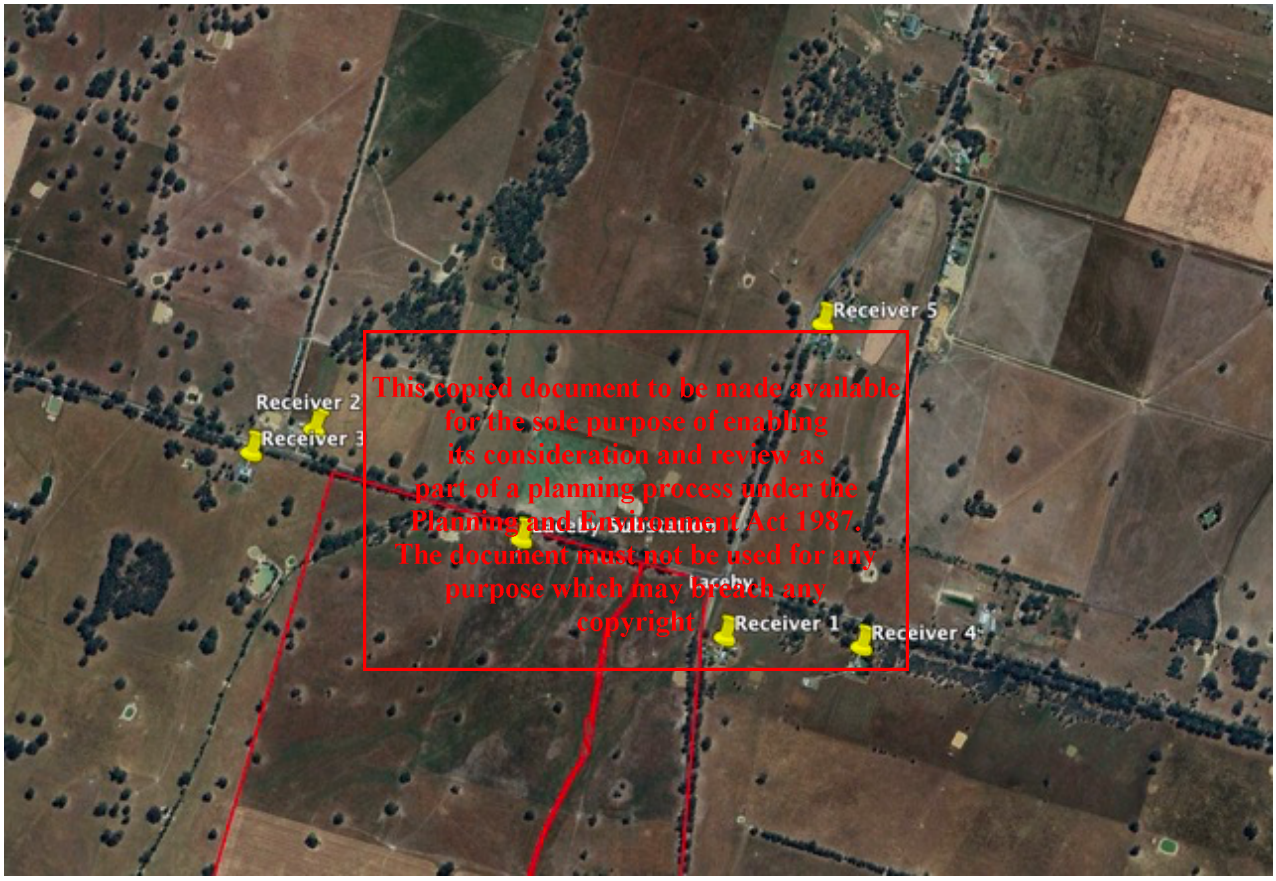


3.2 Adjacent Land Use and Sensitive Receivers

The land is in a rural area surrounded by farmland adjacent to the site in all directions. Sensitive receivers/receptors refer to locations or areas that are vulnerable or responsive to changes in the surrounding environment.

A survey revealed that some residences are located within proximity of the Project site which can be considered sensitive. The locations of nearby residential receivers are shown in Figure 3-3.

Figure 3-3 Sensitive Receivers



The closest residential receptor to each BESS location has been summarised in Table 3-1. A review of the separation distances indicates that the nearest residential receptor to the BESS site is roughly 500m.

Table 3-1: Distance between BESS and Closest Sensitive Receptor

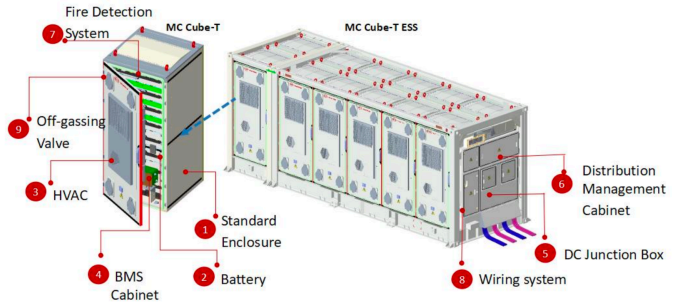
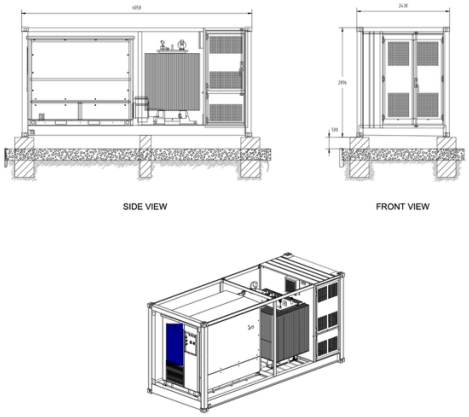
Nearby Residential Receptor	Distance (m) and Direction from BESS
BESS Receiver 1	500m (East)
BESS Receiver 2	577m (West)
BESS Receiver 3	700m (West)
BESS Receiver 4	860m (East)
BESS Receiver 5	911m (North)

3.3 Project Description

Laceby comprises a co-located solar-BESS facility with the following key parameters:

Parameter	Features/ Value / Description
Generation Infrastructure	81MW DC PV Array / 60MW AC Capacity
Transmission Line	66kV Grid
Ancillary Infrastructure	• Site office and control room • Access to the Project site via access roads from Snow Rd (man access) and Wangaratta-Kilfeera Rd. • 4-metre-wide internal access roads to support movement through the facility during the operations. • Security fencing of up to 1.85 m high around the Project site. • Fire water supply storage tanks – 4 x 140kL.
BESS Energy Storage Capacity	≈283.2 MWh (44 × 6,437 kWh BOL nameplate capacity per unit)
Battery Chemistry	Lithium Iron Phosphate (LFP) — BYD Blade Battery cells (confirmed: BYD MC Cube-T ESS)
Battery Unit (assumed for PHA)	BYD MC Cube-T ESS (Model MC12C-B6437-E-R4M04)
Number of BESS Units	44 units
Energy Capacity per Unit	6.44 MWh (6,437 kWh BOL)
Unit Dimensions (approx.)	7528 (L) × 2438 (W) × 2896 (H) mm
Unit Weight (approx.)	53.0 tonnes (53,010 kg)
IP Rating	IP55
Applicable Standards	UL 1973, UL 9540, UL 9540A, IEC 62619, IEEE 1547, CSA TS-800 (Large-Scale Fire Test), NFPA 855, NFPA 68/69
HV Transformer	66/33 kV, 70 MVA
MV Inverter Transformers	TBA
Grid Connection	Existing / proposed] transmission line – [kV]
Operational Workforce	Offsite

Detailed Description

BYD MC Cube-T ESS Model: MC12C-B6437-E-R4M04	Inverter Module (typical)
	

Parameter	Value
DC Data	
Cell Type	LFP
System Configuration	12×1P416S
Battery Capacity (BOL)	6,437 kWh
DC Usable Energy (BOL) @ FAT	6,431 kWh
DC Usable Energy (BOL) @ 1 Month SAT	6,366 kWh
DC Usable Energy (BOL) @ 3 Months SAT	6,302 kWh
Battery Voltage Range	1081.6 ~ 1497.6 V DC
Nominal Power	Busbar 1: 1×804 kW / Busbar 2: 1×804 kW
General Data	
Dimensions (W×D×H)	7528 × 2438 × 2896 mm
Weight	53,010 kg
IP Rating	IP55
Ambient Operating Temperature Range	-30°C ~ +55°C [1]
Relative Humidity	5% ~ 100%
Max. Working Altitude	< 2000 m [2]
Cooling Concept	Liquid Cooling

Parameter	Value
Noise	≤75 dBA
Fire Suppression System	Alarm only
Auxiliary Power Interface	AC 400V / 50Hz, 3P4W
Aux. System Peak Power Req. (@45°C, PF0.9)	58 kVA
Communication Protocols	Modbus TCP/IP
Standard Color	RAL 9003

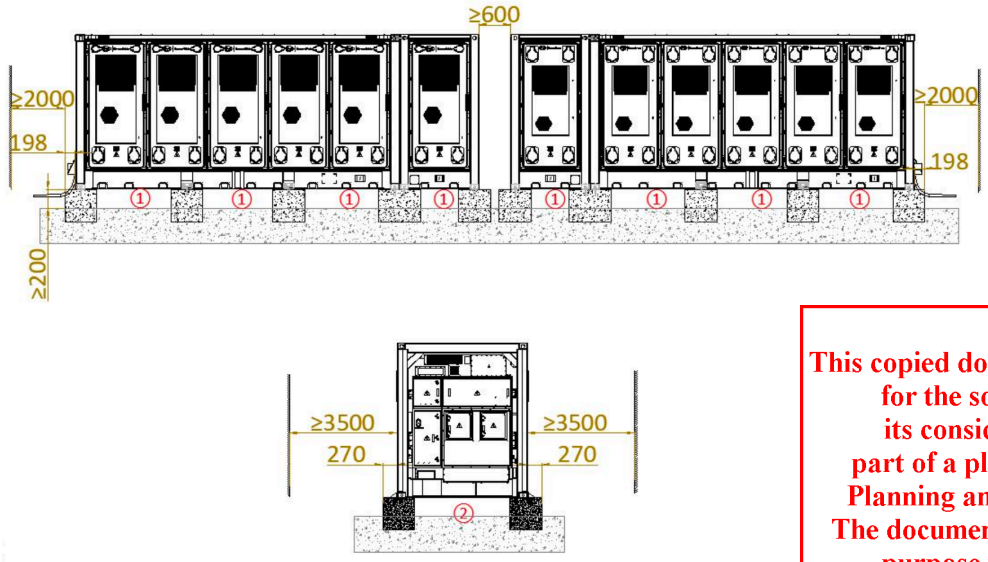
[1] Power derating below -15°C or above +45°C.
[2] Power derating between 2000–3000 m.
All models of the MC Cube utilize a standard IP-55 rated container.

