D.4 Updated Hazards and Risk Assessment (HRA)

Hazard and Risk Assessment

Panorama Battery Energy Storage System (BESS) – SSD 50587460

Panorama BESS SubCo Pty Ltd

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Prepared by:

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SLR Project No.: 660.30234.00007

Revision: R06-v1.9

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
R06-v1.9	23 January 2026	Dr Peter Georgiou	Dr Craig Simpson	Dr Peter Georgiou
R06-v1.8	20 January 2026	Dr Peter Georgiou	Dr Craig Simpson	Dr Peter Georgiou
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R06-v1.0	22 June 2023	Dr Peter Georgiou	Dr Craig Simpson	Dr Peter Georgiou

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Panorama BESS SubCo Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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Acronyms and Abbreviations

ADG	Australian Dangerous Goods (colloquial), as in the ADG Code: Commonwealth Government, National Transport Commission, *"Australian Code for the Transport of Dangerous Goods by Road and Rail"*, Edition 7.9, 2024
ALARP	As Low as Reasonably Practical
APZP	Asset Protection Zone
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
BESS	Battery Energy Storage System
BMS	Battery Management System
DoP	NSW Department of Planning (part of the NSW Department of Planning, Housing and Infrastructure)
EIS	Environmental Impact Statement
HIPAP	Hazardous Industry Planning Advisory Paper
HRA	Hazard and Risk Assessment
ICNIRP	International Commission on Non-Ionizing Radiation Protection
MLRA	Multi-Level Risk Assessment
PHA	Preliminary Hazard Analysis
PRS	Preliminary Risk Screening
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy, eg Resilience and Hazards SEPP
SLR	SLR Consulting Australia Pty Ltd
SSD	State Significant Development

Units

ha	Hectare (= 10,000 m^2)
kL	Kilolitre (= 1,000 litres)
km	Kilometre (= 1,000 metres)
kV	Kilovolt (= 1,000 volts)
kVA	Kilovolt-Amp
kW	Kilowatt (= 1,000 volts)
m	Metre
MW	Megawatt (= 1,000,000 watts)
MWh	Megawatt-hour

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Panorama BESS SubCo Pty Ltd (the Applicant) to undertake an updated Hazard & Risk Assessment (HRA) for proposed amendments to the Panorama Battery Energy Storage System (BESS) and associated infrastructure Project – SSD-50587460 - to be located at 800 Mid Western Highway (Lot 2 DP 864272) and 749 Mid Western Highway (Lot 521 DP 603541), Evans Plains, NSW.

The BESS component of the Project will be located adjacent to the existing 132 kV Transgrid electricity substation near Bathurst NSW.

A Hazard and Risk Assessment was previously prepared by SLR supporting the Project as exhibited in the Environmental Impact Statement (EIS).

- SLR Report 660.30234-R06-v1.0, *"Hazard and Risk Assessment, Panorama BESS, SSD-50587460"*, 20 March 2023.

The Project is deemed to be State Significant Development (SSD).

Accordingly, SLR's 2023 Hazard and Risk Assessment addressed the Secretary's Environmental Assessment Requirements (SEARs), as per SSD-50587460, dated 9 December 2022.

Specifically, SLR's 2023 Hazard and Risk Assessment addressed the following "Key Issues":

Hazards – including:

- A preliminary risk screening completed in accordance with *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development and Applying SEPP 33* (DoP, 2011);
- A Preliminary Hazard Analysis (PHA) must be prepared in accordance with the *Hazardous Industry Planning Advisory Paper No. 6, "Hazard Analysis" and Multi-Level Risk Assessment* (DoP, 2011). The PHA must consider all recent standards and codes and verify separation distances to on-site and off-site receptors to prevent fire propagation and compliance with *Hazardous Industry Advisory Paper No. 4, "Risk Criteria for Land Use Safety Planning* (DoP, 2011); and
- An assessment of potential hazards and risk including but not limited to bushfires, land contamination, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure against the *International Commission on Non-Ionizing Radiation Protection* (ICNIRP) *Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields.*

1.1 Amendments to the Project

Since the Project was exhibited in the EIS, the Applicant has made changes to the specification and design of the BESS, accompanied by amendment reports.

1.1.1 May 2025 (First) Amendment Report

BESS System

- A change in technology of the battery energy storage was proposed from the SolBank 2.0 system to the SolBank 3.0 system.
- This change takes advantage of the improvements in battery energy storage technology since the submission of the EIS:
  - The SolBank 3.0 system offers an increased capacity and enhanced energy density per battery container while reducing the BESS layout footprint by approximately 20% or 0.35 ha.

Site Layout

- The total area of the Development Footprint identified during the EIS process was 3.47 ha.
- Since the submission of the EIS, detailed civil engineering optimisation has taken place recommending that the location and orientation of the development footprint should move to the west by approximately 40 m. To accommodate this change, benching of the BESS would require additional civil battering to improve the safety and landform stability of the Project.
- As a result, the amended Development Footprint would be approximately 5.18 ha.
- Finally, and in response to submissions received, the Applicant has also undertaken an additional visual impact assessment and is proposing to install a visual screen to be added to the perimeter of the BESS Facility. The following screening has been proposed:
  - 3.0 m high perforated metal screen panels along the part northern, western and southern perimeter of the BESS Facility;
  - 0.1 m stainless steel square posts and stainless steel base plates; and
  - The panels and posts coloured “Evergreen” or similar.

This first Amendment Report and associated Submissions Report were prepared in May 2025 – refer:

- NGH. 2025a. Amendment Report – Panorama BESS. Report version Final V1.0 dated 15 May 2025.
- NGH. 2025b. Submissions Report – Panorama BESS. Report version Final V1.0 dated 15 May 2025.

The amendment application was approved by the NSW Department of Planning, Housing and Infrastructure (DPHI) in June 2025 - refer.

- NSW Department of Planning, Housing and Infrastructure (DPHI). 2025. Amendment of Panorama Battery Energy Storage System (SSD-50587460). Letter dated 11 June 2025.

1.1.2 2026 (Second) Amendment Report

The proponent is in the process of preparing a second amendment report to request additional changes to the Project. The request follows consultation with Transgrid, during which it was identified that the existing substation would need to be expanded to allow for connection of the proposed BESS.

To accommodate the substation expansion, the proposed development footprint for the Project will need to increase to facilitate the necessary construction activities. The expansion will see the footprint of the substation grow to the north and west, including an additional substation bay to accommodate the capacity of the proposed BESS.

The key elements of the substation expansion works include:

- Construction of new access roads within the Transgrid perimeter fence (all sides) as well as from the existing access road to the northwest corner of the substation to assist with construction access.
- Upgrade of existing access roads on the eastern, southern and western sides.
- Civil and earth works in preparation of the substation, including leveling of the area north and west of the current bays for the new bay and installation of a retaining wall.
- Construction of underground cabling and associated earthworks from the Project to the Transgrid substation.
- Installation and commissioning of electrical infrastructure and associated equipment for the additional substation bay.
- Undertaking of structural works on the substation for ongoing functionality and security.
- All secondary system upgrades required to connect the Panorama BESS.
- New security fencing.
- Enabling works for the new access tracks as well as laydown areas for the substation expansion.
- A new water pipe and new boundary gutter for water drainage.

This updated HRA responds to the changes outlined in **Section 1.1.2**.

1.2 Structure of Report

The remainder of this HRA report is structured as follows:

- **Section 2** Description of the Proposed BESS with latest amendments
- **Section 3** Preliminary Risk Screening
- **Section 4** Preliminary Hazard Assessment
- **Section 5** Bushfire Risk Assessment, Mitigation and Management
- **Section 6** BESS Hazards and Risk Management
- **Section 7** BESS Incident Case Studies – Lessons Learned
- **Section 8** BESS Fire Toxic Plume Risk
- **Section 9** EMF Hazards and Risk Management

1.3 Regarding NEW Sections of this HRA Responding to the 2026 Amendment Updates

Throughout this updated HRA, sections which deal with NEW or UPDATED assessment are marked with a | vertical BLUE line in the left side margin – as shown next to this paragraph.

1.4 Relevant Regulatory Documents

The HRA has been undertaken according to the following regulatory standards and guidelines (listed by sub-category):

Australian Standards (AS)

- AS/NZS 5139:2019 *Electrical Installations – Safety of Battery Systems for Use with Power Conversion Equipment*.
- *AS1940-2017: The storage and handling of flammable and combustible liquids*.
- AS3780-2023 *The storage and handling of corrosive substances*.
- AS4452-1997: *The storage and handling of toxic substances*.
- AS/NZS 1851: *Maintenance of fire protection equipment*.
- AS/NZS 1850: *Portable fire extinguishers*.
- AS 3439-2002: *Low voltage switchgear and control gear assemblies*.

Commonwealth of Australia

- Commonwealth Government, National Transport Commission, *Australian Code for the Transport of Dangerous Goods by Road and Rail*, Edition 7.9, 2024.

NSW Department of Planning

- NSW Department of Planning, 2011a, (HIPAP 1) Hazardous Industry Planning and Advisory Paper No. 1 – *Emergency Planning*.
- NSW Department of Planning, 2011b, (HIPAP 2) Hazardous Industry Planning and Advisory Paper No. 2 – *Fire Safety Study Guidelines*.
- NSW Department of Planning, 2011c, (HIPAP 4) Hazardous Industry Planning and Advisory Paper No. 4 – *Risk Criteria for Land Use Safety Planning*.
- NSW Department of Planning, 2011d, (HIPAP 6) Hazardous Industry Planning and Advisory Paper No. 6 – *Hazard Analysis*.
- NSW Department of Planning, 2011e, *Multi-Level Risk Assessment*.
- NSW Department of Planning, 2011f, *Applying SEPP 33 - Hazardous and Offensive Development Application Guidelines.*
- NSW State Environmental Planning Policy (*Resilience and Hazards*) 2021 (herein Resilience and Hazards SEPP).
- NSW Government Code of Practice, *Managing Risks of Hazardous Chemicals in the Workplace,* August 2019.
- NSW Government, *Notifications of Schedule 11 Hazardous Chemicals and Abandoned Tanks – Guidance Material*, Safework NSW, WH&S Regulation, 2017.

EMF & EMR

- ARPANSA (Australian Radiation Protection and Nuclear Safety Agency), *Report by the ARPANSA Radiofrequency Expert Panel on Review of Radiofrequency Health Effects Research – Scientific Literature 2000-2012,* ARPANSA Technical Report No 164, 2014.
- ARPANSA (Australian Radiation Protection and Nuclear Safety Agency), *Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz,* Radiation Protection Series S-1 (Rev.1), February 2021.
- ICNIRP (International Commission on Non-Ionizing Radiation Protection) 1998, *Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)*, 2020.
- United States Environmental Protection Agency, 2021. *About Acute Exposure Guideline Levels*.

General Guidance

- ASC/ESC 5000: The Australian Battery Guide, Energy Storage Council, March 2023.
- DNV Report No. OAPUS301WIKO(PP151894, Rev.4), *Considerations for ESS Fire Safety*, prepared for Consolidated Edison and NYSERDA, NY, February 2017.
- Fire Protection Research Foundation, 2016. *Hazard Assessment of Lithium Ion Battery Energy Storage Systems*.
- FM Global, 2020. Property Loss Prevention Data Sheet 5-33, *Electrical Energy Storage Systems*.
- National Fire Protection Association, 2023 - NFPA 855 *Standard for the Installation of Stationary Energy Storage Systems*.
- Underwriters Laboratory, 2017. UL 9540A Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.
- Underwriters Laboratory, 2020. UL 9540 Standard for Safety of Energy Storage Systems and Equipment.
- UK Department for Energy Security & Net Zero - Guidance: Health and Safety in Grid Scale Electrical Energy Storage Systems, April 2024

2.0 Proposed Panorama BESS Development

2.1 Development Site Update

In the context of the amendments to the proposed Panorama BESS facility, i.e. the entire updated Project, reference is made in this updated HRA to:

- The BESS Compound – which remains essentially as previously assessed in the mid-2025 Amendment report.
- The Transgrid (Substation) Compound – which refers to the augmentation of Transgrid's Panorama Substation as described in **Section 1.1.2**.

2.1.1 HRA Aspects Unchanged from Approved (First Amendment) Project

Features of the development relevant to this HRA which have not changed since the June 2025 DPHI Approval include the following:

- The BESS compound would still be located immediately to the south-southwest of Transgrid's Panorama substation, located just under 1 km from the outskirts of Robin Hill.
- The BESS compound would retain the previously approved footprint, as well as key physical features, including the perimeter fence, perimeter vegetation, etc.
- The BESS compound would still be served by the same private access road (off Mid-Western Highway) as the substation.
- The BESS itself would comprise the same configuration of Solbank 3.0 BESS units and their inverters, BESS compound transformer, etc.

2.1.2 HRA Aspects Changed from Approved (First Amendment) Project

Features of the development relevant to this HRA which have changed since the June 2025 DPHI Approval include the following:

- New access roads within the Transgrid perimeter fence (all sides).
- New access road from the overall site's private access road (off Mid Western Highway) the northwest corner of the Transgrid compound for construction access.
- A new (connection) bay within the Transgrid compound located to the northwest of the existing bays which will require ground levelling and a new retaining wall.
- Underground cabling from the BESS compound to the Transgrid compound, running around the western edge of the Transgrid compound.
- A new Security Fence around the Transgrid compound (same footprint).

The overall site context is shown in **Figure 1**.

The new features within the Transgrid compound are shown in **Figure 2**.

Figure 1 Site Context of the Proposed BESS Facility

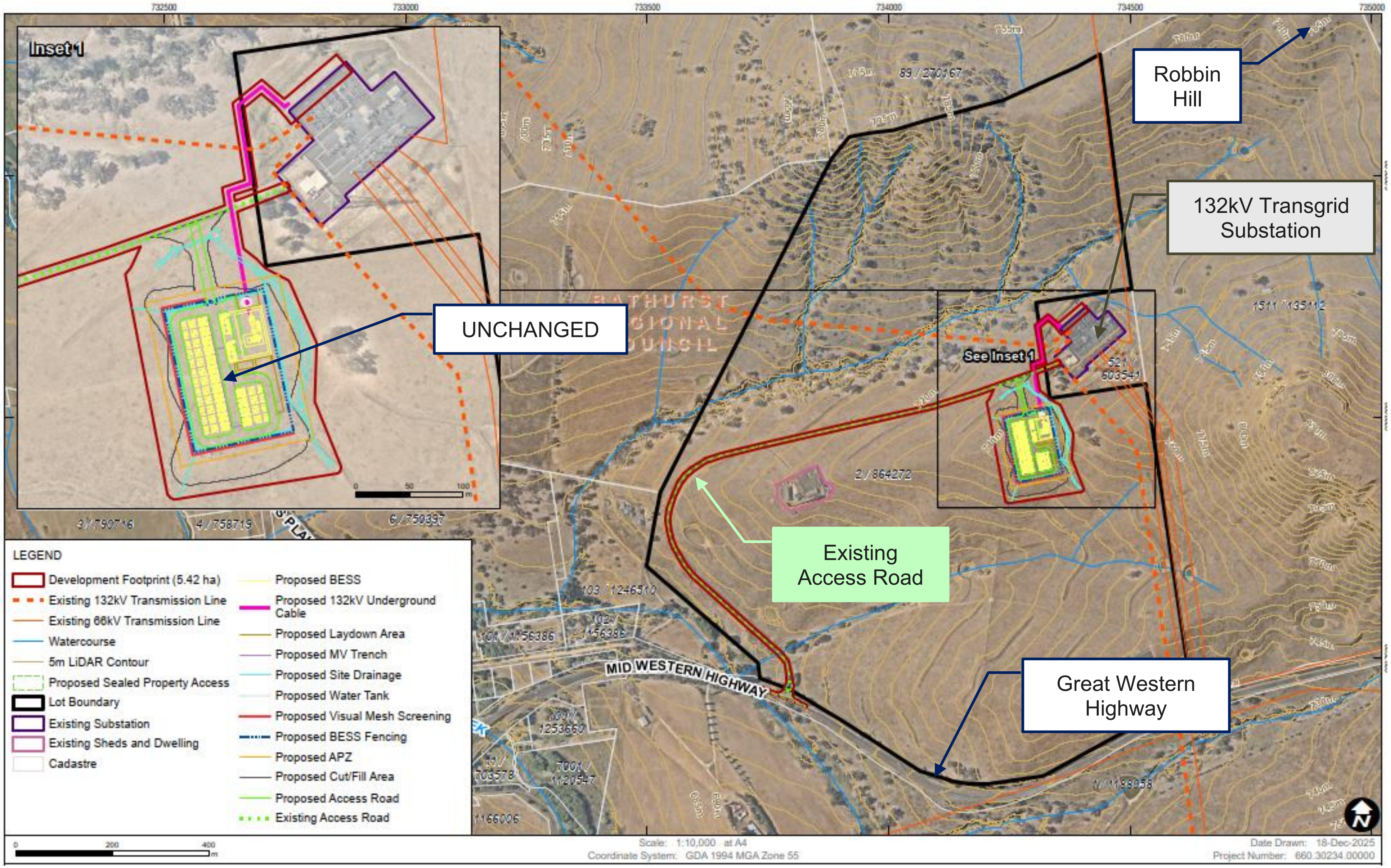


Figure 2 Site Plan of Amended Transgrid Compound

2.2 Nearest Sensitive Receivers

The nearest sensitive receivers (refer **Figure 3** and summary in **Table 1**) are as follows:

- A residential property located at 800 Mid-Western Highway, Evans Plains (DP 86427); several rural residences located to the southwest; residences to the east on Windemere Road; and residences to the north on Hartwood Avenue.