Source: BYD MC Cube-T ESS System Specification MC-E-R4M04-SPE-001, Rev. 209 (2025-02-24)

3.4 Minimum Separation Clearances

BESS container clearances per manufacturer installation manual (to be confirmed at detailed design):

- Side-to-side: minimum 3500 mm
- Back-to-back/ End to end: minimum 600 mm



3.5 Dangerous Goods Quantities and Screening

The classes and maximum quantities of DGs at the site are presented in Table 3-2. Transformer oil type is not yet confirmed; conservatively assumed as a C1 combustible liquid. Quantities estimated based on a 30,000L for the HV transformer.

Table 3-2: DG Classes and Maximum Quantities

Area / Material	DG Class	Description	Quantity	Exceeds Thresholds?
BESS	9	Lithium Batteries	246,048 Kg	No – no published Class 9 threshold
Ester Oil - Transformer (HV)	N/A	Combustible liquid	30,000 L estimate to be determined in DD	No – C1 in non-flammable storage area
Transformer oil (MV)	N/A	Combustible liquid	To be confirmed	No – C1 in non-flammable storage area
Diesel Generator	Class 3 C1	Combustible liquid	2000L estimate to be determined in DD	No – C1 in non-flammable storage area
Refrigerant (BESS cooling)	2.2	HVAC R134a refrigerant	132 kg	No – Class 2.2 excluded
Refrigerant (BESS cooling)	2.2	HVAC R410a refrigerant	132 kg	No – Class 2.2 excluded
BESS UPS	Exempt	VRLA lead-acid batteries (non-spillable UPS)	1,320 kg	No – exempt

4.0 Dangerous Goods Compliance Screening

Dangerous Goods (DG) screening of the proposed BESS was conducted against the Dangerous Goods (Storage and Handling) Regulations 2022 (Vic), the Occupational Health and Safety Regulations 2017 (Vic), and the Australian Dangerous Goods (ADG) Code.

None of the hazardous materials identified in the Manifest Register are listed in Schedule 14 of the Occupational Health and Safety Regulations 2017. The storage quantities on site therefore do not trigger a Major Hazard Facility (MHF) classification.

4.1 Dangerous Goods Storage

The Dangerous Goods (Storage and Handling) Regulations 2022 set out requirements for the use, handling and storage of hazardous chemicals in a Victorian workplace. This assessment compares the quantities of dangerous goods stored and handled at the BESS facility against the placard, manifest and fire protection quantity thresholds compiled in the project's Dangerous Goods Manifest Register, and against Schedule 2 published thresholds.

A summary of the dangerous goods stored including within the 44 BESS containers, and the corresponding threshold exceedances, is provided in Table 4-1. Where storage quantities exceed the applicable thresholds, the regulatory requirements are summarised in Section 4.4.

4.2 Dangerous Goods on Site

Each of the 44 BESS containers holds the following dangerous goods, per the manufacturer's safety manual and the basis recorded in the project's DG Manifest Register (Calculation sheet):

- Lithium-ion battery electrolyte (UN 3480, Class 9, PG II) – up to 5,592 kg per container, giving a site total of 246,048 kg across 44 containers (specified quantity per the OEM safety manual).
- HVAC R134a refrigerant (UN 3159, Class 2.2) – 1 HVAC unit per container, 3 kg charge assumed per unit, giving a site total of 132 kg.
- HVAC R410a refrigerant (UN 3163, Class 2.2) – 1 HVAC unit per container, 3 kg charge assumed per unit, giving a site total of 132 kg.
- VRLA lead-acid UPS batteries, non-spillable (UN 2800) – 1 UPS per container (30 kg/container), giving a site total of 1,320 kg. Non-spillable batteries are generally exempt from DG classification under the ADG Code special provision for this UN number.

4.3 Summary of Dangerous Goods and Threshold Quantities

Table 4-1: Threshold Quantities for BESS Hazardous Materials (44 container units)

Material	UN No.	Class	Category	Pkg Grp	Project Quantity	Manifest Threshold[1]	Placard / Fire Protection Threshold[2]	Exceeds?
Lithium-ion battery electrolyte	3480	9	Miscellaneous DG	II	246,048 kg	10,000 kg	1,000 kg / 20,000 kg	Yes – all three
HVAC R134a refrigerant	3159	2.2	Non-flammable, non-toxic gas	n/a	132 kg	Not prescribed[3]	Not prescribed[3]	NA
HVAC R410a refrigerant	3163	2.2	Non-flammable, non-toxic gas	n/a	132 kg	Not prescribed[3]	Not prescribed[3]	NA
VRLA lead-acid batteries (non-spillable, UPS)	2800	Non-spillable battery	Exempt[4]	n/a	1,320 kg	Exempt[4]	Exempt[4]	No – exempt

1. Per the project's Dangerous Good Classes / Manifest Quantity schedule: Class 9 (PG II/III, or mixed PG) = 10,000 kg or L; Class 2.2 not separately prescribed.

2. Placard (1,000 kg) and Fire Protection (20,000 kg) figures are the published Schedule 2 thresholds for Class 9 PG II/III dangerous goods under the Dangerous Goods (Storage and Handling) Regulations 2022 (Vic).

3. Non-spillable batteries meeting the UN 2800 special provision are generally excluded from classification as dangerous goods for storage and handling purposes under the ADG Code; included here for completeness only.

The Class 9 quantity (lithium-ion battery electrolyte) is 246,048 kg, which remains well in excess of the 10,000 kg mixed-packing-group Class 9 threshold.

4.4 Dangerous Goods Regulatory Requirements

As the storage quantities in Section 4.3 exceed the Placard, Manifest, and Fire Protection Quantity thresholds (driven primarily by the lithium-ion battery electrolyte), the following DG regulatory requirements apply.

4.4.1 Placard Quantities

The lithium-ion battery electrolyte exceeds the 1,000 kg Placard Quantity threshold for Class 9 dangerous goods.

"HAZCHEM" outer warning placards must be displayed at every road vehicle entrance to the site and at the entrance to each BESS container (or group of containers) in which these materials are stored, in accordance with s46-s47 and Schedule 4 of the Dangerous Goods (Storage and Handling) Regulations 2022.

Each BESS container shall have DG information placard installed and maintained at each container entry.

4.4.2 Manifest Quantities

The 10,000 kg Manifest Quantity threshold for Class 9 dangerous goods is exceeded. Accordingly:

- ANZA Power (AP), as occupier, must notify WorkSafe Victoria of the dangerous goods exceeding manifest quantities (s64 Regs).
- The manifest must be kept on site at access point and in a location accessible to the Country Fire Authority (CFA)
- An emergency plan must be prepared for the site and provided to the CFA for written advice (s53 Regs).

4.4.3 Fire Protection Quantities

The Li-io battery electrolyte exceeds the 20,000 kg Fire Protection Quantity threshold (Class 9 PG II). As per s52 Regs, AP must request the written advice of the CFA regarding the design of the fire protection system for the BESS container and have regard to that advice when finalising system design.

This will extend to compliance with CFA Design Guidelines and Model Requirements for Renewable Energy Facilities v4.4.

The CFA may request a Fire Safety Study (FSS), per HIPAP No. 2 methodology and to provide any enhanced, detailed analysis of fire and explosion safety system requirements.

Management of fire water runoff must also be addressed, including provision for containment of contaminated fire water (e.g. bunding, sumps, or purpose-built impervious retention facilities), in accordance with AS 4681–2000 Section 7.3.9.

5.0 Hazard Identification

Hazard identification has been performed and is presented at Appendix A, consistent with HIPAP No. 6. The HAZID register identifies potential offsite hazards, their causes, consequences and safeguards. No hazards have been eliminated from the assessment prior to detailed analysis in this section.

The primary BESS hazard is thermal runaway with the hazard being characterised across several differing causal paths. Thermal runaway can result in several risk scenarios including fire, deflagration/ explosion event, toxic exposures.

The following hazardous scenarios have been considered and detailed in the hazard identification table:

- Battery thermal runaway
- Transformer fire
- Transfer explosion
- Explosive gas generation
- Fire/explosion (non battery fire)
- External/ Bushfire impact
- Electric Shock
- Arc Flash
- Toxic gas dispersion
- EMF exposure
- Other
  - Emergency responder safety

Hazards with an offsite potential are considered further below and carry forward analysis determined. Other operational and/or environmental hazards have not been considered

5.1 Properties of Dangerous Goods

DG Class	Hazardous Properties
Class 9 – Miscellaneous DGs	Lithium-ion batteries classified as miscellaneous dangerous goods per the ADG Code. Battery chemisty is Lithium Ion Phosphate (LFP). The primary hazard is thermal runaway – an escalating exothermic reaction leading to heat, off-gas, and potentially fire. LFP chemistry is significantly more thermally stable than other battery (NMC or NCA) chemistries, with a normalised heating rate of ~1.5°C/min versus 200–400°C/min for cobalt-based chemistries.
C1 – Combustible Liquid	Transformer oil (mineral or synthetic). Flash point typically >60°C. Requires sustained heating or high-energy ignition source to ignite. Primary concern is bund fire following transformer failure. Note - HV transformer oil proposed is Ester Oil which is non dangerous good/ non-hazardous classification. For the purposes of this assessment, it has been assumed that a natural ester oil such as FR3 will be used which is >99% soybean oil (mixture of triglycerides). These triglycerides are esters of fatty acids, predominantly linoleic acid (circa 50%). Linoleic acid has a flash point of approximately 200 oC, while the FR3 oil itself has a higher flash point of >265 OC. For the purposes of providing a conservative analysis, pure linoleic acid has been selected as the transformer oil.

5.2 LFP Thermal Runaway

Lithium-ion batteries can undergo thermal runaway through several degradation mechanisms including: chemical reduction of the electrolyte at the anode or cathode; thermal decomposition of the electrolyte; internal short circuit; or physical damage. These effects arise from high discharge rates, overcharging, manufacturing defects, or mechanical damage.

LFP ($LiFePO_4$) chemistry is used in this project. LFP does not release oxygen during thermal runaway (unlike NMC/NCA), substantially reducing fire propagation risk. The normalised heating rate at peak for LFP is ~1.5°C/min, compared to 200–400°C/min for cobalt-based chemistries. Nail puncture testing of LFP cells demonstrates no ignition on membrane perforation.

In-built BYD battery safety features include:

- Shut-down separator (overheating) – local and remote
- Vent / pressure relief (severe outgassing)
- Thermal interrupt (overcurrent / overcharge / environmental exposure)
- Battery Management System (BMS) monitoring and shutdown
- Panel monitoring and alarm system/s
- Smoke, thermal and combustible gas detection
- Inter-cabinet fire isolation and heat insulation design

Based on UL9540A test data for comparable LFP BESS products (to be confirmed in detailed design), thermal runaway triggered in one cell does not propagate to all cells in a module, nor to adjacent modules. Should a container fire develop, the enclosure typically contains the fire, remaining intact at temperatures exceeding 900°C.

Conclusion: The potential for LFP thermal runaway resulting in fire is low. Should fire develop within a single container, propagation to adjacent containers is unlikely given the fire safety design features. This incident is not carried forward for further quantitative analysis, however, the following controls also apply.

5.3 Separation Review

The site is agricultural land. The nearest sensitive receptor is approximately 500m from BESS units. BESS containers are to be separated per manufacturer's instructions including a minimum of 600mm end to end and minimum of 3500mm side to side.

Given the remote location, fire safety management plan and absence of combustible infrastructure in the immediate vicinity, fire propagation would not be expected to increase impacts to sensitive receivers.

5.4 Propagation between units

The BYD MC Cube has several design features to mitigate fire propagation between units including in house blade battery technology, active detection and off-gassing, modular cabinet design, inter-cabinet fire isolation and Battery-Distribution Cabinet Isolation.

BYD MC Cube under CSA TS-800 LSFT tests modelled 1000°C fire, with a peak heat release rate of 5.43MW. Adjacent cabinets' temperatures remained below 60°C, well below the thermal runaway threshold for LFP (270-300°C).

In addition, lessons learnt from incidents including The 2021 Geelong Victorian Big Battery (VBB) fire found the back-to-back layout was not the cause of propagation and was caused by strong winds directing flames from a burning Megapack into the unprotected plastic vent/fan cover atop an adjacent unit, which ignited and directly contacted battery modules.

Lessons incorporated into the project detailed design:

- Vent covers / fan covers to be constructed of non-combustible metal (not plastic)

- Battery packs or flammable materials not to be located directly beneath ventilation openings.
- Enhanced commissioning protocols, sensor coverage and alarm responses per VBB investigation recommendations.

Conclusion: Supported by BYD/CSA TS-800 LSFT scenario testing, propagation between units is considered unlikely and not carried forward for further analysis.

5.5 Li-Ion Battery Fire and Toxic Gas Dispersion

Carbon Dioxide (CO_2)

CO_2 is a colourless, odourless gas. STEL is 30,000 ppm (3%). Concentrations >100,000 ppm (10%) coma or death probable. CO_2 is a combustion byproduct from carbon-containing battery components (wiring, plastics, anodes). A review of comparable BESS fires (including VBB) indicates that CO_2 generation would not produce a downwind plume of sufficient concentration to cause offsite injury.

This incident is not carried forward.

Carbon Monoxide (CO)

CO is a by-product of incomplete combustion. IDLH is approximately 1,200 ppm. The combustible load within LFP BESS containers relative to the available atmospheric oxygen makes credible offsite CO concentrations causing injury implausible.

This incident is not carried forward.

Fluoride Gases (HF, PF_5, POF_3)

Electrolytes in Li-ion batteries (typically $LiPF_6$) can, in the event of a fire, generate hydrogen fluoride (HF), phosphorous pentafluoride (PF_5), and phosphoryl fluoride (POF_3). HF IDLH is 30 ppm; 10-minute lethal concentration is 170 ppm. HF is hygroscopic and highly corrosive.

Due to a full container fire being the necessary initiating event and potential for LFP fire is considered negligible, toxic fluoride gas dispersion reaching offsite receptors at harmful concentrations is not a credible scenario. Preliminary consequence modelling was performed (using the Effects LFP Thermal Runaway model) and confirmed no offsite impact potential based and based on a full container thermal runaway which is considered improbable.

This incident is not carried forward.

5.6 Electrical Equipment Failure and Fire

Electrical equipment within switch rooms (switchgear, servers, control systems) can fail due to arcing, overheating or short circuit. Switch room fires typically develop slowly (smouldering) and are contained within the room. The fire would be unlikely to result in substantial offsite impacts.

Incident not carried forward.

5.7 Transformer Internal Arcing, Oil Spill, Ignition and Bund Fire

If internal transformer arcing occurs, arc energy thermally decomposes the oil, generating light hydrocarbon and combustible gases and causing rapid pressurisation. Reservoir rupture allows oxygen ingress and auto-ignition above the autoignition temperature, potentially igniting oil in the bund. Transformers are ubiquitous with low failure rates. All transformers are to be bunded (self-bunded skid or concrete bund), limiting oil pool spread. Separation distances to site boundary make offsite impacts unlikely.

A quantitative consequence analysis has been performed for this scenario to confirm site boundary impacts remain within screening criteria.

5.8 Transformer Electrical Surge Protection Failure and Explosion

An extreme electrical surge (e.g. direct lightning strike) defeating surge protection can cause oil decomposition, gas formation, pressurisation, reservoir rupture, oxygen ingress and explosion, generating significant overpressure. Transformers are equipped with surge protection devices but these do not protect against all events.

This incident has been carried forward for quantitative consequence analysis.

5.9 Electromagnetic Field (EMF) Impacts

BESS facilities generate extremely low frequency (ELF) EMFs from operational equipment including transformers, inverters, transmission lines and battery electrical components. ELF EMF frequencies range from 0–300 Hz. In Australia, the dominant frequency is 50 Hz (grid frequency).

There is no mandatory Australian standard for exposure to 50 Hz EMF; the assessment adopts the ICNIRP (2010) reference levels, which ARPANSA endorses as the appropriate benchmark. The ICNIRP public exposure reference level is 2,000 milligauss (mG) / 200 µT at 50 Hz for continuous 24-hour exposure and 1000 µT occupational (ICNIRP 2010).

Source	Typical Measurement (mG)	Range (mG)
Personal computer	5	2 – 20
Distribution powerline (under line)	10	2 – 20
Transmission powerline (under line)	20	10 – 200
Substation / transformer (adjacent)	Up to ~1,000 at source	Rapidly attenuates to background within 5–10 m
Inverter / BESS unit (adjacent)	Up to ~110–277 µT at source	Attenuates to background within 2–3 m

EMF attenuates rapidly with distance. ARPANSA advises that EMF from high voltage powerlines becomes indistinguishable from background within ~50 m, and from substations within 5–10 m. Field studies at utility-scale solar/BESS facilities confirm magnetic fields adjacent to inverters and transformers are below ICNIRP occupational limits, and within 2–3 m of equipment reduce to background levels.

Nearest sensitive receptors at this site are approximately 500m from BESS equipment. ICNIRP public reference levels will not be exceeded at any offsite location. Incident not carried forward.

5.10 External Fire / Bushfire Impact

The site sits within a low bushfire risk setting overall (Habitat 2025) with the development area not mapped within the bushfire management overlay. However, it is identified as Bushfire Prone under the Building Regulations, and clause 13.02-1S (Bushfire Planning) requires that bushfire risk be prioritised in decision making.

Whilst the facility is not within proximity to high bushfire intensity prone land (refer site layout). With prevailing winds, embers can travel several kilometres. The site is to maintain a vegetation management plan / asset protection zone (APZ) and limit combustible fuel loads. Grass fires are short-lived with limited sustained radiant heat.

The CFA Design Guidelines and Model Requirements: Renewable Energy Facilities inform facility design including (but not limited to):

- Siting and layout to enable safe emergency access
- Separation distances that reduce the likelihood of fire spreading between battery units, buildings and any vegetation;
- Fire protection systems and water supply capacity
- CFA approved Risk Management Plan, a Fire Management Plan and an Emergency Plan.

The BESS will operate within a facility that already incorporates strong bushfire resilience measures through the approved solar farm layout and supporting emergency access infrastructure. These features include all-weather internal access roads suitable for firefighting appliances, managed fuel loads and perimeter defensible space. The BESS will adopt complementary measures that align with the CFA model requirements and will ensure that the bushfire risk to and from the storage system remains acceptable.

BYD MC Cube BESS enclosures are designed to IP55 standard, providing protection against environmental ingress. LFP chemistry is resistant to external heat-induced thermal runaway at realistic bushfire radiant heat levels. Sustained radiant heat impacts sufficient to damage BESS infrastructure are not expected.

Conclusion: The potential for incident escalation from external bushfire is considered minimal, however the incident will be carried forward for further analysis and traceability in Detailed Design.

6.0 Safety Management System

ANZA Power's operation and maintenance of the facility will be in accordance with a Safety Management System defined within a site specific Laceby Solar Farm and BESS O&M Health Safety Management Plan aligned to Victorian OHS and DG legislation, standards, codes and applicable development provisions, including CFA approved Risk Management Plan, Fire Management Plan and Emergency Plan.

The facility and the overall assessment of risk, considers appropriate management and control of hazards and associated risks. Formal safety management systems allow the risk/s from potentially hazardous installations to be minimised through a combination of preventive and mitigative controls to ensure safe operations.

The assumed systems and processes applicable to the Project include, but are not limited to:

- The Project would be an unmanned facility and assumes no more than 5 workers (routinely) within the Project Area for maintenance and operations requirements.
- The operation of the proposed BESS, Solar Farm and transmission line would be continually monitored and controlled from a central control room via a Supervisory Control and Data Acquisition (SCADA) system
- An O&M manager will be appointed, with overall responsibility and who would be supported by suitably qualified/ competent personnel trained in the operation, maintenance and support of the facility
- Asset management process that ensures equipment and systems (including protective systems and controls) are inspected, tested and maintained in accordance with OEM requirements, applicable standards and engineering good practice.
- A permit to work/ safe system of work for the planning, authorisation and coordination of hazardous work including (but not limited to)
    - Hot work
    - Live Electrical
    - Excavation/ penetration
    - Confined space entry
    - Controlled Access (e.g. HV Apparatus)

- All workers will be provided with induction training, training and access authorisation, and instruction and supervision to ensure health and safety
- All contractors will be managed under a formal Contractor onboarding and contractor safety management process
- Incident management, reporting and response process
- Security fencing and access controls
- Project elements comply with all Codes and statutory requirements with respect to design, work conditions and performance of work
- All Dangerous Goods (DG) will be stored, used and transferred in accordance with relevant legislation, standards and codes, risk assessments and Safety Data Sheet (SDS) requirements, including any minimum PPE requirements
- All personnel working within the Project Area would be provided with the appropriate PPE suitable for use with the specific type of activity i.e. handling of hazardous substances or electricity
- Emergency procedures, including response to any external incidents, would be implemented and personnel would be trained in emergency response. Emergency processes exist for lone workers.
- A first aid station will be installed comprising appropriate first aid kit(s) and first aid

7.0 Reference Bowtie Models

Bowtie analysis provides a structured hazard/risk analysis technique that maps the pathway from threats (causes) through to a central top event (hazardous event/loss of control) and on to consequences. The left side of each bowtie shows threats and prevention barriers that reduce the likelihood of the top event. The right side shows mitigation barriers that reduce the severity of consequences should the top event occur.

Three reference bowtie models are presented for the highest-priority BESS hazard scenarios, structured in accordance with the EPRI/Sandia ESS Failure Mode Analysis framework. Threat, barrier and consequence codes (e.g. [A1], [B2], [C3], [D4]) are summarised consistent with the EPRI/Sandia reference taxonomy and amendments to reflect BYD MC Cube specifications.

Other risk events have not been modelled at this stage of the analysis and may be considered further in final hazard analysis.

These reference bowties inform the preliminary Critical Control summary identified in Section 7.0 and should be reviewed and updated as part of the detailed design HAZOP and final hazard analysis.