Figure 3 Nearest Sensitive Receivers ID Map

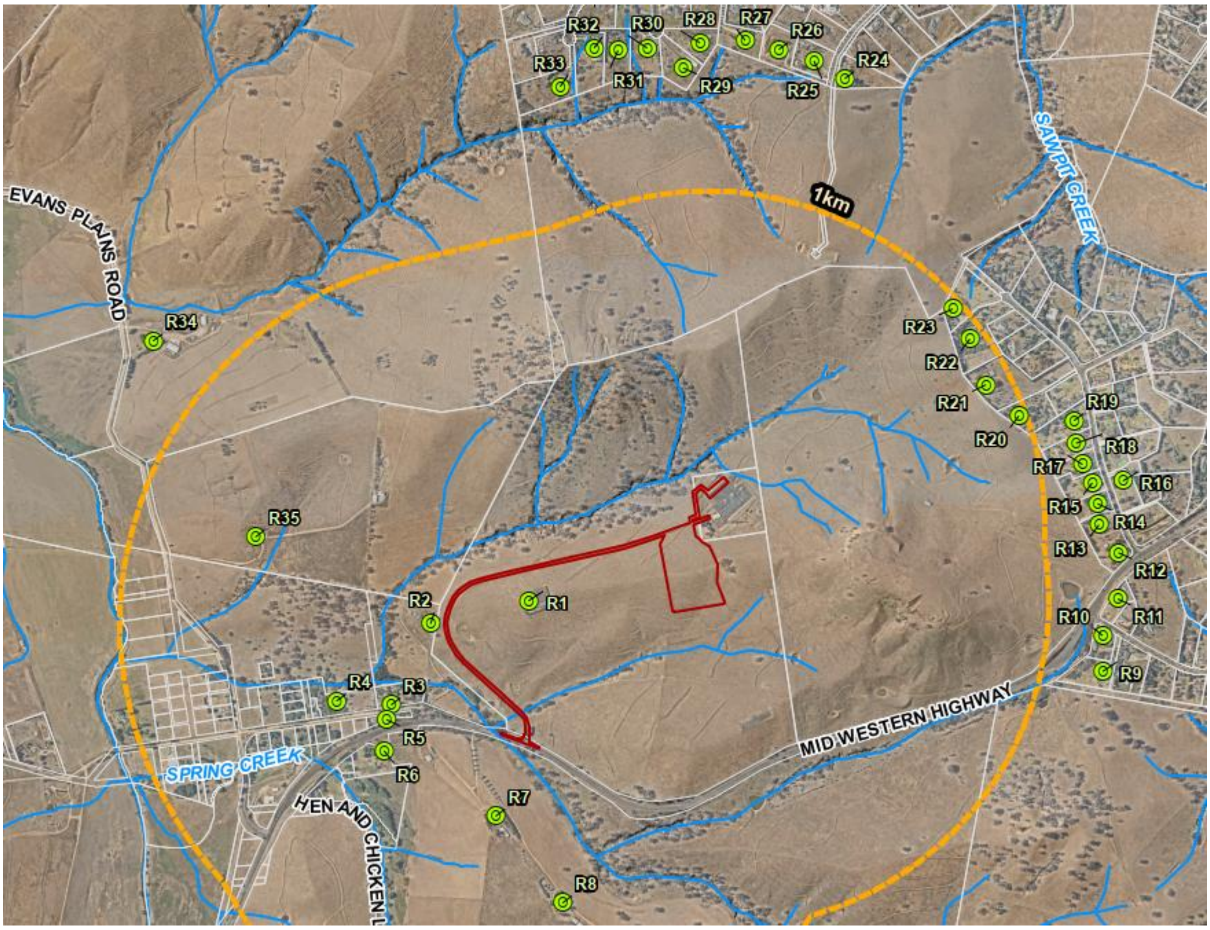


Table 1 Nearest Sensitive Receivers - Summary

ID	Address	Type	Distance (m)	Direction
R1	800 Mid Western Highway, Evans Plains	Residential	490	West
R2	16 Stewart Street, Evans Plains	Residential	790	West
R3	24 Stewart Street, Evans Plains	Residential	950	West-southwest
R7	831 Mid Western Highway, Evans Plains	Residential	870	Southwest
R35	403 Evans Plains Road, Evans Plains	Residential	1340	West
R9-R11	McLennan Close, Robin Hill	Residential	1210	East-southeast
R12-R23	Windemere Road, Robin Hill	Residential	990	Northeast
R24-R33	Hartwood Avenue, Robin Hill	Residential	1,480	North

3.0 Preliminary Risk Screening

Preliminary risk screening of the proposed development is required under the Resilience and Hazard SEPP to determine the need for a Preliminary Hazard Analysis. The preliminary screening assesses the storage of specific dangerous goods classes that have the potential for significant, off-site effects. Specifically, the assessment involves the identification of classes and quantities of all dangerous goods to be used, stored or produced on site with respect to storage depot locations as well as transported to and from the site.

The Project's hazardous materials and associated potential risks are:

- Materials/Activities involved in Construction Phase Activities
- Materials/Activities involved in Operational Phase Activities
- Materials/Activities involved in De-Commissioning Phase Activities
- Facility Electrical Equipment other than the Project BESS units

Hazards and risks related to the BESS element of the Project are examined separately.

3.1 Dangerous of Other Hazardous Materials

3.1.1 Construction Phase Materials / Activities

The key elements of the construction phase of the Project are as follows:

No change from Approved (May 2025 Amendment) Project:

- Access roads and a construction site car park will be built; the site will be surveyed to provide exact installation locations for all facility components. The site will then be mechanically cleared (loose debris, etc), and perimeter security fencing constructed.
- Assuming no contaminated land is encountered on site, any excavated soil will be used for backfilling activities or stockpiled to be available for use during the De-Commissioning phase of the Project, with none leaving the site.
- A Construction Workshop will be built to receive goods and for general maintenance activities.
- Underground wiring trenches will be dug.
- BESS units, Inverter pads, cabling, the sub-station, Control Room, etc, will then be installed.

Change from Approved (May 2025 Amendment) Project:

- New access roads for the establishment of the new bays within the Transgrid compound.
- Underground trenches for the new cable connection of the BESS compound to the new bays within the Transgrid compound.
- Earthworks (levelling) for the new Transgrid compound retaining wall.

3.1.2 Operational Phase Materials / Activities

No change from Approved (May 2025 Amendment) Project:

No hazardous chemicals will be produced during operation of the facility.

Quantities of regulated substances will be stored on-site (for maintenance, repair, emergency, etc, purposes) which are expected to be used entirely, leaving no waste. These will be stored in a properly maintained (and code-compliant) storage area with suitable signage, any PPE requirements if relevant, etc.

They will include fire extinguishers, machine oils and lubricants, hydraulic fluid and spare (emergency) fuel.

Maintenance of the Project site will require vegetation throughout to be kept low, both for occupational health and safety reasons and fire safety. In relation to such maintenance, if any herbicides are used, the Project is committed to only using general use, over-the-counter, herbicides, as opposed to restricted use herbicides sometimes used in intensive commercial operations where such herbicides require a special restricted use license. Similarly, if a growth regulator is used in order to slow down vegetation growth, only commonly-used products will be chosen such as those regularly used on highway roadsides, golf courses, etc.

Change from Approved (May 2025 Amendment) Project:

The new Switchgear for the upgraded Transgrid compound has not been selected. Insulation options for the switchgear include:

- Air | SF_6(gas) | Oil | CO_2

Small quantities of the above (depending on the option) may be stored on site.

Each of these insulation options generate different risk scenarios:

- SF_6 is a Class 2.2 gas (non-flammable, non-toxic)
- Switchgear insulating oil would be similar to the quantities of replacement oil for the transformers on the site: likely mineral oil or natural or synthetic ester oils. These do not carry a DG designation.

3.1.3 De-Commissioning Phase Materials / Activities

The De-Commissioning phase of the Project will mirror the Construction phase in terms of materials and equipment activities.

3.2 Resilience and Hazard SEPP Risk Screening

The dangerous goods that will require transportation and storage at the Project site are identified in **Table 2** and **Table 3,** along with their respective SEPP-relevant ADG Thresholds.

Table 2 ADG Classification of SEPP Related Dangerous Goods - Storage

Class	Category	Item / Usage	SEPP Thresholds	Project Storage
Class 2.2	Non-flammable Non-toxic	Fire Extinguishers . Fire Suppression Gas	na	na
Class 2.2	Non-flammable Non-toxic	SF_6 [1] . Switchgear insulation	na	na
Class 3	Flammable Liquids	Fuel (diesel) . CONSTRUCTION	5 tonne	1 tonne
Class 3	Flammable Liquids	Fuel (diesel) . OPERATION		Nil
Class 6.1	Toxic Substances	Pesticides (Herbicides) . ground cover management	2.5 tonne	< 100 kg
Class 9	Miscellaneous Dangerous Substances and Articles	BESS Li-ion batteries	Na	Refer PHA **Section 4**

Note 1 SF_6 not yet confirmed, dependent on final choice of Switchgear

Table 3 ADG Classification of SEPP Related Dangerous Goods - Transport

Class	Category	SEPP-Allowed Quantity	SEPP-Allowed Movements	Project Quantity	Project Movements
Class 2.2	Fire Suppression Gas	na			
Class 2.2	SF_6 [1]				
Class 3 PGII	Fuel (diesel) . CONSTRUCTION	3 tonne (bulk) 10 tonne (packs)	>750/yr cumul. >45/wk	1 tonne	100/yr cumul. 5/wk
Class 3 PGII	Fuel (diesel) . OPERATION			Nil	Nil
Class 6.1 PGII	Pesticides (Herbicides)	1 tonne (bulk) 3 tonne (packs)	All	< 100 kg	1 per 3-4mo
Class 9	Li-ion batteries	na	>1,000/yr cumul. >60/wk	Na	Refer PHA **Section 4**

Note 1 SF_6 not yet confirmed, dependent on final choice of Switchgear

The final quantity and transportation parameters of the materials listed in **Table 2** and **Table 3** will be confirmed during detailed design but, as currently foreseen, they do not exceed the relevant storage (or transport) thresholds.

Storage protocols will comply with relevant guidelines and standards, eg AS 1940-2017 for the storage of fuels and pesticides/herbicides at the Project laydown area.

3.3 Dangerous Goods Storage

The storage and handling of dangerous goods to be used or stored at the facility and transported to/from the facility is not considered potentially hazardous with regards to the screening thresholds contained in the Resilience SEPP. Further detailed analysis, ie via a Preliminary Hazard Analysis, is therefore not required.

The Project's BESS units are battery powerpacks consisting of lithium ion batteries. Lithium ion batteries are classed as Class 9 Miscellaneous Dangerous Substances and articles, which are excluded from the Resilience and Hazard SEPP screening process.

However, the hazards associated with these batteries mandate that a Preliminary Hazard Analysis is required to further assess the hazards and risks associated with the lithium ion batteries, in accordance with the SEARs requirements for the Project.

This is covered in **Section 4** of this HRA.

4.0 Preliminary Hazard Analysis

Risk Management involves a determination of the level of risk to people, property, the environment and surrounds, taking into account the implementation of controls.

In accordance with the Resilience and Hazard SEPP, a Preliminary Hazard Analysis must be prepared in accordance with *Hazardous Industry Planning Advisory Paper No.6 - Guidelines for Hazard Analysis* (HIPAP No.6, DoP, 2011) and *Multi-Level Risk Assessment* (MLRA, DoP, 2011).

The assessment process typically comprises two elements:

- Hazard Analysis (HA); and
- Multi-Level Risk Assessment (MLRA).

HA (Hazard Analysis)

The objective of HA is to develop a comprehensive understanding of the hazards and risks associated with an operation or facility and of the adequacy of safeguards. The hazard analysis process may include qualitative and quantitative methods.

Consideration should include:

- the nature and quantities of hazardous materials stored and processed on the site;
- the type of plant and equipment in use;
- the adequacy of proposed technical, operational and organisational safeguards;
- the surrounding land uses or likely future land uses; and
- the interactions of these factors.

MLRA (Multi-Level Risk Assessment)

MLRA provides guidance on the criteria for using the results of the screening, classification and prioritisation steps to determine which of three levels of further analysis is appropriate.