Threat / Cause	Barrier / Control	Top Event	Consequence
Blue box – left side	Grey box – left and right side	Red/orange circle – centre	Red box – right side

Bowtie 1: LFP Cell Internal Failure and Thermal Runaway

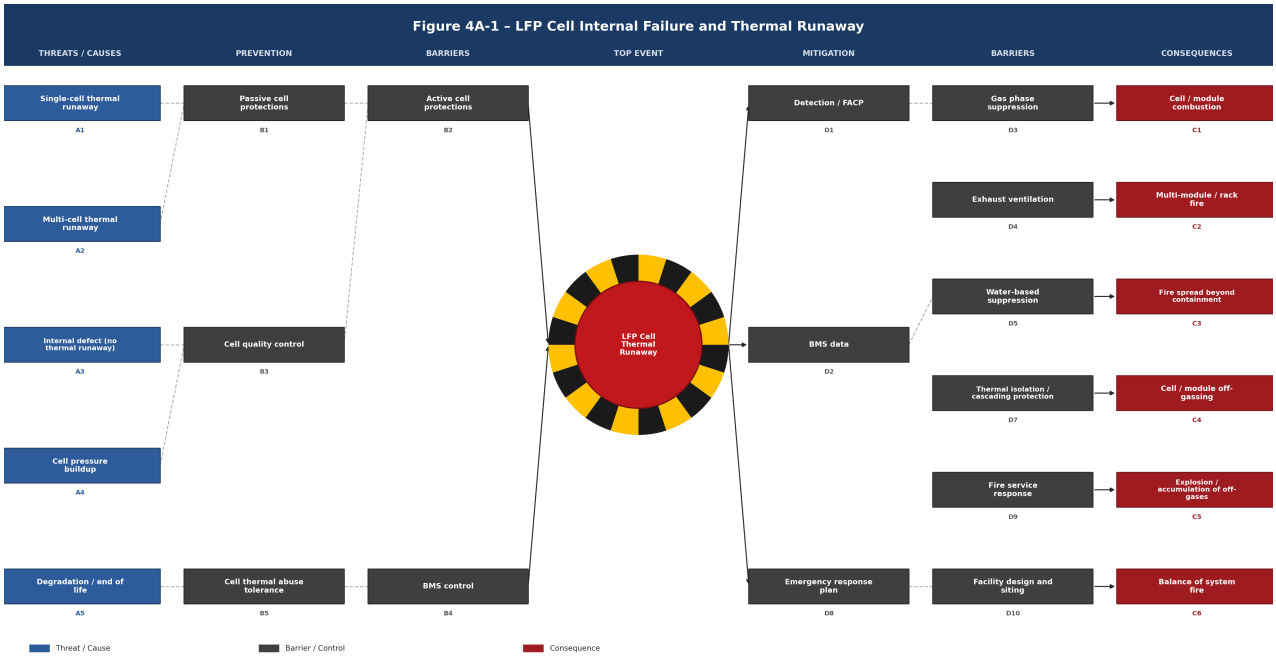


Figure 7-1: Bowtie 1 – LFP Cell Internal Failure and Thermal Runaway

Threats [A1–A5]: Single-cell thermal runaway; multi-cell thermal runaway; internal defect (no TR); cell pressure buildup; degradation/end of life.

Prevention barriers [B1–B5]: Blade Battery LFP cell chemistry (no oxygen release during thermal runaway); shut-down separator (local and remote) and thermal interrupt (overcurrent/overcharge/environmental exposure); cell manufacturing quality control; BYD Battery Management System (BMS) monitoring and shutdown; LFP cell thermal abuse tolerance.

Mitigation barriers [D1–D10]: Smoke, thermal and combustible gas detection with fire alarm panel; BMS data; vent/pressure relief and exhaust ventilation; inter-cabinet fire isolation, heat insulation design and non-combustible vent/fan covers; emergency response plan; fire service response; facility design and siting.

Consequences [C1–C6]: Cell/module combustion; multi-module/rack fire; fire spread beyond containment; cell/module off-gassing; explosion/accumulation of off-gases; balance of system fire.

Bowtie 2: Non-Cell Thermal Risks

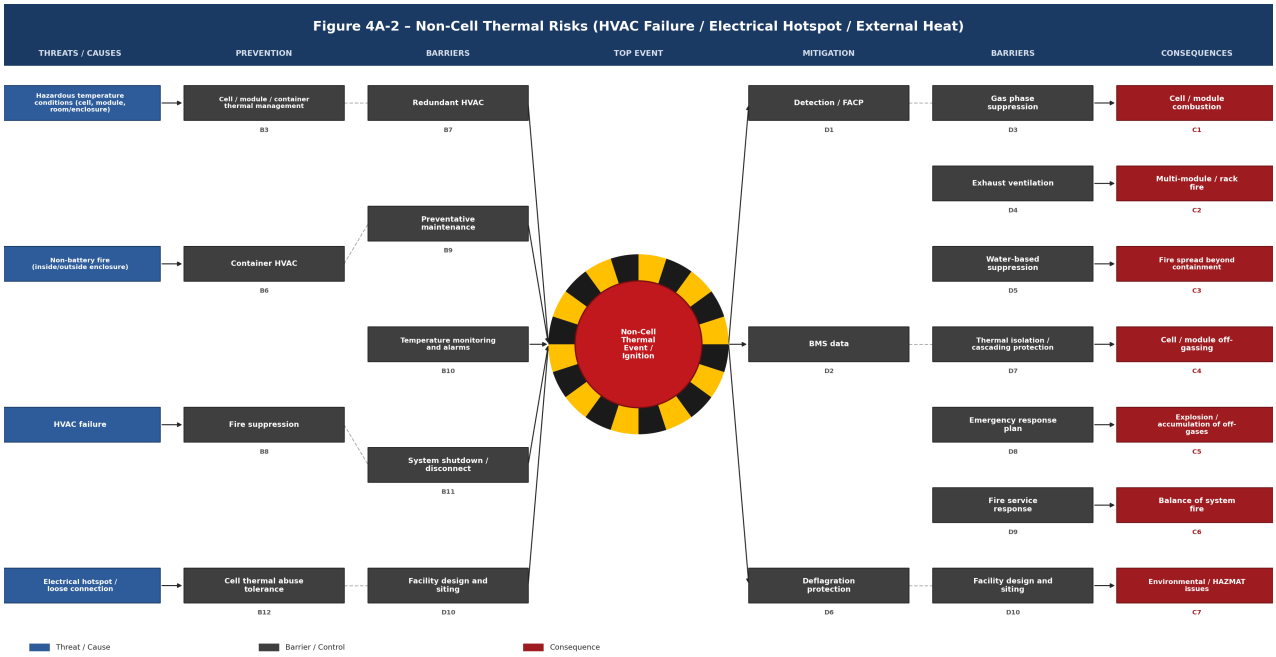


Figure 7-2: Bowtie 2 – Non-Cell Thermal Risks: HVAC Failure / Electrical Hotspot / External Heat

Threats [A6–A12]: Hazardous temperature conditions (cell, module, room/enclosure); non-battery fire (inside/outside enclosure); HVAC failure; electrical hotspot/loose connection.

Prevention barriers [B3, B6–B12, D10]: Liquid cooling thermal management (cell/module/container); container HVAC; redundant HVAC; preventative maintenance; panel monitoring and temperature alarms; BMS-initiated system shutdown/disconnect; LFP cell thermal abuse tolerance; facility design and siting.

Mitigation barriers [D1–D10]: Smoke, thermal and combustible gas detection with fire alarm panel; BMS data; vent/pressure relief and exhaust ventilation; inter-cabinet fire isolation and heat insulation design; emergency response plan; fire service response; facility design and siting, deflagration protection.

Consequences [C1–C7]: Cell/module combustion; multi-module/rack fire; fire spread beyond containment; cell/module off-gassing; explosion/accumulation of off-gases; balance of system fire, environmental/HAZMAT issues [C7].

Bowtie 3: External and Environmental Risks

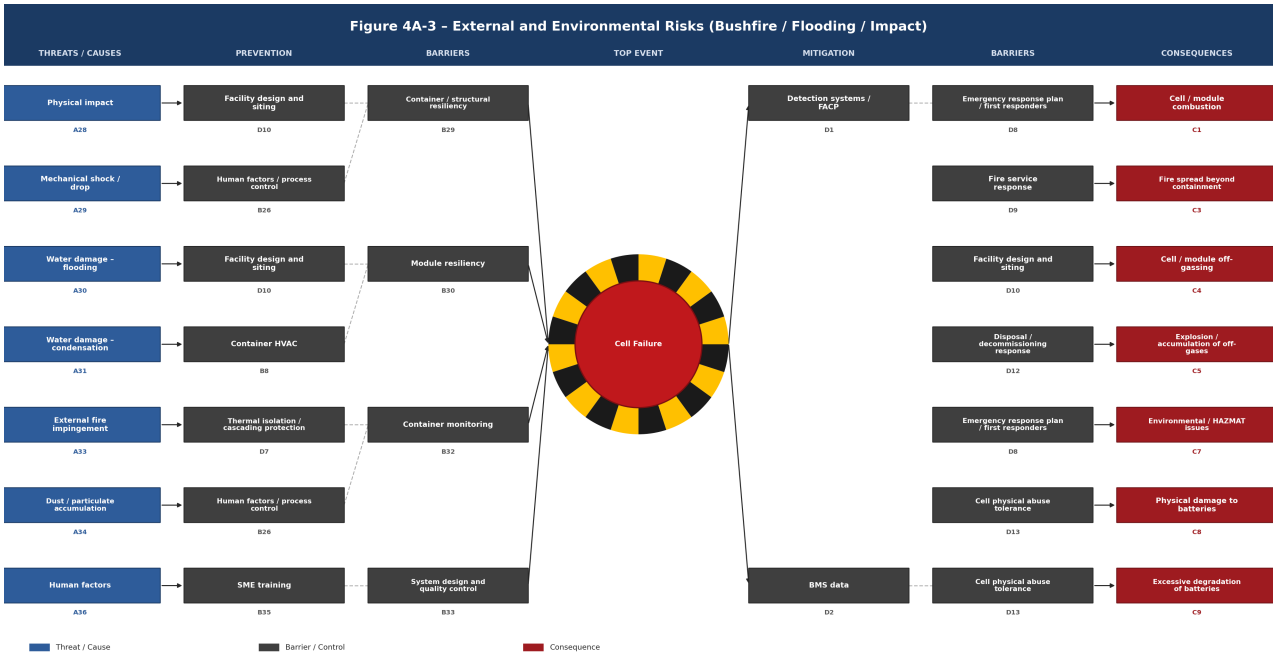


Figure 7-3: Bowtie 3 – External and Environmental Risks: Bushfire / Flooding / Impact

Threats [A28–A36]: Physical impact; mechanical shock/drop; water damage (flooding/condensation); external fire impingement; dust/particulate accumulation; human factors.

Prevention barriers [B26, B29–B33, D7, D10]: Facility design and siting; IP55-rated container/structural resiliency; Blade Battery module resiliency; container monitoring; system design and quality control; system maintenance; human factors/process control; SME training; inter-cabinet fire isolation and heat insulation design.

Mitigation barriers [D1–D2, D8–D10, D12–D13]: Smoke, thermal and combustible gas detection/FACP; BMS data; emergency response plan; fire service response; facility design and siting; disposal/decommissioning response; LFP cell physical abuse tolerance.

Consequences [C1, C3–C5, C7–C9]: Cell/module combustion; fire spread beyond containment; off-gassing; explosion/off-gas accumulation; environmental/HAZMAT issues; physical damage to batteries; excessive degradation of batteries.

7.1 BESS Critical Controls Summary

Critical controls (those whose failure alone could lead to a major consequence) are identified from the reference bowtie analysis and are subject to formal verification and ongoing assurance. The critical controls derived from Bowties 1–3 are consolidated in the register below.

Each is assigned a performance requirement and a verification/assurance activity and is to be confirmed and resourced during detailed design and the design HAZOP.

CC ID	Critical Control	Function	Bowtie Ref & Top Event Addressed	Performance Requirement	Verification / Assurance & Owner
CC-01	BYD Battery Management System (BMS)	Prevent	B4 (BT1), B11 (BT2) — cell internal failure & thermal runaway; non-cell thermal	Continuously monitors cell voltage, current, temperature and SOC; alarms and isolates/disconnects affected strings on out-of-tolerance conditions.	FAT/SAT of alarm and trip setpoints; periodic functional testing; alarm/event log review. Owner: OEM / O&M contractor.
CC-02	Cell Quality Control & Manufacturing QA	Prevent	B3 (BT1) — cell internal failure & thermal runaway	Cells from a qualified manufacturer (BYD Blade Battery LFP cells); batch testing and defect screening to UL 1973 / IEC 62619; UL 9540A data available.	Supplier qualification records; certificates of conformance; incoming inspection. Owner: Procurement / OEM.
CC-03	Thermal Management & HVAC (Liquid Cooling, incl. N+1 redundancy)	Prevent	B3, B6, B7 (BT2) — non-cell thermal risks	Maintains cell/enclosure temperature within the OEM operating band via liquid cooling; redundant cooling sustains control on single-unit failure.	Commissioning test; preventative-maintenance schedule; temperature trend monitoring. Owner: O&M contractor.
CC-04	Temperature Monitoring & Alarms	Prevent / Detect	B10 (BT2) — cell & non-cell thermal	Independent temperature sensing with alarm to SCADA / control room at defined thresholds ahead of runaway.	Sensor calibration; alarm response and cause-&-effect testing. Owner: O&M contractor.
CC-05	Smoke, Thermal & Combustible Gas Detection with Fire Alarm Panel	Mitigate / Detect	D1 (BT1–3) — all thermal top events	Detects off-gassing before flaming combustion and initiates the alarm and ventilation sequence (no active suppression installed).	Detector calibration; cause-&-effect test; FACP inspection. Owner: O&M / fire contractor.
CC-06	Vent / Pressure Relief, Deflagration Protection & Exhaust Ventilation	Mitigate	D4, D6 (BT1/BT2) — explosion / accumulation of off-gases	Vent/pressure relief and enclosure ventilation, with deflagration panels sized to prevent overpressure per NFPA 68/69.	Design verification; vent / panel inspection and integrity check. Owner: Designer / O&M contractor.
CC-07	Fire Suppression — Not Installed (Compensating	Mitigate	D3, D5 (BT1) — module/rack fire; fire spread	No active fire suppression system is installed within the BESS containers (confirmed alarm-only configuration). Fire	Confirm design basis and compensating controls (CC-05, CC-06, CC-08) are documented in the

CC ID	Critical Control	Function	Bowtie Ref & Top Event Addressed	Performance Requirement	Verification / Assurance & Owner
	Controls Apply)			events are managed via early detection and alarm (CC-05), vent/pressure relief and deflagration protection (CC-06), and inter-cabinet fire isolation (CC-08), pending fire service response and CFA confirmation of this design basis.	Fire Engineering Report and reviewed by CFA. Owner: Designer / Fire Engineer.
CC-08	Inter-Cabinet Fire Isolation & Heat Insulation Design (unit separation)	Prevent / Mitigate	D8 (BT1–3), B5 — fire spread beyond containment	Inter-unit spacing and rated barriers limit module-to-module and enclosure-to-enclosure propagation; supported by BYD/CSA TS-800 LSFT test data showing adjacent cabinet temperatures remained below 60°C during a simulated 1000°C internal fire.	UL 9540A test-data review; as-built separation survey. Owner: Designer.
CC-09	Facility Design & Siting (separation distances)	Prevent / Mitigate	D10 (BT1–3) — all consequences; external impact	Separation to site boundary, adjacent assets and sensitive receptors per AS / NFPA 855 and PHA findings.	Design review against PHA separation criteria; as-built survey. Owner: Designer / Proponent.
CC-10	Emergency Response Plan & Fire Service Liaison	Mitigate	D7 (BT1–3) — escalation / off-site impact	Site-specific BESS ERP; pre-incident plan shared with CFA / FRV; tactical water supply available.	ERP endorsement; joint exercise / drill; pre-incident plan review. Owner: Operator / Proponent.
CC-11	Preventative Maintenance & Electrical Integrity	Prevent	B9 (BT2), B31–B32 (BT3) — electrical hotspot; non-cell fire	Scheduled inspection of connections, thermographic survey and torque verification of electrical terminations.	PM completion records; infrared (IR) scan reports. Owner: O&M contractor.
CC-12	Structural / Container Resiliency & Physical Protection	Prevent	B29–B30 (BT3) — physical impact; water damage; external fire	Enclosures rated IP55 for environmental ingress protection, flood immunity, impact and bushfire (BAL) exposure at the site.	Design certification; site inspection. Owner: Designer.

8.0 Preliminary Facility Fire Safety Evaluation

In accordance with CFA and WorkSafe advice/ clarifications issued to ANZA, a preliminary fire safety evaluation has been performed against section 4 of the CFA Design Guidelines and Model Requirements for Renewable Energy Facilities v4.4.

Several design requirements are committed to with further demonstration to be supported in Detailed Design packages. In addition, specific requirements relating to Facility Construction and Commissioning (section 5) and Facility operations and maintenance (section 6) will be captured in later assessments and management plans.

It is recommended that these items are further considered in the Fire Safety Study and installation confirmed/ evidence demonstrated during commissioning Inspection and Test Plans.

Legend: Y = Yes / Compliant | N = No / Not compliant | NA = Not Applicable | TBC = To Be Confirmed

SECTION 4 — FACILITY LOCATION AND DESIGN

Ref.	Requirement	Comply (Y / N / NA)	Notes / Evidence
4.1 Facility Location — Low-Risk Siting			
4.1	BESS sited in low-risk location where Bushfire Management Overlay (BMO) and Land Subject to Inundation Overlay (LSIO) do not apply.	Y	Site is outside BMOLSIO
4.1	Risk Management Plan (RMP) informs siting of battery energy storage systems.	TBC	Confirm RMP addresses siting rationale.
4.1.1 High-Risk Environments (if applicable)			
4.1.1a	Assessment against VPP Clause 13.02-1S (Bushfire Planning) where facility is in a Bushfire Prone Area (BPA).	TBC	Provide bushfire hazard site and landscape assessment. Preliminary bushfire risk discussion provided; formal bushfire hazard assessment to be confirmed/provided separately.
4.1.1b	Impact of any ignitions from infrastructure on nearby communities, infrastructure and assets assessed.	Y	Carried forward offsite impact consequence assessment
4.1.1c	Impact of bushfire on the infrastructure (ember attack, radiant heat, flame contact) assessed.	Y	Assessed in Section 5.10 — low bushfire risk setting; ember travel, radiant heat and LFP resistance to external heat-induced thermal runaway considered.
4.1.1d	Assessment of whether proposal increases risk to adjacent land and how risks on site are reduced to acceptable level.	Y	Addressed in Sections 4.5 and 4.11 — remote siting and complementary bushfire resilience measures maintain acceptable risk to/from BESS.

4.2.1 Emergency Vehicle (Fire Truck) Access

4.2.1a	Minimum 4 m perimeter road constructed within the perimeter fire break.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1b	Roads all-weather construction capable of accommodating 15-tonne vehicle (no compacted earth).	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1c	Constructed roads ≥ 4 m trafficable width with 4 m vertical clearance. Fencing allows width of fire vehicles.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1d	Average grade ≤ 1:7 (14.4% / 8.1°); maximum 1:5 (20% / 11.3°) for no more than 50 m.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1e	Dips no more than 1:8 (12.5% / 7.1°) entry and exit angle.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1f	Passing bays ≥ 20 m long × ≥ 6 m wide incorporated at least every 600 m. At least one bay where road < 600 m.	TBC	To be confirmed at detailed design (civil/roads design).
4.2.1g	Road network enables access to all areas of facility — fire service infrastructure, buildings, BESS, substations, grid connections.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1h	At least two (2) access points provided into each section where BESS is located. Number and location determined in consultation with CFA.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.1	Turning areas (court-bowl 8 m radius or T-head) provided where dead-end roads exceed 60 m from hardstand.	Y	Ring Road. To be further confirmed at detailed design (civil/roads design).

4.2.2 Firefighting Water Supply — General Requirements

4.2.2a	Water access points clearly identifiable and unobstructed.	Y	To be further confirmed at detailed design (fire water infrastructure).
4.2.2b	Static water tank installations comply with AS 2419.1-2021 Fire hydrant installations.	Y	To be further confirmed at detailed design (fire water infrastructure).
4.2.2c	Static water tanks are above-ground, constructed of concrete or steel.	Y	To be further confirmed at detailed design (fire water infrastructure).
4.2.2d	Tanks capable of being completely refilled automatically or manually within 24 hours.	TBC	To be confirmed at detailed design (fire water infrastructure).
4.2.2e	Tanks located at vehicle access points, positioned ≥ 10 m from all infrastructure.	TBC	To be confirmed at detailed design (fire water infrastructure).
4.2.2f	Hard-suction point provided with 150 mm full-bore isolation valve with Storz connection; Storz tree adapters	TBC	To be confirmed at detailed design (fire water infrastructure).