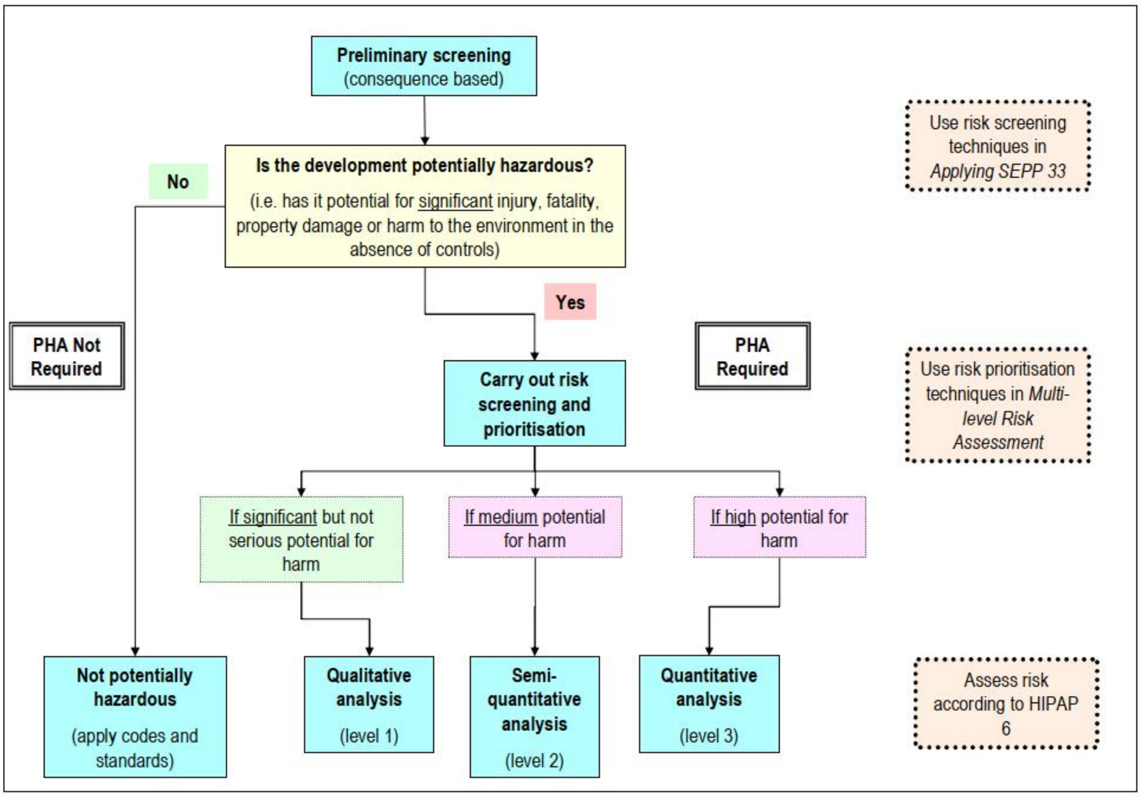
- Level 1 is an essentially qualitative approach based on comprehensive hazard identification to demonstrate that the activity does not pose a significant off-site risk.
- Level 2 supplements the qualitative analysis by sufficiently quantifying the main risk contributors to show that risk criteria will not be exceeded.
- Level 3 is a full quantitative analysis.

The overall MLRA approach can be seen in **Figure 4**.

HA & MLRA

Combining HA and MLRA should result in the estimation of the level of risk to people, property and the environment from operations at the Site and in the presence of controls.

Figure 4 The Multi-Level Risk Assessment Approach[1]



4.1 Further Discussion of HA (Hazard Analysis)

HA relies on a systematic and analytical approach to the identification and analysis of hazards and the quantification of off-site risks to assess risk tolerability and land use safety implications. The level and extent of analysis must be appropriate to the hazards present and therefore, need only progress to the extent necessary for the particular case.

4.1.1 Methodology

The procedures adopted for assessing hazardous impacts involve the following steps:

Step 1: Hazard identification;

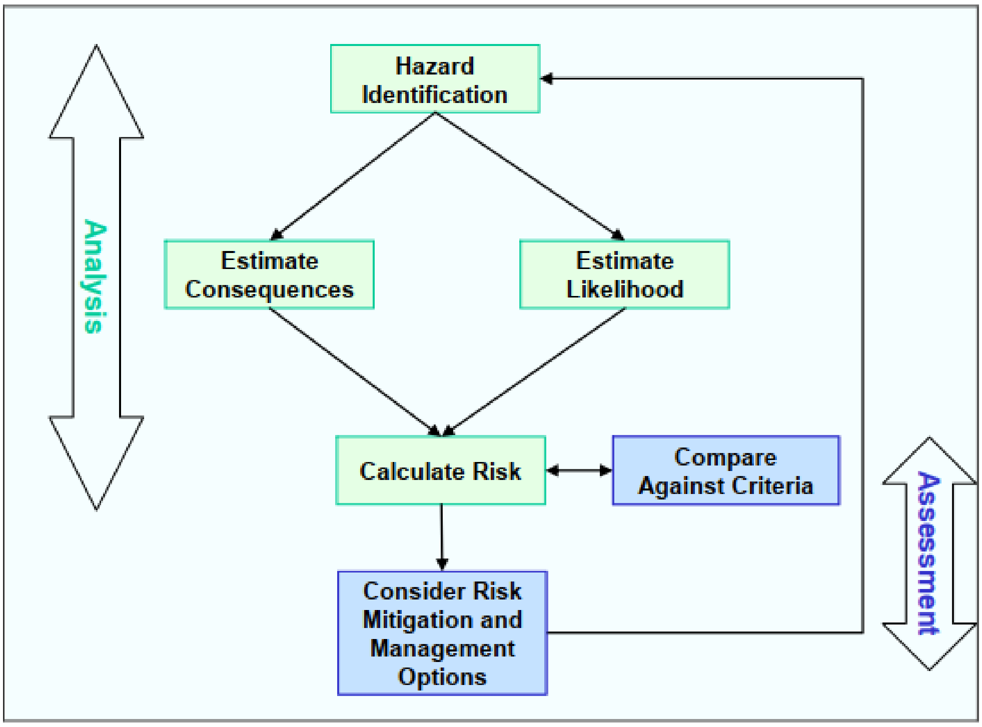
Step 2: Hazard (matrix) analysis (consequence and probability estimations); and

Step 3: Risk evaluation and assessment against specific criteria.

A schematic of the hazard analysis process is shown in **Figure 5**.

[1] Source Planning NSW, 2011a Multi-Level Risk Assessment, New South Wales Government, figure 3)

Figure 5 Basic Methodology for Hazard Analysis (source: HIPAP 6)



4.1.2 Step 1: Hazard Identification

The first step involves the identification of all theoretically possible hazardous events as the basis for further quantification and analysis. This does not in any way imply that the hazard identified, or the theoretically possible impact, will occur in practice. Essentially, it identifies the particular characteristics and nature of hazards to be further evaluated in order to quantify potential risks.

Hazard identification was undertaken on the following basis:

- SLR's previous experience with grid-scale BESS facilities; and
- Engagement with the Project Team to confirm anticipated hazards and identify additional hazards, involving events which are outside normal operating conditions, and which have the potential to create negative impacts, both internally and externally.
- The results are documented in **Table 10**.

4.1.3 Step 2: Hazard (Matrix) Analysis

After a review of the events identified in the hazard identification stage and the prevention and/or protection measures incorporated into the design of the site, any events which are considered to have the potential to result in impacts or which have the potential to escalate to larger incidents are carried to the next stage of analysis.

Examples of environmental hazards associated with BESS facilities can include:

- Contaminants generated during a fire at the BESS and to a lesser extent the release of chemicals from physical damage to the BESS.
- Oils released into the environment from physical damage to a transformer.

- Combustion products released within the smoke plume and as fire residues during and following a BESS Fire Event, including hydrogen fluoride (HF), phosphoryl fluoride (POF_3) and phosphorus pentafluoride (PF_5). (Larsson *et al*, 2017).
- Other gasses released during combustion, which may include volatile organic compounds (VOCs) and volatile polyaromatic hydrocarbons (PAHs).
- Particulate matter generated during the combustion, which can include soot, PAHs, and metal oxides of nickel (Ni), aluminium (Al), lithium (Li), copper (Cu) and cobalt (Co).

The risk from these and all other hazards is assessed in subsequent sections of this report.

Consequence Estimation

This aspect involves the analysis and modelling of the credible events carried forward from the hazard identification process in order to quantify their impacts outside the boundaries of the site.

Risk (Probability Likelihood) Estimation

Where necessary, the likelihood of incidents identified above are determined by adopting probability and likelihood factors derived from published data, experience, etc.

4.1.4 Step 3: Risk Evaluation and Assessment

The risk analysis includes the consequences of each hazardous event and the frequencies of each initiating failure. The results of consequence calculations (eg for BESS Fire/Explosion radiation and overpressure contours, etc) together with the probabilities and likelihoods estimated are then compared against the accepted criteria applicable for the site.

Whether it is considered necessary to conduct the predictions would depend on the probabilities and likelihood estimated and if the risk criteria are exceeded.

4.1.5 Risk Criteria

As part of the MLRA, hazards are identified and the risk from the hazards estimated. Risk criteria take into consideration surrounding land uses, and the category of risk. They encompass such elements as injury/ irritation, individual and societal risk of fatality, property damage and harm to the biophysical environment. Criteria may be expressed in qualitative or quantitative terms.

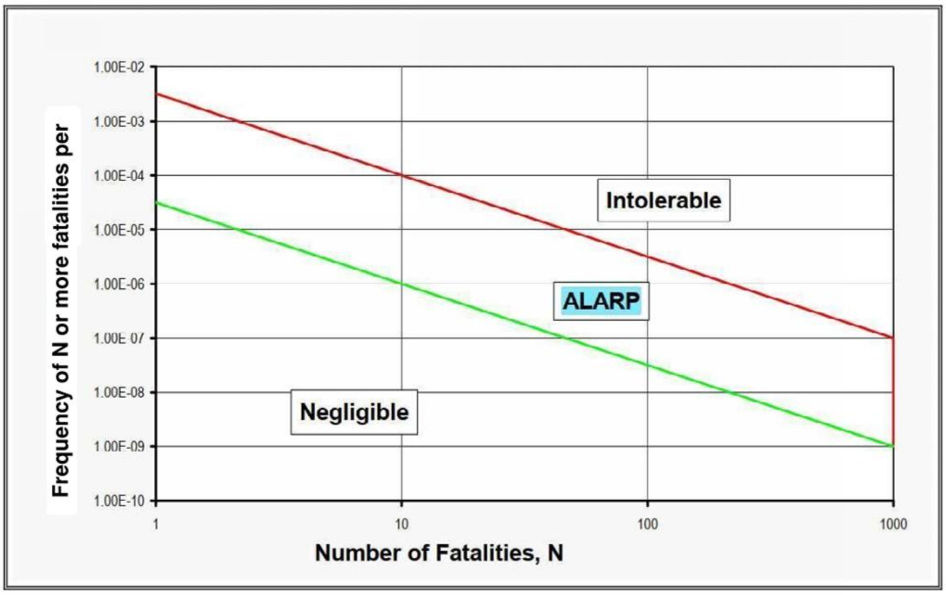
A key concept in the risk criteria is that societal risks should be *"as low as reasonably practical"*, known as the ALARP principle.

The ALARP principle has been described by the UK Health and Safety Executive (HSE) in the following terms:

> *'In weighing the costs of extra safety measures the principle of reasonable practicability (ALARP) applies in such a way that the higher or more unacceptable a risk is, the more, proportionately, an employer is expected to spend to reduce it'.*

The indicative societal risk criteria reflect these regions as three societal risk bands: negligible, ALARP and intolerable, as shown in the example below in **Figure 6**.

Figure 6 Indicative Societal Risk Criteria



In **Figure 6:**

- Below the “Negligible” line, provided other individual criteria are met, societal risk is not considered significant.
- Above the “Intolerable” line, an activity is considered undesirable, even if individual risk criteria are met.
- Within the ALARP region, the emphasis is on reducing risks as far as possible towards the negligible line. Provided other quantitative and qualitative criteria are met, the risks from the activity would be considered tolerable in the ALARP region.

The risk assessment in the current study was based on hazard identification, consequence assessment and likelihood assessment, to create an overall risk assessment.

Descriptors for the qualitative risk assessment at the various levels of consequence of a particular event, and the likelihood (or probability) of such an event occurring are presented in **Table 4** and **Table 5**.

The resulting risk ratings are defined as the following:

- Negligible - The risk is acceptably low (also referred to as “Low”).
- ALARP - As Low As Reasonably Practical, the risk has been reduced to as low a level as possible, and all feasible controls and mitigation strategies are implemented.
- Intolerable - The risk cannot be reduced to an acceptable level with residual impacts likely to have significant impact on the local environment or stakeholders. Intolerable risk which is not addressed would preclude the development of a Project.

Table 4 Qualitative Likelihood Rating

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Could occur
D	Unlikely	Could occur but not expected
E	Rare	Conceivable, but only in exceptional circumstances

Table 5 Qualitative Consequence Rating

Level	Descriptor	People	Environment	Water Supply
5	Catastrophic	Multiple fatality	Extreme environmental harm, eg widespread catastrophic impact	Major impact for large population, complete failure of systems
4	Major	Permanent total disabilities, single fatality	Major environmental harm, eg Widespread substantial impact	Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
3	Moderate	Major injury or health effects, eg. major lost workday case/permanent disability	Serious environmental harm, eg widespread and significant impact	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
2	Minor	Minor injury or health effects, eg. restricted work or minor lost workday case	Material environmental harm, eg localised and significant impact	Minor impact for small population, some manageable operation disruption, some increase in operating costs
1	Insignificant	Slight injury or health effects, eg. first aid/minor medical treatment level	Minimal environmental harm, eg interference or likely interference to an environmental value	Insignificant impact, little disruption to normal; operations, low increase in operation costs

The risk rating matrix has been set out in **Table 6**.

In assessing the tolerability of risk from potentially hazardous activities/events, the relevant general principles from HIPAP 6 are:

- the avoidance of all avoidable risks;
- the risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low;
- the effects of significant events should, wherever possible be contained within the site boundary; and
- where the risk from an existing installation is already high, further development should not pose any incremental risk.

Table 6 Risk Rating Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	ALARP	ALARP	Intolerable	Intolerable	Intolerable
Likely	Low	ALARP	ALARP	Intolerable	Intolerable
Possible	Low	Low	ALARP	ALARP	Intolerable
Unlikely	Low	Low	Low	ALARP	ALARP
Rare	Low	Low	Low	Low	ALARP

4.1.6 Risk of Property Damage and Accident Propagation

The siting of an installation must account for the potential for propagation of an accident causing a “domino” effect on adjoining premises. In the current study, the risk of property damage and accident propagation to adjoining residential properties is considered unlikely, based on the distances noted in **Table 1**.

The presence however of the nearby Transgrid 132 kV substation is significant.

4.2 Criteria

Reference is made to HIPAP 4:

- Planning NSW, 2011, *Risk Criteria for Land Use Safety Planning – Hazardous Industry Planning Advisory Paper No 4*, New South Wales Government.

HIPAP 4 contains the criteria relevant to this assessment.

- Individual Fatality Risk, Individual Injury Risk and Risk of Property Damage and Accident Propagation.

The relevant criteria are shown in **Table 7, 8 and 9** respectively. The criteria contain both:

- A physical element (eg a value of heat flux radiation or explosion overpressure); and
- A probability of occurrence element (eg an annual probability of occurrence of 50 in a million, 0.005%)

Table 7 HIPAP Criteria – Individual Fatality Risk

Land Use	Risk Criteria (fatal injuries per million per year)
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment	5
Sporting complexes and active open space	10
Industrial Applications	50

Table 8 HIPAP Criteria – Individual Injury Risk

Injury Risk Event	Risk Criteria (fatal injuries per million per year)
Heat Radiation (4.7 kW/m^2)	50
Explosion Overpressure (7 kW/m^2)	50
Exposure to Toxic Gas/Smoke/Dust (resulting in serious injury upon short-term exposure)	10
Exposure to Toxic Gas/Smoke/Dust (resulting in irritation on term exposure)	50
Industrial Applications	50

Table 9 HIPAP Criteria – Risk of Property Damage and Accident Propagation

Injury Risk Event	Risk Criteria (property damage per million per year)
Heat Radiation (23 kW/m^2)	50
Explosion Overpressure (14 kW/m^2)	50

4.3 Potential Hazardous Incidents Identified for Review

Following a review of the Project, potentially hazardous events or scenarios were evaluated to establish if further comprehensive qualitative analysis was required.

These were developed in consultation with the Project Team and are being developed and documented in the Project Risk Register (spreadsheet).

The hazardous events/scenarios are detailed in the Hazard Register shown in **Table 10** which covers the Construction, Operational and De-Commissioning phases of the Project.

Two categories of risk are identified in the Hazard Register:

- Scenarios with risk levels which can be reduced to the Negligible or ALARP level via standard engineering design approaches, adherence to relevant design codes, etc.
  - An example of this category is ensuring that all equipment at the Site is designed to withstand the impact of extreme winds (via compliance with AS 1170.2-2021) or earthquakes (via compliance with AS 1170.4-2024).
- Risk levels which require detailed, site-specific or non-standard management and mitigation measures to achieve at least an ALARP risk rating.
  - These risks require a detailed hazard assessment, achieved via a Level 1, Level 2 or Level 3 assessment.

The following hazards were deemed to lie within the second category:

External

- Bushfire Risk

Internal

- BESS Unit fire-related and/or explosion-related risk, potentially caused by:
    - A thermal runaway event.
    - Radiation from an adjacent fire (eg MV Skids).
- Transformer Pool Fire risk – relevant to both the BESS compound transformers (MV Skids) and the Main Substation Transformer.
- BESS Container fire-related Toxic Plume Risk - containing potentially hazardous substances, e.g. Hydrogen Fluoride (HF), and the risk of downstream firewater contamination.

The above hazards are addressed in subsequent sections of this HRA.

Table 10 Summary of Potential Hazard Scenarios, Uncontrolled Risk & Residual Risk after Implementation of Controls

Note 1: Project Phase: ⭘ = **Construction** | ■ = **Operation** | ▲ = **De-Commissioning**

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
Vandalism	⭘ ■ ▲	Illegal site entry and damage to equipment. Damage to equipment from outside boundary, e.g. gunshot	Structural damage ranging from minimal to major. Vandals may also suffer electric shock or other accidents while on site.	Unlikely	Minor to Major	ALARP	BESS site has security measures in place, such as secure fences, gates, etc, to restrict unauthorised access to BESS	Negligible
Traffic Accident	⭘	Traffic into and out of the site during peak construction could lead to vehicle collisions	Driver fatality, road closure, equipment damage	Possible	Major to Catastrophic	ALARP to Intolerable	Construction Traffic Management Plan will implement all recommendations from the Traffic Impact Assessment, (TIA) including: . drivers to follow the Project Driver Code of Conduct (refer TIA) and obey all VIC road rules . site entry design consistent with Australian Standards and Austroad Guidelines . additional Advisory signage to be provided near site entry . drivers to obey 40 kph	Low to ALARP

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
							speed limit within the property boundary.	
Physical Damage to Transformers (no combustion)	● ■ ▲	Transformers damaged during installation, vehicle collision or from acts of vandalism	Release of oils from transformers which will be slowly absorbed into the ground.	Unlikely	Minor to Major	Negligible to ALARP	Suite of controls covering: • On-site personnel to have relevant training in receiving equipment, unloading, temporary placement, etc. • Operational personnel to have relevant training in installation and initial equipment checks of transformers. • Substation design to include secondary containment to contain spill. Design to follow guidance in relevant standards such as *AS 1940 The storage and handling of flammable and combustible liquids, and AS2067-2016 Substations and high voltage installations greater than 1kV(ac).* • The site has security measures in place, such as secure fences, gates,	Negligible

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
							etc to restrict unauthorised access to transformers and fire barriers for the transformer itself. • FEMP – Fire and Emergency Management Plan will deal with emergency response to physical damage to transformers, HAZMAT, etc. The areas of soil directly contaminated by oil may be removed to a suitable depth, for example 10cm - 20cm based on advice from a Land Contamination expert. The soil removed to be taken off site for suitable disposal based on a waste classification of the soil	
Physical Damage to BESS Containers (no combustion)	○ ■ ▲	BESS unit damaged during installation, vehicle collision or from acts of vandalism	Limited release of electrolyte. The main chemicals released may be gases, such as carbon dioxide (CO_2), carbon monoxide (CO),	Unlikely	Minor ○ ▲ to Moderate ■	Negligible to ALARP	Suite of controls covering: • Handling - operational personnel to have relevant training in routine installation and maintenance of BESS. • BESS site has security measures in place, such	Negligible

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
			methane (CH_4), ethylene (C_2H_4) and ethane (C_2H_6)				as secure fences, gates, etc to restrict unauthorised access to BESS. FEMP – Fire and Emergency Management Plan will deal with emergency response to physical damage to transformers, HAZMAT, etc.	
External Fire Impact (eg Bushfire)	⊙ ■ ▲	Fire starts off site, moves on site and impinges on BESS units, transformers and other equipment and buildings	Fire damage to BESS and other equipment on site, including Transmission Line connection. Loss of connection of the facility and the ability of the Site to complete commissioning testing; or loss of ability of the Site to provide power to the grid in an emergency; or interruption to grid prior top isolation during	Possible	Major ⊙ ▲ Catastrophic ■	ALARP to Intolerable	Suite of controls covering: • Defendable Space and perimeter Fire Break, internal access roads allowing unimpeded firefighting access to and within the Site • Adequate water supply • FEMP – Fire and Emergency Management Plan for dealing with the threat of an external bushfire attack. • Emergency Response Training - operational personnel to have completed relevant training in dealing with an external bushfire attack, including drills	Negligible to ALARP **Refer PHA Section**

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
			de-commissioning				with local firefighting services. • Equipment management systems (e.g. BESS Unit BMS) which enables automatic shutdown of any threatened piece of equipment if safe limits of voltage, current and/or temperature are exceeded in the event of a catastrophic bushfire event.	
Internal Fire Impact from any Internal Source	○ ■ ▲	Fire starts in another section of the site and impinges on BESS Containers or main transformers	Combustion of a BESS fire may release a range of combustion products in the smoke plume and as fire residues. Combustion of the electrolyte releases toxic gases including hydrogen fluoride (HF), phosphoryl fluoride (POF_3) and phosphorus pentafluoride	Unlikely	Moderate ○ ▲ Catastrophic ■	ALARP to Intolerable	Site design to include adequate separation distances between main transformer and BESS units and between battery enclosures. Taking into consideration advice from battery manufactures, QFD and relevant codes of practice and standards. In a non-BESS initiated fire, firefighting practice would protect BESS units by keeping batteries cool with water. Site will have a total of 20 kL dedicated firefighting water supply. Regarding	Negligible

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
			(PF_5). Other gasses released during combustion will include volatile organic compounds (VOCs) and volatile polyaromatic hydrocarbons (PAHs). Smoke plume carries particulate contaminants off site. Potentially contaminated water on site generated by firefighter's operations on site. Potential for environmental contamination of surface water and to a lesser extent ground water.				contaminated firewater, the Site has a dedicated plan to safely manage and dispose of water from a firefighting incident. Site design to include secondary containment, bunding / sediment traps to retain all water on site. Once the fire is extinguished, where possible the water may be collected and removed from site for offsite disposal. Once the fire is extinguished, the areas of soil directly contaminated by the fire may be removed to a suitable depth, for example 10cm - 20cm based on advice from a Land Contamination expert. The soil removed to be taken off site for suitable disposal based on a waste classification of the soil	

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
			Transformer (pool) fire can release significant amounts of oil plus smoke p0lume impacts.					
BESS Container Fire	○ ■ ▲	Thermal runaway starts fire in one of the batteries. Overvoltage / Overcharge in one of the batteries leads to a build-up of pressure in battery culminating in a catastrophic venting of gases and fire. External short circuit Sustained electrical arch fault Ignites surrounding materials.	Combustion of a BESS fire releases a range of combustion products in the smoke plume and as fire residues. Combustion of the electrolyte releases toxic gases including hydrogen fluoride (HF), phosphoryl fluoride (POF_3) and phosphorus pentafluoride (PF_5). Other gasses released during combustion will include volatile	Unlikely	Major	ALARP	Using established systems and relevant standards to prevent a thermal runaway or short circuit or other fault within the battery from occurring. Battery management system, including automatic shut down in case of any safe limits of voltage, current and temperature being exceeded. Site design to include adequate separation distances between battery enclosures. Taking into consideration advice from battery manufactures, NSW RFS and relevant codes of practice and standards. In a BESS fire, the standard firefighting practice is to let burning batteries burn out and to avoid the spread of	Negligible Refer UL9540A Test Results

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
		Excessive discharge demand on battery outside design parameters Inadequate ventilation leads to build up and ignition of flammable gases (hydrogen) Inadequate management of operating environment (temperature, humidity, dusts, etc) Cascading failure/ thermal effects from adjacent battery cells within pack	organic compounds (VOCs) and volatile polyaromatic hydrocarbons (PAHs). Smoke plume carries particulate contaminants off site. Potentially contaminated water on site generated by firefighter's operations on site. Potential for environmental contamination of surface water and to a lesser extent ground water				fire to adjoining batteries, protecting the surrounding BESS by keeping those unaffected batteries cool with water. Site will have a dedicated 20 kL water supply. Regarding contaminated firewater, the site will have in place a dedicated plan to safely manage and dispose of water from a firefighting incident. Site design to include secondary containment, bunding / sediment traps to retain as much water as possible on site. Once the fire is extinguished, where possible the water may be collected and removed from site for offsite disposal. Once the fire is extinguished, the areas of soil directly contaminated by the fire may be removed to a suitable depth, for example 10cm - 20cm based on advice from a Land Contamination expert. The soil removed to be	

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
							taken off site for suitable disposal based on a waste classification of the soil	
Transgrid Compound Switchgear Fire	■	Fire can be initiated by insulation breakdown, arcing, overloading, or external damage, especially where flammable materials like insulting oil are involved. Initiators include: ageing, moisture, human error, animal interference, etc.	Switchgear fires can result in nearby equipment being disabled and system power loss. Consequences depend on insulation: air / gas / vacuum. Oil-filled units can generate fires endangering nearby equipment. SF_6 escape can result in toxic plumes.	Unlikely	Insignificant to Major	Negligible to ALARP	Risks are straightforwardly managed via standard engineering techniques: regular inspections and maintenance, component replacement, especially circuit breakers, bunding (for oil-filled units), firefighting water on hand if needed, etc.	Negligible
Extreme ambient temperatures	⊙ ■ ▲	Extreme temperatures	Equipment-Related: System failures in any equipment due to heat	Rare	Insignificant to Major	Negligible	The temperature data at the Bathurst Airport weather station from 1990-2025 were as follows: mean annual maxima ranged from 14.1ºC to 28.9ºC; mean	Negligible

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
							annual minima ranged from 0.9ºC to 14.1ºC; the highest and lowest temperatures since 1990 were 42.1ºC and -8.1ºC respectively. The proposed BESS unit for the Project will be designed for safe operation at the above highest historical temperature, plus an appropriate temperature buffer confirmed during detailed design.	
Contact with Low or High Voltage. (Electric) Arc Flash	● ■ ▲	Contact during wiring and connection activities, or through inadvertent cabling left exposed	Serious to critical injury to personnel	Possible	Major to Catastrophic	ALARP to Intolerable	Compliance with Australian and IEC electrical and wiring design standards and AS/NZS3067:2016, Victorian Blue Book Equipment selection and separation distances, insulation, guarding, electrical protection systems, insulated tools, barricading around high risk work areas. Training and competency of workers; mandatory licensing requirements, authorisation systems and	Negligible to ALARP

Hazard or Incident	Project Phase [1]	Scenario	Consequence Range	WITHOUT Controls			Controls	Risk WITH Controls
				Likelihood	Consequence	Risk		
							supervision of electrical workers. Arc Flash Detection and Shutdown Trips/Relays. Personal Protective Equipment (PPE).	
Lightning Strike	◉ ■ ▲	Incidence of lightning	Injury, electric shock. Grass fire.	Possible	Major ◉ ▲ Catastrophic ■	ALARP ◉ ▲ Intolerable ■	EMP procedures for dealing with lightning: weather monitoring, safe harbour locations, etc. Project to satisfy the applicable requirements for lightning protection specified in AS/NZ 1768 Lightning protection.	Negligible ◉ ▲ ALARP ■
EMF	■	Exposure to EMF	Health effects related to Electro-magnetic fields	Rare	Insignificant to Major	Negligible	Nil EMFs from BESS facilities are comparable to the EMFs from many household items and the separation distances to nearest receptors is significant	Negligible

5.0 Bushfire Risk and Management Assessment

Bushfire Risk for the Project will be managed via a comprehensive Bushfire Emergency Management Plan that will span all stages of the Project: construction, operation through to final de-commissioning.

5.1 Bushfire Context

A search on the NSW Rural Fire Service (RFS) website, using the RFS mapping tool, revealed that the Project site is NOT identified as being within bushfire prone land – refer **Figure 7**.

Nevertheless, mitigation measures have been considered as if the Project was located within bushfire prone land, given:

- The critical infrastructure nature of the Project; and
- The immediate proximity is similarly critical infrastructure, ie Transgrid's sub-station.

refer: https://www.rfs.nsw.gov.au/plan-and-prepare/building-on-bush-fire-prone-land/bush-fire-prone-land/check-bfpl

Figure 7 RFS Bushfire Mapping Tool – Site Search Results

BESS Compound component **Transgrid Compound component**

5.2 Designated 10/50 Vegetation Entitlement Clearing Area

The NSW Rural Fire Service (RFS) mapping tool also indicates that the Subject Sites are identified as being within designated 10/50 vegetation entitlement clearing areas.

Rules regarding the removal of vegetation on the site can be found in:

- NSW RFS, *"10/50 Vegetation Clearing - Code of Practice for NSW"*, September 2015.

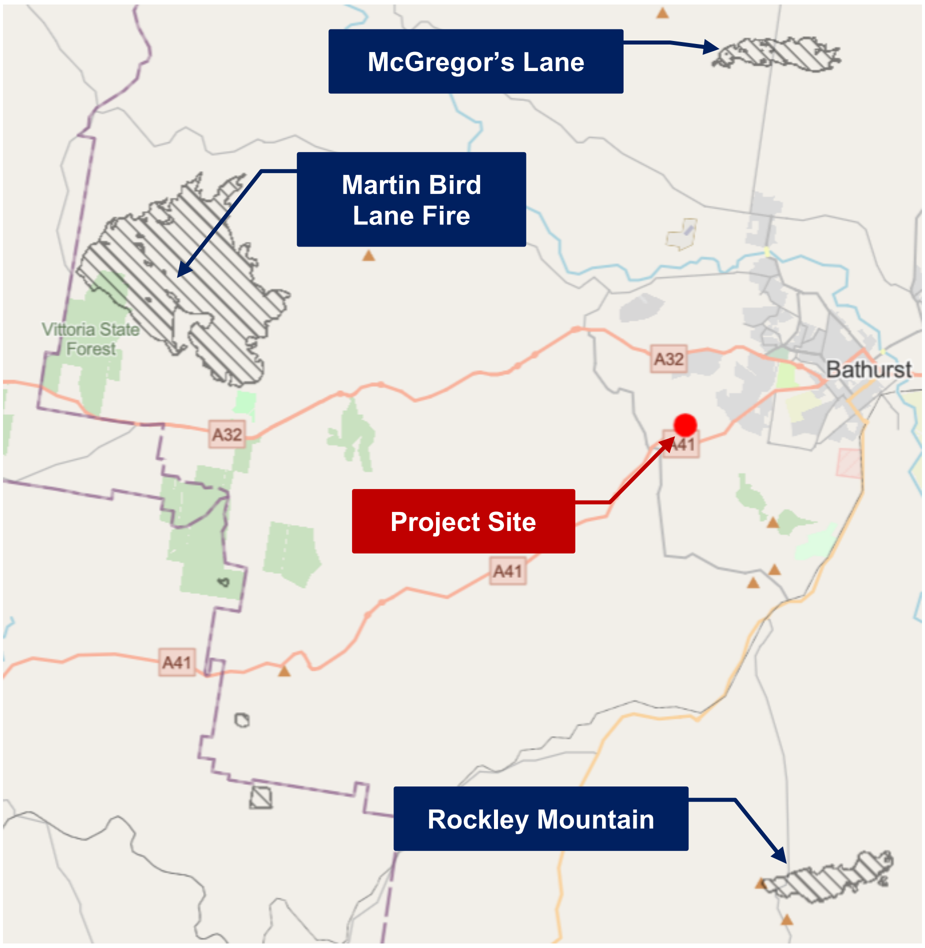
5.3 Bushfire History

The NSW Government SEED initiative mapping tool documents historical NPWS wildfires in NSW. The results for the broad area surrounding the Project are shown in **Figure 8**.