	(125/100/90/75/65 mm) and blank end cap provided.		
4.2.2g	Hard-suction point within 4 m of a hardstand area with clear personnel access.	TBC	To be confirmed at detailed design (fire water infrastructure).
4.2.2h	All-weather road and hardstand (≥ 15 t GVM, ≥ 8 m long × ≥ 6 m wide) provided to hard-suction point.	Y	To be further confirmed at detailed design (civil/roads design).
4.2.2i	Road access and hardstand kept clear at all times.	Y	O&M control
4.2.2j	Hard-suction point protected from mechanical damage (e.g. bollards) where necessary.	TBC	To be confirmed at detailed design (fire water infrastructure).
4.2.2k	8 m radius turning circle provided at tank where access road has one entrance.	NA	
4.2.2l	External water level indicator provided, visible from hardstand.	TBC	To be further confirmed at detailed design (fire water infrastructure).
4.2.2m	'FIRE WATER' signage and tank capacity fixed to each tank (per AS 2419.1-2021 Cl. 11.3.6).	TBC	To be further confirmed at detailed design (fire water infrastructure).
4.2.2n	Directional signage at each vehicle entrance indicating direction to nearest static tank.	TBC	To be further confirmed at detailed design (fire water infrastructure).
4.2.2 Firefighting Water Supply — Centralised BESS (no reticulated water)			
4.2.2(1b-i)	Static fire water supply ≥ 288,000 L, or as per AS 2419.1-2021 Table 2.2.5(D) for Open Yards flowing ≥ 4 hours at 20 L/s — whichever is greater.	Y	4x140kl proposed
4.2.2(1b-ii)	Quantity of static fire water storage calculated from number of hydrants required per AS 2419.1-2021 Table 2.2.5(D).	TBC	To be confirmed at detailed design (fire water supply sizing).
4.2.2(1b-iii)	Fire hydrants located so every part of BESS is within reach of 10 m hose stream from nozzle at end of 60 m hose.	TBC	To be confirmed at detailed design (fire water supply sizing).
4.2.2(1b-iv)	Fire water supply located at vehicle entrances, ≥ 10 m from all infrastructure.	TBC	To be confirmed at detailed design (fire water supply sizing).
4.2.2(1b-v)	Fire water supply adjacent to BESS and accessible without undue danger (tanks closer to entrance than BESS).	TBC	To be confirmed at detailed design (fire water supply sizing).
4.2.2(1b-vi)	Fire water supply complies with AS 2419.1-2021 Section 5: Water storage tanks.	TBC	To be confirmed at detailed design (fire water supply sizing).

4.2.3 Fire Detection and Suppression Equipment			
4.2.3a	Fire detection and suppression for on-site buildings per National Construction Code (NCC).	Y	To be confirmed at detailed design (building fire protection).
4.2.3b	Fire protection for dangerous goods storages per relevant Australian Standards.	TBC	Refer to Section 4.4.3 Fire Protection Quantities; specific provisions to be confirmed against applicable Australian Standards.
4.2.3c	Minimum two (2) suitable fire extinguishers within 3–20 m of each PCU (Power Conversion Unit).	TBC	To be confirmed at detailed design.
4.2.3d	All vehicles/heavy equipment carry ≥ 9 L water stored-pressure extinguisher (≥ 3A rating) when on-site during Fire Danger Period.	TBC	Operational requirement — to be incorporated into O&M procedures/SMS.
4.2.4 & 4.2.5 Vegetation, Landscape Screening and Fire Breaks			
4.2.5a	10 m minimum fire break established and maintained around perimeter of facility (from boundary or from vegetation screening inside property boundary).	TBC	Vegetation Management Plan/APZ commitment noted; specific firebreak dimensions to be confirmed at detailed design.
4.2.5b	10 m minimum fire break established around control rooms, electricity compounds, substations and all buildings on-site.	TBC	Vegetation Management Plan/APZ commitment noted; specific firebreak dimensions to be confirmed at detailed design.
4.2.5	Fire break width verified at least the distance at which radiant heat from fully involved vegetation does not create ignition potential on-site infrastructure.	TBC	To be confirmed via fire radiant heat modelling at detailed design.
4.2.5 BESS	Fire break established and maintained around BESS and related infrastructure (≥ 10 m minimum width or greater per RMP).	TBC	Vegetation Management Plan/APZ commitment noted; specific firebreak dimensions to be confirmed at detailed design.
4.2.5 BESS	Width of fire breaks between vegetation and BESS accounts for radiant heat output from BESS fully involved in fire — must not create ignition potential for vegetation.	TBC	BESS fire likelihood assessed as low and not carried forward for quantitative modelling; radiant-heat-based firebreak sizing not yet performed — recommend confirming at detailed design if required by CFA.
4.2.5	Fire breaks non-combustible (concrete, mineral earth, or non-combustible mulch such as crushed rock). Free of vegetation and obstructions at all times.	TBC	To be confirmed at detailed design.
4.2.6 (BESS) Design-Specific Requirements — Battery Energy Storage Systems			
4.2.6(1a)	Separation distance between battery containers/enclosures and other containers, on-site buildings,	TBC	Separation to be determined via fire radiant heat flux analysis. Quantitative radiant heat flux analysis not yet

	substations, site boundary, and vegetation — at least the distance at which radiant heat from BESS fully involved in fire does not create ignition potential.		performed for BESS containers (fire risk screened out qualitatively); separation currently based on manufacturer minimum clearances Recommend confirming against CFA requirement at detailed design.
4.2.6(1b)	Fire break ≥ 10 m around BESS and related infrastructure (non-combustible construction).	TBC	To be confirmed at detailed design.
4.2.6(1c-i)	Site layout considers safety of emergency responders.	Y	Addressed in site layout and (all-weather access roads, defensible space).
4.2.6(1c-ii)	Site layout minimises potential for grassfire/bushfire to impact BESS.	Y	Addressed in APZ, managed fuel loads, perimeter defensible space.
4.2.6(1c-iii)	Site layout minimises potential for BESS fire to impact on-site and off-site infrastructure.	Y	Addressed in— separation distances and containment design limiting escalation potential.
4.2.6(2a)	BESS located reasonably adjacent to site vehicle entrance suitable for emergency vehicles.	NA	BESS and Entry site layout allows access for emergency vehicles.
4.2.6(2b)	Site entrance and firewater tanks not aligned to prevailing wind direction (to avoid smoke impact on access during BESS fire).	TBC	Final layout to be confirmed at detailed design (site layout). Current layout may require change to fire tank location so not downwind of BESS.
4.2.6(2c)	In-built fire and gas detection systems provided in BESS containers.	Y	Confirmed — BYD MC Cube in-built smoke, thermal and combustible gas detection with Fire Alarm Panel
4.2.6(2d)	Explosion prevention via sensing and venting, or explosion mitigation via deflagration panels, provided.	Y	Confirmed — vent/pressure relief and deflagration protection
4.2.6(2e)	Suitable ember protection provided to prevent embers penetrating battery containers.	TBC	IP55-rated enclosures provide general environmental ingress protection (CC-12); ember-specific screening not explicitly confirmed — recommend confirming at detailed design.
4.2.6(2f)	Suitable access roads for emergency vehicles to and within site, including to BESS and fire service infrastructure.	Y	To be confirmed at detailed design (civil/roads design).
4.2.6(2g)	BESS installed on non-combustible surface (e.g. concrete).	Y	To be confirmed at detailed design (civil/foundation design).
4.2.6(2h)	BESS provided with suitable ventilation.	Y	Confirmed — liquid cooling and exhaust ventilation
4.2.6(2i)	Impact protection ≥ equivalent of W guardrail-type barrier provided to prevent mechanical damage to BESS containers.	TBC	To be confirmed at detailed design.

4.2.6(2j)	Enclosed wiring and buried cabling provided, except where above-ground required for grid connection.	TBC	To be confirmed at detailed design.
4.2.6(2k)	Spill containment provided, including provision for management of fire water runoff.	TBC	Transformer bunding confirmed; dedicated BESS fire water runoff containment not yet confirmed
4.2.6.4 Management of Fire Water Runoff			
4.2.6.4	Infrastructure provided for containment and management of contaminated fire water runoff (bunding, sumps, or impervious retention facility).	TBC	To be confirmed at detailed design — no dedicated fire water containment infrastructure documented in this PHA.
4.2.6.4	Containment and management capacity equivalent to on-site fire protection system volume.	TBC	To be confirmed at detailed design.
4.2.6.4	Containment per AS 4681-2000 Section 7.3.9: Control of run-off.	TBC	To be confirmed at detailed design.
4.3 BESS Safety and Protective Systems (CFA Recommended)			
4.3	Battery management/monitoring systems for monitoring state of battery to ensure safe operation.	Y	BMS and Remote Monitoring
4.3	Systems for detecting smoke, heat, fire, and toxic off-gassing within BESS containers. Off-gas detection single-trigger, covering both lighter and heavier-than-air gases.	Y	Smoke, Heat and Off-Gas detection
4.3	Systems to prevent heat/fire spread within BESS containers (thermal barriers, shutdown separators, isolation systems, cooling systems).	Y	Confirmed — shut-down separator (local/remote), inter-cabinet fire isolation & heat insulation design, liquid cooling (CC-01, CC-03, CC-08).
4.3	Systems to prevent explosion within BESS containers (ventilation, pressure relief, exhaust systems).	Y	Confirmed — vent/pressure relief, deflagration protection & exhaust ventilation (CC-06).
4.3	Systems to prevent water ingress; appropriate IP ratings for containers/cabinets and/or battery modules.	Y	IP55-rated enclosures
4.3	Warning and alarm systems for early notification of faults, off-gassing, smoke, and fire.	Y	Fire Alarm Panel integrated with detection systems

9.0 Consequence Modelling Outputs

Consequence modelling was performed for the hazardous scenarios identified in Section 5.0 that were assessed as having potential for offsite impact. Modelling determines the distances at which impact criteria (thermal radiation, overpressure, toxic concentration) are reached, enabling comparison against HIPAP No. 4 consequence screening thresholds.

The following scenarios were carried forward for consequence modelling based on the hazard identification screening described in Section 5.0:

a) Transformer bund fire (pool fire) – HV transformer (worse case)

b) Transformer explosion (rapid pressure release) – HV transformer

The following scenarios were screened out and were considered to not require consequence modelling:

a) Li-ion battery thermal runaway / container fire – LFP chemistry; no credible offsite fire radiation identified

b) Toxic gas dispersion (CO_2, CO, HF) – source term insufficient for offsite impact/ exceedance

c) Electrical equipment fire – slow growth; contained within switch room

d) EMF – attenuates to background within metres; nearest receptor 500m

e) Bushfire – short-lived; grass fuel load; APZ controls implemented

9.1 Modelling Methodology and Software

Consequence modelling was performed using Gexcon EFFECTS, which is proprietary software which has been developed based upon the TNO Colouring books and validated based upon CFD modelling tests and physical verification experiments. The software can model a range of incidents including pool fires, flash fires, explosions, jet fires, toxic dispersions, warehouse smoke plumes, etc. All modelling was performed in accordance with HIPAP guidance.

Modelling Assumptions and Input Parameters

Parameter	Value / Assumption
Consequence software	Gexcon EFFECTS
Wind speed (u)	5 m/s (fire/explosion)
Ambient temperature	35 °C (conservative)
Relative humidity	50%
Ground roughness	0.01 m (flat open rural terrain)
Terrain	Flat; conservative (no terrain shielding assumed)
Transformer oil type	Linoleic acid; conservative assumption for Ester Oil (FR3 or similar oil has much higher Flash Point)
Transformer oil inventory (HV)	30,000L; full tank volume (assumption)

Transformer oil inventory (MV each)	MV not modelled at PHA stage
Bund area (HV transformer)	10 x 7m; Assumption – to be updated as per detailed design bund dimensions
Bund freeboard / drain assumption	No drain active during incident (conservative)
Surface Emissive Power (SEP); pool fire	62kW/m2; (mineral oil, per conservative clear flame with Effect)
Atmospheric transmissivity	0.8 (conservative)
TNT equivalence; transformer explosion	5% efficiency (conservative)
Gas/vapour inventory in transformer for explosion	26700 kg equivalent hydrocarbon
Ignition probability	1.0 assumed (conservative; worst case)

9.2 Thermal Radiation; Transformer Pool Fire

A transformer oil pool fire was modelled for the HV transformer (worst case; largest oil inventory). The pool fire extends to the limits of an assumed bunded area. Thermal radiation contours (kW/m2;) were calculated as a function of distance from the pool fire centre.