The nearest documented wildfire events are:

- Martin Bird Lane Fire - 14 km west of the Project site
  - December 2009 Wildfire 2,134 ha
- McGregor's Lane - 12 km north of the Project site
  - December 2009 Wildfire 250 ha
- Rockley Mountain - 15 km south of the Project site
  - December 2009 Wildfire 282 ha

Figure 8 NPWS Wildfire Events – Fire Historical Database (SEED Mapping Tool)



The absence of documented wildfires in the near vicinity of the site indicated by the SEED mapping tool is in line with the generally lower bushfire risk profile of the site and surrounds as suggested in **Figure 7.**

5.4 Bushfire Attack Level (BAL)

A key input in the assessment of bushfire risk is to determine the BAL (Bushfire Attack Level) of the project site of interest. The Panorama BESS site BAL has been assessed according to:

- Australian Standard AS3959:2018, "Construction of Buildings in Bushfire-Prone Areas".

In AS3959:2018, BAL is defined as:

- A means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact, using increments of radiant heat expressed in kW/m^2, and the basis for establishing the requirements of construction to improve protection of building elements from attack from bushfire.

The steps involved in assessing a site specific BAL are shown in **Figure 9**.

Table 11 lists the six BALS defined in AS3959:2018.

Table 11 AS3959:2018 Bushfire Attack Levels (BALs)

Bushfire Attack Level (BAL)	Classified Vegetation within 100m of the site and heat flux exposure threshold	Description of Predicted Bushfire Attack and Levels of Exposure
BAL - LOW		There is insufficient risk to warrant specific construction requirements
BAL - 12.5	≤ 12.5 kW/m^2	Ember Attack
BAL - 19	> 12.5 kW/m^2 and ≤ 19 kW/m^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux
BAL - 29	> 19 kW/m^2 and ≤ 29 kW/m^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux
BAL - 40	> 29 kW/m^2 and ≤ 40 kW/m^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux with the increased likelihood of exposure to flames
BAL - FZ	> 40 kW/m^2	Direct exposure to flames from fire front in addition to heat flux and ember attack

Figure 9 BAL Analysis Methodology

**Step 1
FIRE DANGER INDEX
(FDI)**

The Fire Danger Index (FDI) is a measure of the probability of a bushfire starting, its potential rate of spread, its likely intensity, and the success or otherwise of suppression options available (which vary with local weather conditions, fuel load build-up, most recent period of drought, etc).

Guidance is available on a State-by-State level for establishing the FDI applicable to a specific site.

↓

**Step 2
Surrounding Vegetation Classification.**

Once the FDI is established, it is necessary to classify the vegetation surrounding the site, according to the seven (7) categories described in AS3959:2018:

Forest, Woodland, Scrubland, Scrub, Mallee/Mulga, Rainfall, Grassland

AS3959:2018 allows for certain "low threat" vegetation exclusions, which would then lead to a determination of a BAL-LOW outcome.

↓

**Step 3
Site to Vegetation Distance**

After identifying the surrounding vegetation type, the next stage is to determine the horizontal distance of the site (buildings, infrastructure, etc) to that vegetation.

This is done for all key directions and separately computed for each different vegetation type identified in Stage 2.

↓

**Step 4
Ground Slope Under Surrounding Vegetation**

Bushfires are known to travel more rapidly UP a hill rather than DOWN a hill. It is therefore necessary to establish the slope of the land beneath the vegetation surrounding the site. Note that this is not the slope of the land between the surrounding vegetation and the site, but the slope under the categorised vegetation.

AS3959:2018 Figure 2.3 provides guidance in determining the worst-case upslope or downslope of the surrounding vegetation.

↓

**Step 5
Compute the Project-Specific BAL**

For each assessed direction from the site, the BAL is computed taking into account the specific vegetation category, distance and slope involved. AS3959:2018 Tables 2.4 to 2.8 can be used to determine the BAL, or suitable software (eg CSIRO's BAL Calculation Suite)

For all compass directions assessed (ie all vegetation types in all directions) take the worst-case BAL for further consideration of bushfire management.

5.5 BAL Inputs

5.5.1 BAL Assessment Step 1: FDI

The FDI for the Panorama BESS site has been determined to be 80.

This was based on:

https://research.csiro.au/bushfire/assessing-bushfire-hazards/hazard-identification/fire-danger-index/

NSW RFS, May 2017, *NSW Local Government Areas FDI:* development.policy@rfs.nsw.gov.au

5.5.2 BAL Assessment Step 2: Vegetation Classification

Examples of the vegetation types surrounding the Panorama BESS site are shown in **Photo 1**.

The development site is not mapped by the Biodiversity Values Map and Threshold Tool (DPE 2022a) as containing biodiversity values. There is no native vegetation within the Project site. Site vegetation contains exotic pasture species, which based on the ecological site inspection conducted for the Project, have been assessed as providing only marginal artificial habitats for threatened species. Removal of these features is not likely to result in a significant impact on threatened species.

The vegetation categories defined in AS3959:2018 are listed in **Appendix A** along with descriptive summaries. Of specific interest are:

- Open/Sparse Woodland and Grassland.

5.5.3 BAL Assessment Steps 3 and 4: Distance to Vegetation and Slope Under Vegetation

The general topography surrounding the Project Site is shown in **Figure 10**.

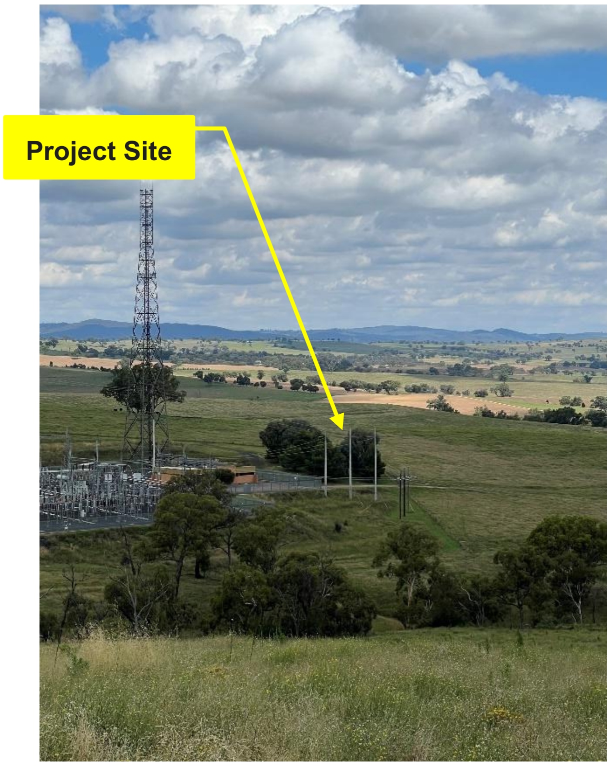
- The topography surrounding the site slopes generally downwards from east to west.
- A hillock located just over 300 m to the east is roughly 80 m higher than the Project site.

Figure 10 Topography of the Project Site and Surrounds

Photo 1 Photos of Project Site and Surrounds

View of Access Road to Site

View from North



View from South

View from West

(Photo 1 cont'd)

Looking North from the Transgrid Compound Component

Looking East along the Transgrid Compound Component North Perimeter

Table 12 lists the vegetation type and slope parameters used in the BAL calculations.

Table 12 Vegetation Type and Slope Parameters used for the BAL Calculations

Direction	Regional Ecosystem Classification	Slope Under Vegetation
BESS - North	Open Woodland / Grassland	Down - 5°
BESS - East	Open Woodland / Grassland	Flat - 0°
BESS - South	Open Woodland / Grassland	Down - 5°
BESS - West	Open Woodland / Grassland	Down - 10°
Transgrid - North	Open Woodland / Grassland	Flat - 0°
Transgrid – West	Open Woodland / Grassland	Down - 10°

5.6 BAL Calculation

The BAL Calculation for the site has been carried out using:

- CSIRO's BALA (Bushfire Attack Level Assessment) Tool

https://best-practices-assessment-tool.herokuapp.com/calculator?slope=0&vegslope=0&FFDI=60&vegtype=Tussock

Distances to the nearest vegetation have been based on the risk associated with sloping ground:

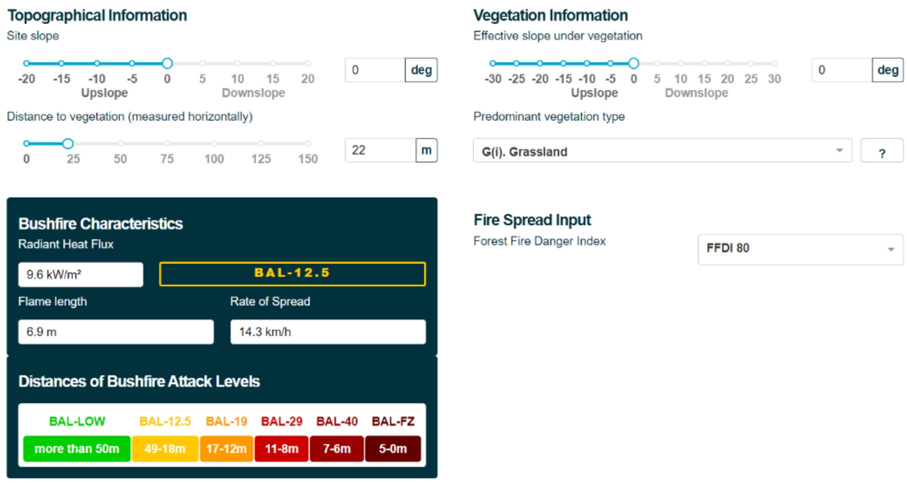
- Bushfire travels more quickly UP a hill than DOWN a hill.
- An assumption has been made that the clearance distances at the site enabled by the "inner" and "outer" areas of the site's APZ (Asset Protection Zone) have been adjusted to reflect the site topography.

The BAL calculation results are shown in **Figure 11**, with the following key outcomes:

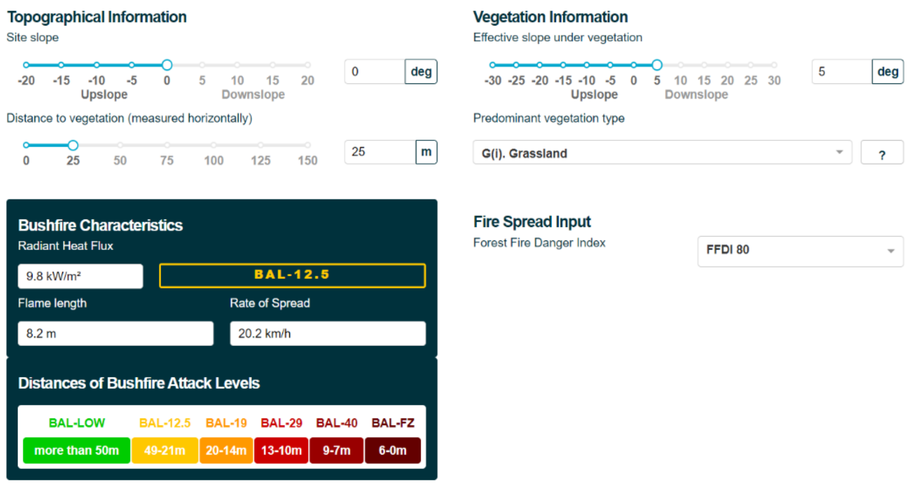
- The target BAL for the site is BAL-12.5 (all directions).
- This is the lowest BAL requiring specific construction action for bushfire management as per AS3959:2018.
- Maximum radiant heat flux at the nearest site boundary is **9.9 kW/m^2.**
- The above results have been enabled by varying the APZ distance for the site perimeter to the north, east, south and west, with the largest APZ distance to the west where a fire approaching the site would be travelling UPHILL.

Figure 11 Panorama BESS Site – BAL Calculation using the CSIRO BALA Tool

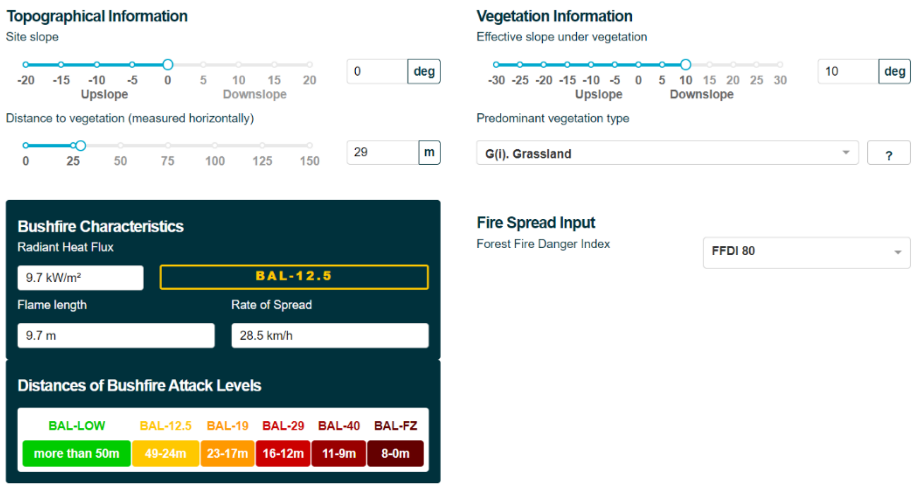
East



North / South



West



5.7 Bushfire Risk Mitigation and Management

The site requirements needed to address a potential bushfire attack fall into the following categories:

- Asset Protection Zones (APZs) to minimise the impact of radiant heat and flame contact;
- Construction Standards and Design to minimise building vulnerability to bushfire flames, radiation and embers;
- Access and Egress for the public and for firefighters and their equipment;
- Adequate Water Supply for fire suppression;
- Landscape Management; and
- Emergency Response and Management – Preparedness and Planning.

5.8 Asset Protection Zone

The recommended APZ was developed in accordance with guidance contained in:

- NSW Govt, NSW Rural Fire Service, *"Planning for Bush Fire Protection: A Guide for Councils, Planners, Fire Authorities and Developers"*, November 2019.
- NSW Govt, NSW Rural Fire Service, *"Planning for Bush Fire Protection Addendum"*, November 2022.
- NSW Govt, NSW Rural Fire Service, *"Standards for Asset Protection Zones"*.

The recommended Asset Protection Zone for the amended geometry BESS facility has been adopted for the facility and is shown in **Figure 12.**

- The recommended APZ creates a total separation from the nearest piece of equipment on the site to the nearest vegetation of the following:
  - 22 m to the east (upslope vegetation);
  - 25 m to the north and south (gentle down slope vegetation); and
  - 29 m to the west (slightly greater downslope vegetation).
- The APZ is situated on cleared ground and will provide adequate total site access for vegetation maintenance and firefighting personnel.

Benefits of the APZ at the Site Boundary

The recommended APZ achieves the following:

- The BESS and Transgrid elements of the Project will experience a radiant heat flux level **LESS THAN 10 kW/m^2** at all footprint plan equipment boundaries.

Updated APZ Compared to Approved Project

- The new Transgrid element of the Project will feature an APZ located within the existing footprint of the Panorama Substation and which currently consists of cleared ground – no vegetation needs to be cleared to achieve the APZ.

Comment on BAL recommendation.

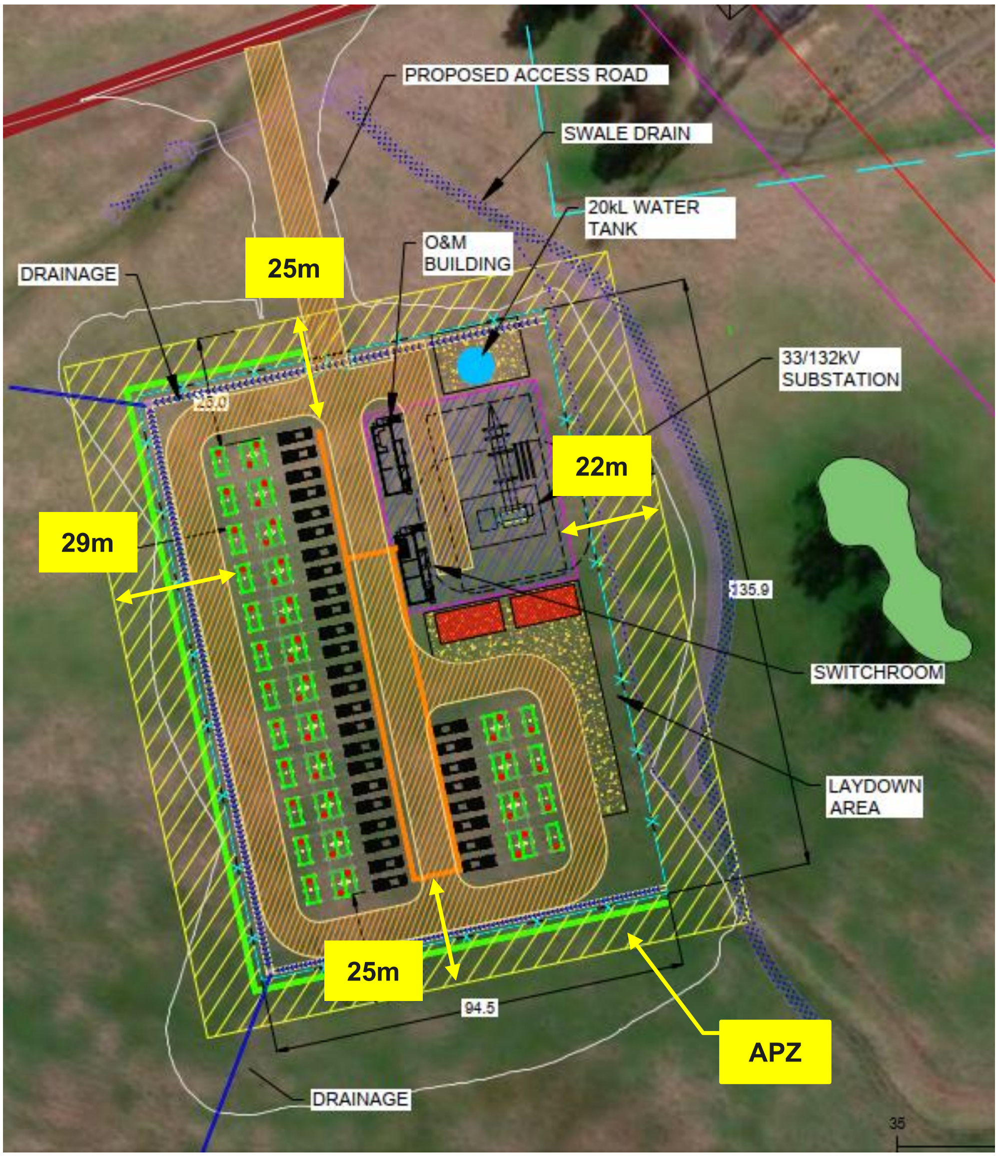
Compliance with PBP-2019 (NSW RFS, *Planning for Bushfire Protection*, November 2019) for residential development is achieved with a target BAL-29 level – related to the ability of buildings to withstand a bushfire until firefighting resources arrive on site in an emergency.

The Project is subject to PBP-2019 Section 8 and therefore, a risk assessment based on the nature of the site. The more stringent BAL-12.5 level has been recommended as this would ensure that the maximum exposure at any point of a facility will be below 10 kW/m².

This will maximise the safety of firefighters and other emergency workers to safely defend the facility, evacuate personnel if needed and allow access to and from all areas within the subject Sites.

Figure 12 Confirmed Asset Protection Zone for the Panorama BESS Site

BESS Compound APZ



(Fig.12 cont'd)

Transgrid Compound APZ

Note: The new Transgrid component of the APZ would be located within the existing footprint of the Transgrid Substation at Panorama and consists of cleared ground.

The following is noted:

- A radiant heat flux of 10 kW/m^2 is the threshold for piloted ignition of dry timber and failure of plain glass, and more generally is a target maximum exposure at any point of a site building wall or façade.
- A radiant heat flux of 10 kW/m^2 is also the threshold where firefighters and other emergency services can operate, for both firefighting and evacuating occupants from threatened buildings.
- Limiting radiant heat flux level to 10 kW/m^2 at the BESS site boundary forms a critical element of the risk management for what are termed "vulnerable" uses, which includes community infrastructure for essential services.
- Accordingly, the facility's proposed APZ achieves a performance-based outcome relevant to NSW Rural Fire Service guidelines.

Additional Project Commitment

- The Applicant commits to establishing a management regime to ensure the ongoing integrity of the proposed APZ, including responsibility for ongoing maintenance, etc.

5.9 Construction Standards and Design

The National Construction Code (NCC) is a performance based code which comprises the Building Code of Australia (BCA) as Volumes 1 and 2 and the Plumbing Code of Australia as Volume 3.

- The NCC contains Performance Requirements and Deemed-to-Satisfy provisions relating to the construction of buildings in bush fire prone areas.

The construction requirements of AS3959:2018 and the National Association of Steel-framed Housing (NASH) Standard contain Deemed-to-Satisfy solutions in the NCC, (can be varied State-to-State), for buildings in designated bush fire prone areas.

The general requirements for the construction of buildings specified in AS3959:2018 are separated according to the relevant BAL at the site of interest.

For the Panorama BESS facility, and hence for BAL-12.5, the relevant code sections are Sections 3 and 5.

Relevant Areas of AS3959:2018 Section 3

The guidance in AS3959:2018 pertains mainly to standard building construction, with a focus on external features prone to ember attack, covering items such as attached structures, garages, carports, external mouldings, bushfire shutters, glazing, etc. None of these is relevant to the BESS design.

Relevant Areas of AS3959:2018 Section 5

Again, the guidance in AS3959:2018 Section 5 pertains mainly to standard building construction, with a focus on external features prone to ember attack, covering items such as attached exposed floor supports, floor slabs, walls, external glazing, doors, roofs, verandas, etc.

Of relevance:

- Clause 5.8 states that any above-ground, water supply pipes **shall be metal.**
- Clause 5.8 also covers gas pipes and fittings – not relevant to the BESS design.

5.10 Access

Access requirements are crucial to the enabling of adequate firefighting capability and for emergency planning purposes (eg emergency evacuation). Reference is made to:

- NSW Govt, NSW Rural Fire Service, *"Planning for Bush Fire Protection: A Guide for Councils, Planners, Fire Authorities and Developers"*, November 2019.

The following general principles and RFS-compliant design apply to ensure that firefighting vehicles are provided with safe, all-weather access to the proposed BESS facility.

- BESS site firefighting access roads should be two-wheel drive, all-weather roads and appropriately sign-posted.
- Road widths accessing the site and within the site must be sufficient to accommodate firefighting vehicles. Perimeter roads are to be provided with a minimum clear width of 8 m. Non-perimeter roads are to be provided with a minimum clear width of 5.5 m.
- An unobstructed clearance height of 4 m should be maintained above all access roads including clearance from building construction, archways, gateways, overhanging structures and vegetation overhanging roads.

- In relation to vehicle turning circle requirements, any curved carriageways should be constructed using the minimum swept path dimensions shown in Table A3.2 of the above RFS 2019 Planning Guideline.
- Dead ends that are longer than 200 m must be provided with a turning head area that avoids multipoint turns. “No parking” signs are to be erected within the turning head. Example turning heads and minimum dimensions are provided in Figure A.3 of the above RFS 2019 Planning Guideline.
- Passing bays should be provided every 200 m. Where required, passing bays shall be 20 m in length and provide a minimum trafficable width at the passing point of 6 m.
- Maximum grades for sealed roads should not exceed 15° with an average grade of not more than 10°.

RFS Vehicle Specifications

In recent years, the NSW RFS has taken possession of a large number of new firefighting equipment. For specific details on RFS vehicles, refer https://www.fire.nsw.gov.au/page.php?id=161

Project Commitment:

Given the current design development stage, the Applicant has committed to the following:

- The road carrying capacity, turning circles, etc, will be designed for fully loaded firefighting vehicles of up to 23 tonnes.

Access

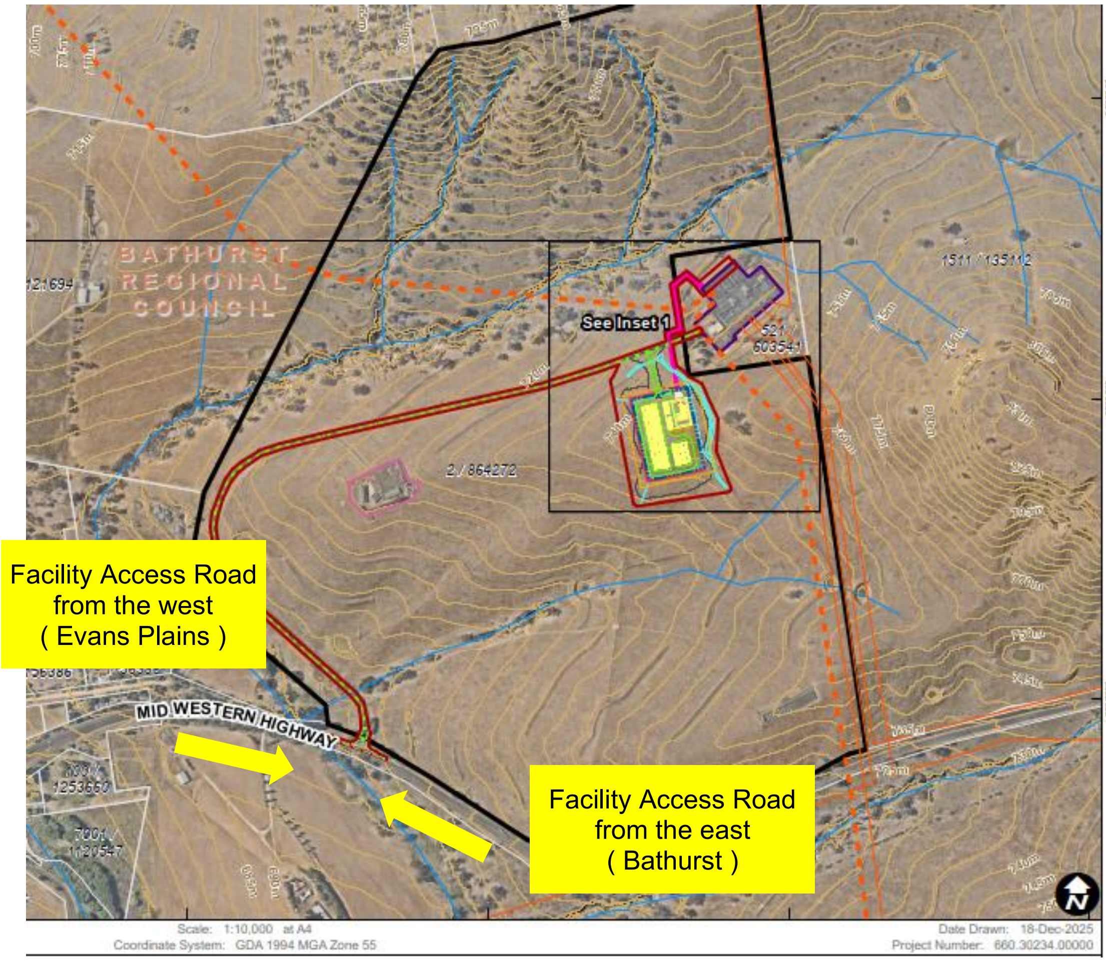
Where practical and feasible, flexible access to a facility is recommended for consideration so that access can be enabled regardless of the direction of tan oncoming bushfire.

Access provisions to the Panorama BESS site are shown in **Figure 13**.

- The access road to the facility can be approached from the EAST along Mid-Western Highway from the Bathurst direction.
- The access road to the facility can also be approached from the WEST along Mid-Western Highway from the Evans Plains direction.

Accordingly, firefighting resources have two approach paths to the facility’s access road in the event of an emergency situation.

Figure 13 Panorama BESS Facility – Access



5.11 Water Supply

It is assumed that a reticulated water supply is NOT available at the site.

In this instance, an appropriate static water supply must be provided to support effective emergency services response. This will include a water tank that satisfies the following.

The water tank:

- is clearly identified by directional signage at all access points to the facility.
- must be readily accessible by firefighting appliances.
- should be located as close as possible to the BESS facility security perimeter.
- shall have a volume as specified in AS 2304:2011.
- shall be constructed of concrete or metal; all connecting above-ground water service pipes and taps being metal.
- will be located in an area such that medium rigid vehicles (eg a 15-tonne fire appliance) have clear access within 4 m of the tank and with sufficient parking adjacent for other emergency service vehicles.

- if serviced by a rural fire brigade, is provided with IPA-rated rural fire brigade tank fittings including a 65 mm Storz outlet valve and relevant coupling. Ball valves and pipes should be adequately sized for water flow and shall be constructed of metal. The supply pipes from the tank to the ball valve should have the same bore size to ensure flow volume.
- Raised tanks have their stands constructed from non-combustible material or bush fire-resisting timber (see *Appendix F* AS 3959).