Table 9-1: HIPAP No. 4 Thermal Radiation Consequence Criteria and Model results

Thermal Radiation Level (kW/m2)	Effect	Result – Distance (m)	Exceeded at Boundary
35	• Cellulosic material will pilot ignite within one minute's exposure • Significant chance of fatality for people exposed instantaneously	6	No
23.0	• Likely fatality for extended exposure and chance of fatality for instantaneous exposure • Spontaneous ignition of wood after long exposure • Unprotected steel will reach thermal stress temperatures which can cause failure • Pressure vessel needs to be relieved or failure would occur	10	No

12.6	• Significant chance of fatality for extended exposure. High chance of injury • Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure • Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure	12	No
4.7	• Will cause pain in 15-20 seconds and injury after 30 seconds' exposure (at least second-degree burns will occur)	13	No
2.1	• Minimum to cause pain after 1 minute	17	No

Transformer Pool Fire Thermal Impact

9.3 Explosion Overpressure; Transformer Failure

A transformer explosion was modelled for the HV transformer assuming rapid oil vaporisation, gas accumulation and ignition following loss of containment.

This could include an extreme electricity surge (e.g. lightning strike, the ester oil within the transformer may ignite and explode resulting in overpressure impacts. A confined vapour cloud explosion using TNT equivalence is modelled.

The following data has been obtained to model a transformer explosion:

• W 26,700 kg (based on the 30,000 L of oil contained within a single transformer and an oil density of 890 kg/m3)

• α 0.05 for hydrocarbons

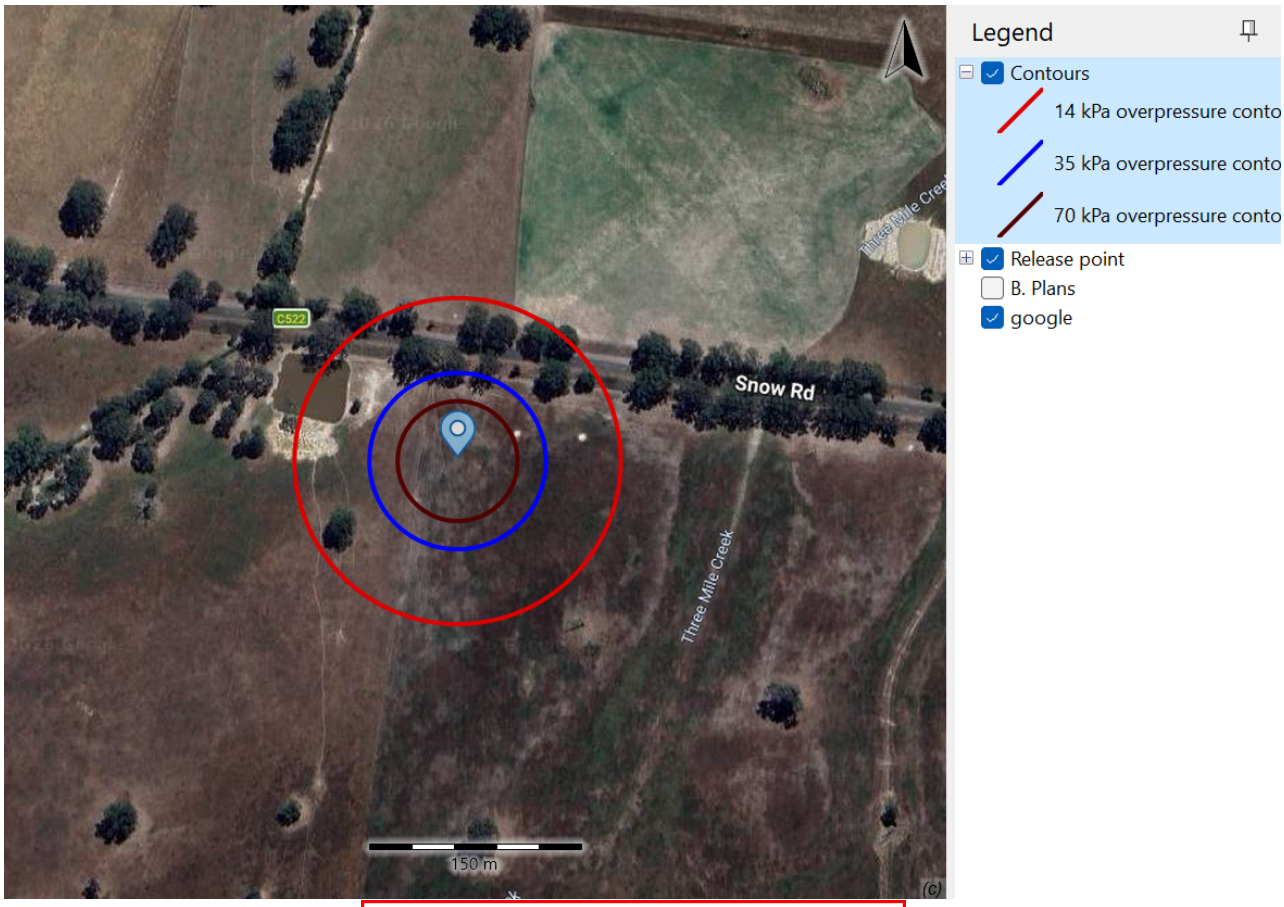
The above inputs into GexCon Effects with the results of the explosion calculations provided below

Table 9-2: HIPAP No. 4 Explosion Overpressure Consequence Criteria and Model Result

Overpressure (kPa)	Effect	Result – Distance (m)	Exceeded at Boundary
70	• Threshold of lung damage • 100% chance of fatality for a person in a building or in the open • Complete demolition of houses	42	No
35	• House uninhabitable • Wagons and plants items overturned • Threshold of eardrum damage • 50% chance of fatality for a person in a building and 1 5% chance of fatality for a person in the open	62	No
21	• Reinforced structures distort • Storage tanks fail • 20% chance of fatality to a person in a building	86	Yes – No offsite structures or sensitive receptors
14	• House uninhabitable and badly cracked	115	Yes – No offsite structures or sensitive receptors
7	• Damage to internal partitions and joinery but can be repaired • Probability of injury is 10%. No fatality	197	Yes – No offsite structures or sensitive receptors
3.5	• 90% glass breakage	334	Yes – No offsite structures or

	• No fatality and very low probability of injury		sensitive receptors

Transformer Explosion Impact Contours



10.0 Qualitative Risk Assessment Summary

Risk Assessment Outcomes

The following table summarises the risk assessment outcomes for all identified hazard scenarios. Scenarios screened out as having no credible offsite consequence are noted. Scenarios carried forward are assessed against HIPAP No. 4 criteria.

Scenario	Assessment Approach	Consequence (with controls)	Likelihood	Risk Level
Li-ion battery thermal runaway – LFP	Qualitative (Level 1) – screened out	Onsite only	Unlikely	LOW
Fire propagation between containers	Qualitative – screened post-VBB review	Onsite only	Remote	LOW
Toxic gas dispersion (CO_2, CO, HF)	Qualitative – screened out (Quant modelled of HF)	Onsite only	Remote	LOW
Electrical equipment / switch room fire	Qualitative – screened out	Onsite only	Remote	LOW
Transformer bund fire	Quantitative consequence analysis	[See modelling]	Highly Unlikely	LOW
Transformer explosion (surge)	Quantitative consequence analysis	[See modelling]	Highly Unlikely	MEDIUM
EMF impacts	Qualitative – screened out	Onsite only	Remote	LOW
External / bushfire impact	Qualitative – screened out	Negligible	Remote	LOW

A preliminary BESS H&S risk assessment is considered in Appendix B.

It is recommended that health and safety risk assessment of onsite risks is further assessed and considered in the O&M Health and Safety Management Plan and supporting site specific risk assessments and safe systems of work.

11.0 Conclusions and Recommendations

A hazard identification process was performed for the proposed Laceby BESS to identify potential hazards associated with operations and materials storage. Based on identified hazards, scenarios with potential for offsite impacts were advanced and assessed.

Advanced scenarios were assessed qualitatively. Any scenarios without credible offsite impact were eliminated from further assessment. Incidents carried forward for more detailed analysis produced no observed offsite impacts exceeding HIPAP No. 4 criteria for thermal radiation. However, for explosion overpressure the 7kPa boundary was exceeded. It is recommended that frequency analysis is considered in later design stages and confirmed assumptions in the final hazard analysis.

Based on the analysis in this report, the project is classified as potentially hazardous and would be permissible within the current land zoning for the site, subject to the implementation of the recommendations below.

11.1 Recommendations

Ref.	Recommendation	Responsibility	Timing
R1	BESS must be designed, supplied and tested in accordance with UL9540A and manufacturer recommendations, including clearances.	Proponent / Contractor	Procurement/ Construction
R2	BESS to be installed with fire protection systems specified by the manufacturer and UL9540A report.	Contractor	Construction
R3	UL testing information to be made available to any certifying authority. A confidentiality agreement may be required.	Proponent	Pre-approval
R4	Vent covers of BESS units to be constructed of non-combustible material (metal mesh / sheet).	Proponent / Contractor	Detailed Design
R5	Where practicable, vents must not be located directly above battery packs within the BESS container.	Proponent / Contractor	Detailed Design
R6	All transformers to be bunded to contain oil releases. Transformers may be self-bunded on a skid; otherwise a dedicated concrete bund is required.	Proponent / Designer	Detailed Design
R7	Undertake a detailed HAZOP and safety in design review for the selected equipment with specific attention on thermal runaway detection, control and containment.	Proponent / Contractor	Detailed Design
R8	Consult with relevant authorities and determine if a fire safety study is required to ensure site infrastructure and emergency response capability satisfy operational requirements.	Proponent	Detailed Design
R9	Confirm detail design and ensure compliance to CFA Design Guidelines and Model Requirements for Renewable Energy Facilities v4.4	Proponent	Detailed Design
R10	Implement a design and operating principle that assumes a thermal runaway event can occur during the asset lifetime.	Proponent / Designer	Detailed Design

R11	Implement a robust quality plan and inspections throughout the supply chain and during construction, including factory and site acceptance testing to prevent installation of defective units.	Contractor	Construction
R12	Develop and implement an asset management plan in line with OEM recommendations and good industry practice.	Proponent	Prior to Operation
R13	Make provisions for training and education of operations staff and emergency response services (BESS technology, incident response, site familiarisation).	Proponent	Prior to Operation
R14	Implement an asset protection zone (APZ) (to be determined) around the BESS compound and maintain a vegetation management plan to limit combustible fuel loads.	Proponent	Construction / Operation
R15	Further consider frequency analysis for explosion overpressure is considered in later design stages/ confirmed assumptions in the final hazard analysis.	Proponent	Detailed Design
R16	Formally document and confirm implementation of a safety management system (SMS) and site-specific O&M Health Safety Management Plan prior to commissioning and operations.	Proponent	Prior to Operation