Project Commitments:

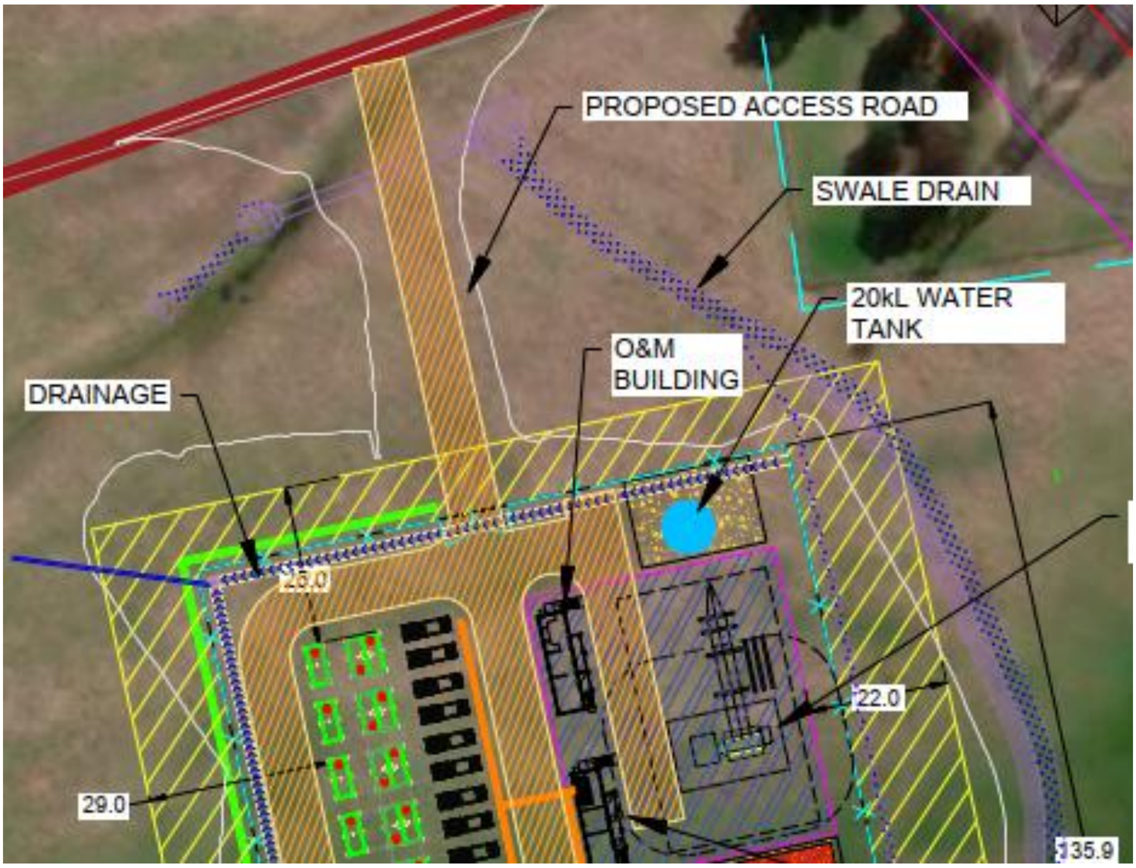
It is noted that the BESS site area is approximately 14,000 m^2.

Given the size of the development footprint, the Applicant has committed to the following:

- Ensure that the above water tank requirements are met.
- Provide a minimum 20 kL dedicated water supply for firefighting purposes.

The proposed water tank is shown in **Figure 14**.

Figure 14 Dedicated Firefighting Water Supply

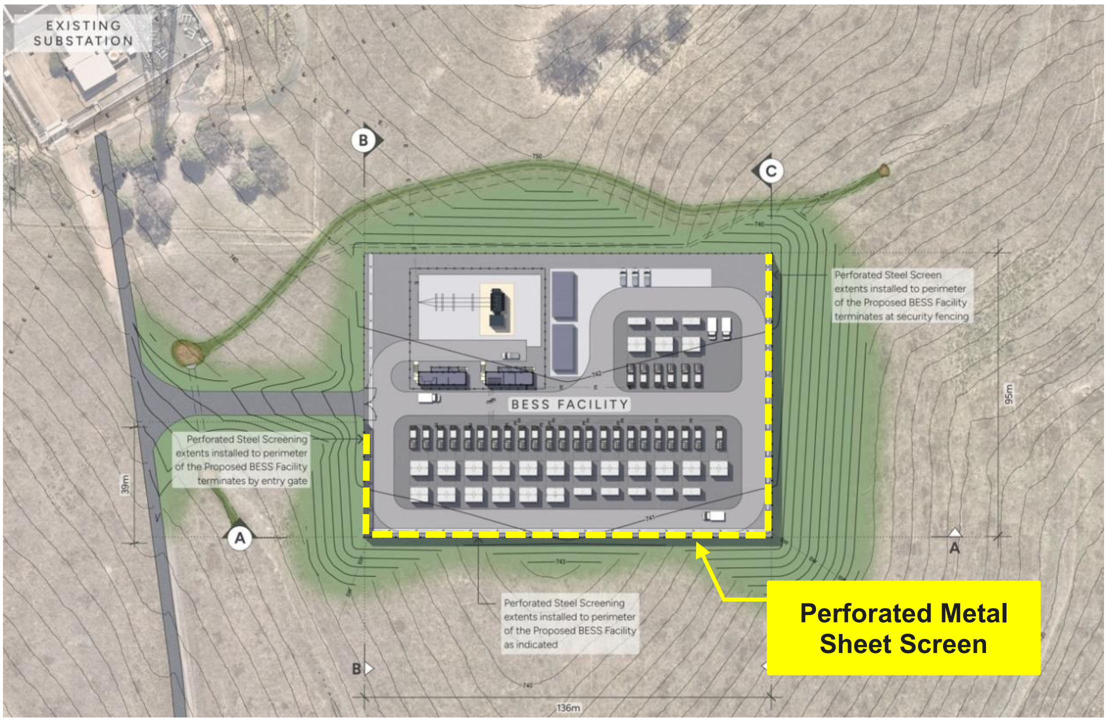


5.12 Landscape Plan

The landscape design for the amended BESS Facility design incorporates perforated steel screening finished in a recessive colour palette to minimise visual impact and blend with the surrounding environment – refer **Figure 15.**

The selected fire-rated Duratec Intensity 'Evergreen' finish ensures the screening integrates with the natural landscape, reducing contrast and reflective light from its western orientation. The perforated panels are fire-retardant and are positioned to the visually exposed perimeter of the amended BESS Facility design to provide effective visual screening while maintaining airflow and security.

Figure 15 Amended Panorama BESS Facility Landscape Concept Plan



While the BESS will have no added vegetation landscaping for visual screening purposes, some ground cover vegetation will be added to the immediate surrounding berms to assist in soli stability and to further ameliorate visual impacts of the facility.

The critical areas for landscape management at the site are therefore (i) the APZ, and (ii) the vegetation immediately surrounding the site.

- The Bushfire Emergency Management Plan for the facility (refer **Section 6.12**) shall contain a provision preventing any vegetation from taking hold within the proposed APZ zone around the site, thereby reducing the bushfire hazard risk and maintaining adequate access to firefighting personnel and equipment.
- The Bushfire Emergency Management Plan for the facility shall also contain a provision pertaining to the management of the vegetation surrounding the site, specifically limiting the height of pasture species surrounding the site to less than 1 m.

As noted in **Section 5.2** the Project is located on a lot designated as an approved 10/50 vegetation clearance zone – refer:

- NSW RFS, *"10/50 Vegetation Clearing Code of Practice for New South Wales"*, September 2015.

Clearing of vegetation under the 10/50 Code can only be conducted with the consent of the landowner. In a designated 10/50 zone, vegetation clearing can be undertaken involving …

> the removal, destruction (by means other than fire) or pruning of any vegetation (including trees) within 10 m; and
>
> the removal, destruction (by means other than fire) or pruning of any vegetation, (except for trees) within 50 m …

of an external wall of a building containing habitable rooms that comprises or is part of residential accommodation or a **high-risk facility**; or of an external wall of a building that comprises or is part of a farm shed.

The area recommended for vegetation clearing will cover:

- The APZ around the Site; and
- The Project's Site Access Road which links to the Private Access Road from Mid-Western Highway to the nearby Panorama Substation.

It is noted the part of the APZ lies outside the security fence of the BESS facility.

It is understood that landowner permission has been granted for the proposed clearing required for the APZ as well as the ongoing vegetation clearing/maintenance for the duration of the Project.

5.13 Management of Bushfire Risk Initiators

Potential "internal" bushfire risk initiators are summarised in **Table 13**, according to the stage of the Project.

Table 13 Potential Bushfire Initiators

Project Phase	Impact
Construction	Clearing activities (eg slashing, mowing and diesel-powered tool use), lightning strikes, storage of fuels/chemicals, hot welding activities, cigarette butts thrown from cars travelling within the site, traffic accidents, etc.
Operational	Ground cover/vegetation within site, ignition of electrical equipment, especially during repairs and maintenance activities, traffic accidents.
De-Commissioning	Decommissioning activities would have similar impacts to that for construction.

The Project's Bushfire Emergency Management Plan (BEMP) will include mitigation measures designed to address the risks detailed in **Table 13**.

5.14 Bushfire Emergency Management Plan (BEMP)

During the detailed design phase of the Project, a Bushfire Emergency Management Plan (BEMP) will be prepared for the Project. Key elements within the BEMP will be:

- APZ locations and management details;
- Schedule of BAL-related requirements and building footprints as well as any specific construction details;
- Access provisions such as locations, passing bays and alternate emergency access;
- Water supplies and bush fire suppression systems;
- Landscaping management requirements; and
- A Bushfire Emergency Management and Evacuation Sub-Plan within the overall BEMP.

5.14.1 Detailed Requirements of the BEMP

The following is a more detailed listing of the BEMP.

- The BEMP will identify specific responsibilities for actions required within the BEMP for the Applicant and Ultimate Operator, as well as Council.
- The BEMP will contain a detailed site layout plan identifying the locations of all site infrastructure, APZs, access routes and water supply details.
- The BEMP will identify key bushfire risks associated with the BESS facility and the strategies developed to mitigate them, including minimum APZ calculations, access requirements, firefighting water supply quantity and other design details aimed at facilitating an effective response to bushfire.
- The BEMP will include site-specific factors relevant to the site's protection from bushfire: the likely direction of bushfire attack if historic evidence indicates a bias in prevailing wind conditions during the fire season, location of evacuation routes and safety zones and identification of secondary risks, eg from nearby sites (if relevant).
- The BEMP will include: a description of the activities to be conducted on the site and in particular personnel movements covering both regular staff, maintenance staff and irregular visitors.
- The BEMP will list the storage or handling of any hazardous chemicals in quantities that would be equivalent to or exceed the threshold quantities set out in the relevant standards.
- The BEMP will show all transportation routes into and out of the site covering personnel, delivery of materials, access routes for emergency services or disaster response, etc. Details will be provide covering road layout, accessways, passing bays, evacuation routes, easements on site, designated routes for fire-fighting appliances, etc. These will be detailed in an Emergency and Evacuation Sub-Plan.
- The BEMP will clearly indicate the total extent of clearing, revegetation and landscaping proposed for the site, which is to be indicated on a site plan, including the APZ for the site. The means by which the APZ will be maintained, including who responsible, will be clearly enunciated.
- The BEMP will include information covering fire maintenance trails, if relevant.

- The BEMP will provide warning and evacuation procedures, plans and routes including capacity of public roads especially perimeter roads and traffic management treatments, and responsibility for their maintenance.
- The BEMP will detail all fire-fighting requirements including infrastructure and water supply, design standards for tanks, fittings and connection details, etc.

5.14.2 Community Engagement

- The BEMP will include recommendations to be passed on the ultimate BESS Operator (if not the Applicant) covering surrounding resident education and awareness.

5.14.3 Local Firefighting Resources

The BEMP will provide a listing of the nearest local firefighting resources, phone/email contacts, etc. The nearest Fire and Rescue NSW stations are currently:

- Bathurst Fire Station
  - 56 Suttor Street, Bathurst NSW 2795 (02) 6339 8516
- Kelso Fire Station
  - 4 Pat O'Leary Drive, Kelso NSWE 2795 (02) 6339 8505
- Blaney Fire Station
  - 23 Church Street, Blaney NSW 2799 (02) 6339 8527

5.14.4 Bushfire Initiator Risk Management – Refer Table 15

Project Stage - Construction

- Bushfire risks during construction will be managed through the implementation of a comprehensive Construction Bushfire Management Sub-Plan (CBEMP), to be prepared by the successful Project Contractor and signed off by all appropriate authorities.
- The CBEMP will ensure adequate site access for RFS along with water supply resources (20,000 L) needed to supress any fire within the Project site.

Project Stage – Operational

- Bushfire risks once the facility is fully operational will be managed through the implementation of the BEMP as described above, to be prepared by the successful Project Operator and signed off by all appropriate authorities.

Project Stage – De-Commissioning

- The BEMP will detail De-Commissioning phase management strategies similar to those deployed for the Construction phase to address the similar risks expected during this last phase of the Project.

5.14.5 Other Management and Mitigation Aspects

In addition to the above measures, the BEMP will:

- Recommend a system for the continuous monitoring of the RFS website for bushfire alerts (especially during the bushfire season).
- Ensure that smoking is prohibited throughout the site and that all employees receive training and instruction on the relevant fire procedures as part of their induction training.

Alignment of the Overall BEMP, CBEMP and ERP

It is important that the Project overall BEMP and Sub-Plan CBEMP and Project site Emergency Response Plan are aligned so that there is no conflict between activities such as the risk control measures adopted for minimising electrical hazards for firefighters attending emergency situations on-site.

All plans will be provided to RFS with copies stored locally within an appropriate "emergency cabinet" securely located within the Project site.

5.15 Bushfire Hazard Risk Conclusion

This section has shown that:

- Bushfire risk issues can be adequately mitigated.
- Accordingly, the BESS facility will be adequately protected from the threat of a bushfire event.

On the basis of the Risk Matrix shown in **Table 6**, SLR considers the residual risk associated with Bushfire fire hazard to be **LOW**, and hence adequately mitigated.

6.0 BESS Hazards and Risk Management

The safety measures involved in BESS Facility design are addressed in this section of the report to demonstrate that the BESS will not increase the extent or severity of hazards identified in **Section 4** to surrounding property, community and environment.

6.1 General Background to BESS Hazard Mitigation and Control Measures

Fire is recognised as the main hazard associated with lithium-ion batteries.

Containerised BESS Unit modules have been designed so that the occurrence of a fire does not spread easily to adjacent containerised modules, when constructed and installed according to relevant standards and guidelines.

- Refer e-STORAGE, *"SolBank 3.0 Installation Manual"*, version 1.0, 2022.

The control measures, described below, are designed to maintain and contain the risks within the site boundary and reduce the risk to areas outside the site boundary. The technical and management safeguards required for BESS units are self-evident and readily implemented as part of plant safety engineering. Following these safeguards, including codes and standards, will ensure that the resulting risk level associated with the BESS units is wither ALARP or LOW and that the proposed Panorama BESS facility meets the principles of:

- the circumvention of all avoidable risks;
- the risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low;
- the effects of significant events should, wherever possible be contained within the site boundary; and
- where the risk from an existing installation is already high, further development should not pose any incremental risk.

Technical and management safeguards relevant to the Project include but are not limited to guidance set out in the following:

- AS1768:2020 Lightning Protection
- AS 5139 Electrical Installations - Safety of Battery Systems for Use with Power Conversion Equipment
- Ditch, Ben & Zeng, Dong. (2019). Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems (FM Global Research Technical Report)
- FM Global Property Loss Prevention Data Sheets 5-33, Electrical Energy Storage
- IEC 62485-1:2015 Safety requirements for secondary batteries and battery installations - Part 1: General safety information
- IEC 62485-2:2010 Safety requirements for secondary batteries and battery installations - Part 2: Stationary Batteries
- IEC 62619:2017 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- IEC 62897 Stationary Energy Storage Systems with Lithium Batteries - Safety Requirements

- IEC 62933:2018 Electrical Energy Storage (ESS) Systems
- NFPA 855: 2020 Standard for the Installation of Stationary Energy Storage Systems
- UL 9540 Standard for Energy Storage Systems and Equipment
- UL 9540A ANSI/CAN/UL Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

6.2 BESS Equipment of Interest

As noted in **Section 1**, improvements in battery energy storage technology since the submission of the EIS mean that the SolBank 3.0 system offers an increased capacity and enhanced energy density per battery container while reducing the BESS layout footprint by approximately 20% or 0.35 ha.

- The rated capacity of the SolBank 3.0 system is 4.7 MWh with an energy density of 339kWh/m^2.