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Appendix A – Summary of Offsite Hazards

Area / Operation	Hazard	Cause	Consequence	Safeguards
Battery Storage	Failure of Li-ion battery protection systems; thermal runaway	Manufacturing defect; mechanical damage; overcharge / overdischarge; cooling system failure; water ingress	Thermal runaway → fire or explosion; incident propagation between cells; toxic smoke (CO_2, CO, HF) dispersion	BMS monitoring & shutdown; overcharge/discharge protection; UL9540A testing; smoke/thermal/gas detection; pressure relief vents; blast panels; HVAC; IP55 enclosure
Battery Storage	Fire propagation from one BESS container to adjacent containers	Radiant heat from burning container; wind-driven flame/ember contact; vent cover failure (VBB lesson)	Multi-container fire; increased combustion byproducts and smoke plume	Manufacturer separation clearances; UL9540A fire propagation testing; non-combustible vent covers; metallic vent mesh; no flammable materials above battery packs; APZ around compound
Battery Storage	Toxic gas dispersion (CO, CO_2, HF, PF_5)	Li-ion battery fire; electrolyte decomposition ($LiPF_6$); incomplete combustion	Toxic gas cloud with potential offsite impact (IHP IDLH 30 ppm; CO IDLH 1,200 ppm)	LFP chemistry minimises gas generation; contained fire reduces source term; large separation to offsite receptors; emergency response plan; gas monitoring
Switch Room / Control Building	Electrical equipment failure and fire	Arcing; overheating; short circuit; insulation failure in switchgear, servers or UPS	Fire within switch room; smoke damage to control systems	Design per AS/NZS 3000:2018; fire detection and suppression in switch rooms; isolation from adjacent BESS containers; slow fire development (smouldering); routine maintenance
Transformers (HV & MV)	Internal arcing; oil vaporisation; reservoir rupture; bund fire	Low oil level; dielectric failure; surge; contamination; ageing	Transformer oil pool fire within bund; heat radiation to surroundings	Self-bunded transformer skid or concrete bund; separation from combustible materials; Buchholz relay; pressure relief devices; surge protection; routine oil quality testing
Transformers (HV & MV)	Transformer explosion (oil-gas ignition)	Extreme electrical surge (lightning); surge protection failure; oil deterioration; water ingress	Explosion; significant overpressure; fire; structural damage	Lightning protection system; surge protection devices; Buchholz relay; Rapid Pressure Rise Relay (RPRR); oil conservator system; regular dielectric testing; no ignition sources adjacent

Electrical Infrastructure (all)	EMF exposure to public / workers	ELF EMF from transformers, inverters, transmission lines, cables	Potential health effects if ICNIRP exposure limits exceeded	Separation distances (~500 m to nearest sensitive receptor); rapid EMF attenuation with distance; equipment shielding; occupational exposure managed via safe work systems
Site-wide	Bushfire / external fire impact on BESS	Ember attack; radiant heat from grass/scrub fire; arson	Ignition of vegetation within site APZ; radiant heat impact to BESS containers	Vegetation management plan / APZ; non-combustible ground cover within BESS compound; IP55 container rating; fire detection; site fence / security
Site-wide (Operations)	Incident / injury to emergency services personnel	Explosion; contact with live electrical components; fire; toxic gas; smoke inhalation	Injury or fatality to first responders	Remote monitoring and shutdown capability; fire safety study with the CFA (Country Fire Authority, Victoria); Emergency Response Plan; staff training; site signage and hazard information for emergency services

Appendix B – Preliminary Risk Register

This preliminary risk register consolidates the risk assessment scenarios (Section 10) with the onsite Health & Safety risk scenarios not carried forward for offsite consequence modelling, cross-referenced to the Critical Controls Summary (Section 7.1). Target consequence, likelihood and risk levels reflect the controls described in the Safeguards / Controls column.

Ref.	Risk Area	Hazard / Risk Issue	Causes	Consequence (Description)	Safeguards / Controls (incl. Critical Controls, s7.1)	Consequence Type (Onsite / Offsite)	Consequence (Target)	Likelihood (Target)	Risk Level (Target)
L1	Battery Storage	Failure of Li-ion battery protection systems resulting in BESS thermal runaway	Manufacturing defect; mechanical damage; overcharge / overdischarge; cooling system failure; water ingress.	Thermal runaway → fire or explosion; incident propagation between cells; toxic smoke (CO2, CO, HF) dispersion.	BMS monitoring & shutdown; overcharge/discharge protection; UL 9540A testing; Design/ install per AS/NZS 3000 and AS/NZS 5139, smoke/thermal/gas detection; pressure relief vents; blast panels; HVAC (liquid cooling); IP55 enclosure. Note: no active fire suppression installed – alarm/detection-only configuration with compensating controls (see CC-07). Critical controls: CC-01, CC-02, CC-03, CC-04, CC-05, CC-06.	Onsite	Minor	Unlikely	LOW
L2	Battery Storage	Fire propagation from one BESS container to adjacent containers	Radiant heat from burning container; wind-driven flame/ember contact; vent cover failure (Victorian Big Battery lesson).	Multi-container fire; increased combustion byproducts and smoke plume.	Manufacturer separation clearances (3,500 mm side-to-side / 600 mm end-to-end); UL 9540A fire propagation testing; non-combustible vent covers; metallic vent mesh; no flammable materials above battery packs; APZ around compound. Critical controls: CC-05, CC-07 (suppression gap documented – compensating controls apply), CC-08, CC-09.	Onsite	Insignificant	Remote	LOW
L3	Battery Storage	Toxic gas dispersion	Li-ion battery fire; electrolyte	Toxic gas cloud with	LFP chemistry minimises gas generation; contained fire reduces	Onsite	Insignificant	Remote	LOW

Ref.	Risk Area	Hazard / Risk Issue	Causes	Consequence (Description)	Safeguards / Controls (incl. Critical Controls, s7.1)	Consequence Type (Onsite / Offsite)	Consequence (Target)	Likelihood (Target)	Risk Level (Target)
		(CO, CO_2, HF, PF_5)	decomposition ($LiPF_6$); incomplete combustion.	potential offsite impact (HF IDLH 30 ppm; CO IDLH 1,200 ppm); assessed against ERPG levels.	source term; large separation to offsite receptors; Emergency Response Plan; gas monitoring. Critical controls: CC-05, CC-06, CC-10.				
L4	Switch Room / Control Building	Electrical equipment failure and fire	Arcing; overheating; short circuit; insulation failure in switchgear, servers or UPS.	Fire within switch room; smoke damage to control systems.	Design and install per AS/NZS 3000:2018; fire detection and suppression in switch rooms (separate from BESS containers); isolation from adjacent BESS containers; slow fire development (smouldering); routine maintenance. Critical controls: CC-10, CC-11.	Onsite	Insignificant	Remote	LOW
L5	Transformers (HV & MV)	Internal arcing; oil vaporisation; reservoir rupture; bund fire	Low oil level; dielectric failure; surge; contamination; ageing.	Transformer oil pool fire within bund; heat radiation to surroundings.	Self-bunded transformer skid or concrete bund; separation from combustible materials; Buchholz relay; pressure relief devices; surge protection; routine oil quality testing. Critical controls: CC-09, CC-10, CC-11.	Offsite	Minor	Highly Unlikely	LOW
L6	Transformers (HV & MV)	Transformer explosion (oil-gas ignition)	Extreme electrical surge (lightning); surge protection failure; oil deterioration; water ingress.	Explosion; significant overpressure; fire; structural damage.	Lightning protection system; surge protection devices; Buchholz relay; Rapid Pressure Rise Relay (RPRR); oil conservator system; regular dielectric testing; no ignition sources adjacent. Critical controls: CC-09, CC-10, CC-11.	Offsite	Major	Highly Unlikely	MEDIUM

Ref.	Risk Area	Hazard / Risk Issue	Causes	Consequence (Description)	Safeguards / Controls (incl. Critical Controls, s7.1)	Consequence Type (Onsite / Offsite)	Consequence (Target)	Likelihood (Target)	Risk Level (Target)
L7	Electrical Infrastructure (all)	EMF exposure to public / workers	ELF EMF from transformers, inverters, transmission lines, cables.	Potential health effects if ICNIRP exposure limits exceeded.	Separation distances (>1 km to nearest residence); rapid EMF attenuation with distance; equipment shielding; occupational exposure managed via safe work systems. Critical controls: CC-09.	Onsite	Insignificant	Remote	LOW
L8	Site-wide	Bushfire / external fire impact on BESS	Ember attack; radiant heat from grass/scrub fire; arson.	Ignition of vegetation within site APZ; radiant heat impact to BESS containers.	Vegetation management plan / APZ; non-combustible ground cover within BESS compound; IP55 container rating; fire detection; site fence / security. Critical controls: CC-09, CC-10, CC-12.	Onsite	Insignificant	Remote	LOW
L9	Site-wide (Operations)	Incident / injury to emergency services personnel	Explosion; contact with live electrical components; fire; toxic gas; smoke inhalation.	Serious injury / illness to first responders.	Remote monitoring and shutdown capability; fire safety study in consultation with CFA; Emergency Response Plan; staff training; site signage and hazard information for emergency services. Critical controls: CC-05, CC-10.	Onsite	Major	Unlikely	MEDIUM
L10	Onsite Electrical Safety	Exposure to voltage (electrocution) – battery system, PCS, transformers, grid connection	Short circuit / electrical connection failure; faulty equipment; incorrect installation or maintenance; human error during maintenance; safety device/circuit compromised; battery casing/enclosure damage; earth potential rise (step and touch potentials).	Electric shock, injury and/or fatality to onsite workers	Equipment designed and tested to relevant Australian/international standards; Decisive Voltage Classification (DVC) followed and equipment marked; electrical switch-in/switch-out protocols; BESS fault detection and safety shut-off; earthing study and earthing per manufacturer and standards; warning signage; perimeter fence and restricted site access; trained personnel; Emergency Response Plan; PPE	Onsite	Major	Unlikely	MEDIUM

Ref.	Risk Area	Hazard / Risk Issue	Causes	Consequence (Description)	Safeguards / Controls (incl. Critical Controls, s7.1)	Consequence Type (Onsite / Offsite)	Consequence (Target)	Likelihood (Target)	Risk Level (Target)
					and rescue kits (e.g. insulated hooks). Critical controls: CC-10, CC-11.				
L11	Onsite Electrical Safety	Arc flash – battery system, PCS, transformers, grid connection	Asset integrity, incorrect procedure during installation/maintenance; disobeying instruction/operation manual; faulty equipment (e.g. conductor corrosion); faulty design; human error during maintenance; insufficient isolation/insulation for applied voltage; mechanical damage; vibration.	Arc blast/ explosion; burns and serious injury to workers; equipment damage; potential ignition source.	Equipment designed and tested to relevant standards (e.g. AS 2067); arc flash boundary warning signs; high-voltage site induction and training; reputable contractors with independent owner's engineer endorsement; isolation and permit-to-work procedures; arc-rated PPE. Critical controls: CC-10, CC-11.	Onsite	Major	Unlikely	MEDIUM