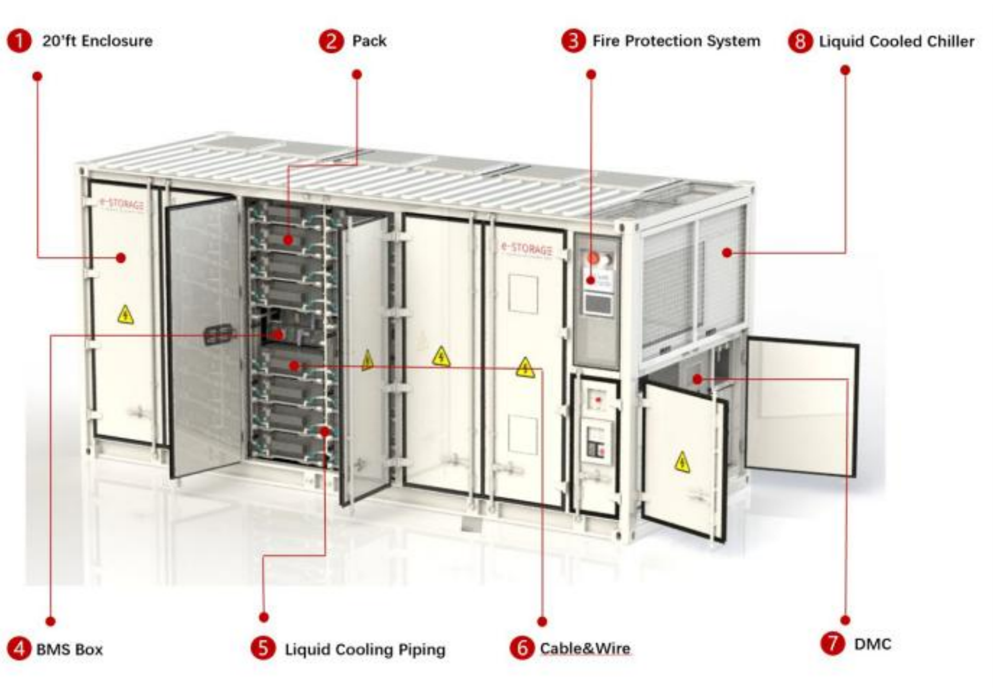
The SolBank 3.0 unit is shown in **Figure 16**.

The design upgrade of the Project will also involve the replacement of previous Twin Skid compact units with Single type compact units.

As a result, the amended Project will now comprise:

- 48 x Battery Storage Containers: SolBank 3.0
- 32 x MV Single Skid Compact Units comprising one invertor and one low voltage to high voltage transformer;
- 33 kV to 132 kV transformer; and
- Control Room Heating, Ventilation, and Air Conditioning (HVAC).

Figure 16 SolBank 3.0 Unit



6.3 BESS Related Fire Hazards

BESS-related fire hazards arise from the following two broad areas.

Risks Associated with Non-Battery Fire Events

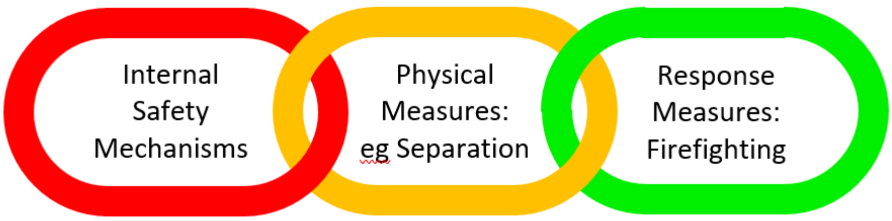
- Wiring Issues, eg short circuits.
- Electrical Safety System Failures, eg fuses, breakers, insulation, etc.
- Mechanical Interference, eg bugs, rodents, mishandling, etc.

Thermal Runaway

- Causes: manufacturer defect, overcharge, over-discharge, mechanical damage, environmental (too hot, too cold).
- Hazards Produced: heat, flame, off-gassing of mainly H2 and CO, off-gassing of other toxic gases, deflagration/explosion risk.

The key “links” in managing “internal” fire related risks within a BESS facility are illustrated in the “Fire Response Chain” shown in **Figure 17**.

Figure 17 Key Strategic Links in Managing BESS Fire-Related Risks – the Fire Response Chain



- **Link 1**: Globally manufactured, commercially available BESS units (battery packs, convertors, etc) come with a range of sophisticated in-built hazard reduction mechanisms to: firstly, avoid the onset of a fire event; secondly, detect a fire and “announce” it to relevant “stakeholders”, and thirdly, contain and suppress the fire until external firefighting resources can be brought to bear to shut the fire down, if it has not already been contained.
- This is the case with the proposed SolBank BESS Units and the MV Inverter Units
- **Link 2**: In between the Link 1 automatic fire-management systems and the Link 3 intervention of fire-fighting resources are a series of physical measures, eg BESS separation distances, APZ zones, etc, designed limit the spread of a fire event until firefighting resources arrive to shut down the fire, if it has not already been contained.
- **Link 3**: Appropriate access for firefighting vehicles, availability of an adequate water supply for firefighting, emergency response planning, etc, form the last link aimed at being able to shut a fire down before it spreads beyond the BESS perimeter and into the surrounding community.

In relation to **Figure 17:**

- A strong **Link 1** places less onus on **Links 2 and 3**, and
- Strong **Links 1 and 2** place less onus on **Link 3**.

6.4 Link 1

It is worth re-stating that grid-scale BESS units provided currently by global manufacturers (eg SolBank's BESS Unit) typically contain a hierarchy of fire management controls which create layers of protection:

- SolBank 3.0 features **LiFePO4 chemistry**:
  - LFP chemistry is preferred over NMC because of the higher onset temperature for Thermal Runaway (270°C for LFP versus 210°C for NMC).
  - LFP also has a significantly lower self-heating rate than NMC chemistry batteries.
- Compared to the previously proposed SolBank units, the updated SolBank 3.0 features:
  - Up to 20% faster detection of abnormal and automatic protection; and
  - Advanced pack thermal isolation, electrical redundancy protection, and multi-level fire protection, effectively minimize potential issues
- SolBank 3.0 units come with an advanced BMS (Battery Management System) which monitors a range of variables related to the onset or incidence of a fire event (temperatures, over and under-voltage, over-currents, etc).
- The BMS will then trigger alarms, instigate internal fire suppression equipment and automatically disconnect each BESS unit in the event of a fire.
- Electrical Protection is enabled via an IP67-rated pack design which features Current Interrupt Devices (CID) and Rack Level Fuse Protection.
- SolBank 3.0 also features its own CSI Intelligent Thermal Management System.
- SolBank's fire detection system includes Thermal and Smoke Detectors, Explosive Gas Sensing and H_2 Detection for Thermal Runaway.
- Mechanical protection is enabled via Pressure Relief Valves.
- Cabinet walls which are adjacent to other units are fire-rated to EI60 – this provides a 2-hour fire wall between adjacent units.
- Roof panels are designed for blast loading to minimise the impact of any potential deflagration/explosion, including roof panel rupture.
- SolBank 3.0 Fire Detection and Alarm comprises:
  - A fire alarm panel; heat and smoke detection; and alarm bell and strobe.
- SolBank 3.0 Explosion Prevention features:
  - Combustible gas detection with active ventilation
- SolBank 3.0 Power Back-up is enabled via:
  - Container Uninterrupted Power Supply for a 2-hour control system back-up; and
  - Dedicated fire safety Uninterrupted Power Supply for 24-hour fire alarm back-up.
- SolBank 3.0 Fire Suppression features:
  - Aerosol-based suppression; and
  - A dry pipe sprinkler system.

6.4.1 SolBank 3.0 – Certifications and Standards Compliance

Table 14 SolBank 3.0 Certifications / Standards Compliance

Aspect	Impact
Design	NEC – National Electrical Code® IEEE C84.1 – Standard Preferred Voltage Ratings for Alternating- Current Electrical Systems IEEE 693 – Recommended Practice for Seismic Design of Substations IEEE 1584-2018 – Guide for Performing Arc-Flash Hazard Calculations NFPA 855 – Installation of Energy Storage Systems NFPA 70E® – Standard for Electrical Safety in the Workplace® NFPA 72 – National Fire Alarm and Signalling Code IEC62933-5-2 – Safety requirements for grid-integrated EES systems - Electrochemical-based systems AS3000 - Electrical installations “Wiring Rules”
Product Certification	IEC 60529 – Degrees of protection provided by enclosure IEC62619 – Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications IEC63056 – Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems IEC/EN 62477-1 – Safety requirements for power electronic converter systems and equipment - Part 1: General IEC/EN 61000 – Electromagnetic compatibility (EMC) UL 60730-1 – Standard for safety: Automatic Electrical Controls – Part 1:General Requirements UL9540A – Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems UL1973 – Standard for safety: Batteries For Use In Stationary and Motive Auxiliary Power Applications UL9540 – Standard For safety: Energy Storage Systems and Equipment NFPA 69® – Standard on Explosion Prevention Systems NFPA 68® – Standard on Explosion Protection by Deflagration Venting UN38.3 – Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria
Fire Protection and Safety	NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems NFPA 15 – Standard for Water Spray Fixed System for Fire Protection NFPA 2-2023 – Hydrogen technologies code BS 5839-1 – Fire detection and fire alarm systems for buildings BS 7273 -1 – Code of practice for the operation of fire protection measures BS EN 54 Pt1- 21 – series for equipment BS EN 15004-1:-2019 – Fixed firefighting systems. Gas extinguishing systems. Design, installation and maintenance. BS EN 15004-2:2020 – Fixed Firefighting Systems-Gas Extinguishing Systems FK-5-1-12

Aspect	Impact
	BS 6266:2011 – Fire protection for electronic equipment installations – Code of practice BS EN 12094-1:2003 – Fixed firefighting systems. Components for gas extinguishing systems Requirements and test methods for electrical automatic control and delay devices AS 4487-2013 – Condensed aerosol fire extinguishing systems – Requirements for system design, installation and commissioning and test methods for components AS 7240– Fire Detection and Alarm Systems AS1670 – Fire detection, warning, control and intercom systems – System design, installation and commissioning AS 1851-2012 – Routine service of fire protection systems and equipment

6.5 Link 2

The key to **Link 2** (refer **Figure 3**) is to provide sufficient clearance between rows of adjacent BESS units (whether modular/cabinet type or containerised type) and between BESS units and the BESS enclosure perimeter.

- Typically, BESS battery packs have a minimum clearance distance to the nearest boundary of their enclosure of between 5 m to 6 m. This is based on the radiant heat flux from a theoretical BESS battery pack fire that might be experienced by site personnel.
- Rows of adjacent BESS battery pack units will also be separated by a minimum clearance which will vary in terms of the front and end walls and side walls. This is based on the radiant heat flux from a theoretical BESS battery pack fire that an adjacent BESS unit might experience in relation to its structural integrity.

BESS Unit Separation Distances via Regulatory Guidelines

Some information is available amongst international standards and guidelines regarding minimum separation distances between BESS packs and between BESS packs and surrounding personnel access areas.

For example, NFPA 855-2020 Standard for *the Installation of Stationary Energy Storage Systems*, (US) National Fire Protection Association (latest edition 2020) specifies:

- A minimum of 10 feet (3.05 m) separation to lot perimeters, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with the electrical grid.

AS/NZS 5139:2019 *Electrical Installations – Safety of Battery Systems for Use with Power Conversion Equipment* also provides guidance with respect to minimum separation distances from personnel and buildings and other equipment. The minimum separation distances (which range from 600 mm to 900 mm) do not apply in the present instance – the facility's BESS units will be located within their dedicated area, isolated from personnel by the facility's Perimeter Fence as shown in **Figure 2**.

BESS Unit Separation Distances via Quantitative Fire Modelling

SLR has reviewed the literature of credible fire scenarios for comparable containerised BESS systems.

Guidance for example in relation to a fire event relevant to BESS units can be found in:

- AS 1530.4:2014, *"Methods for fire tests on building materials, components and structures – Fire resistance tests for elements of construction".*

Other relevant international standards include:

- SFPE S.01, *Standard on Calculation Fire Exposures to Structures,* Society of Fire Protection Engineers; Gaithersburg MD, 2011.
- SFPE S.02, *Standard on Calculation Methods fo Predict the Thermal Performance of Structural and Fire Resistive Assemblies*, Society of Fire Protection Engineers; Gaithersburg MD, 2015.
- ISO 23932-1:2018, *Fire Safety Engineering – General Principles – Part 1: General*.
- CIBSE Guide E, *Fire Engineering*, 3rd Edition, Chartered Institute of Building Services Engineers, UK, 2010.

The above standards provide parametric fire curves which can be used to estimate the upper bound of the likely fire temperatures relevant to a BESS unit.

These are typically in the range:

- 800-1,000°C at an "open" side of a containerised unit – a typical value found in the literature is 840°C, a standard upper limiting value used in fire simulations for fire spread between office buildings.
- 600°C at a "closed" side of a containerised unit – refer the SPFE and CIBSE Handbooks above, for a severe, fully developed fire in a containerised unit.
- 700-800°C for sides between an "open" and "closed" side.

Common assumptions made in the literature for BESS fire simulations include the following:

- BESS units are assumed to be a "black body" (worst-case from a fire spread point of view).
- Fire spread is via the Stefan-Boltzmann Law, with uniform heat loss.
- Emissivity factors in the range 0.9-1.0.

SLR's literature search of worst-case BESS fire simulations based on the above assumptions indicate the following approximate minimum separation distances:

- 6 m = minimum distance from either the front, end or side walls of any BESS battery pack to the associated enclosure fence perimeter (based on the 4.7 kW/m2 criterion).
- 3 m = minimum distance between adjacent BESS battery pack side walls (based on the 12.6 kW/m^2 criterion).
- 4 m = minimum distance between adjacent BESS battery pack front and end walls (based on the 12.6 kW/m^2 criterion).

On the basis of the above, various possible configurations of BESS battery packs within a rectangular area can then be assessed for a given total area allocated to the facility.

BESS Unit Separation Distances via Certified Tests – UL9540A

The standard certification test for establishing (amongst a number of design parameters) the minimum fire-related clearances for commercially available BESS containerised units is UL9540A:

- UL 9540A ANSI/CAN/UL *Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage System*.

In fact, UL has established a database of its BESS container fire tests and provides free access to this database:

- Refer … https://www.ul.com

The proposed SolBank 3.0 BESS Units has been subject to fire testing under UL9540A and certification to NFPA 855. From these, the following minimum equipment distances have been determined for maintenance and ventilation – these distances should be confirmed via the detailed (post-approval) Fire Safety Study carried out for the Project.

- SolBank3.0 units can be installed as stand-alone units or back-to-back.
- The “left” side should keep no less than 1.7 m free for air exhaust distance, maintenance of the liquid cooling piping and safety channel distance.
- The “right” side should keep no less than 2.5 m for maintenance of the chiller.
- If back-to-back:
  - The “front” side housing the access doors must always have a clear 3.5 m between the SolBank3.0’s surface and all obstructions – for door swing, battery pack replacement and movement of equipment and personnel.
- If side-by-side:
  - Units must maintain a minimum clearance of over 2.5 m between them to accommodate emergency stop buttons and maintenance and operating procedures.

Figure 18 shows some actual installations involving CSI SolBank BESS Units based on the above unit-to-unit distances.

On the basis of the UL9540A certified unit-to-unit separation distances noted above, the space allocated for the 48 SolBank 3.0 BESS Units (~9,000 m^2 – refer **Figure 2**) should be more than sufficient to accommodate the 100 MW/200 MWh BESS capacity proposed for the site.

Figure 18 Example CSI SolBank Installations

6.6 Link 3

Within this report, Section 5 separately addressed:

- **Asset Protection Zones, Landscaping and Construction Standards:** including non-combustible security fencing to be installed around BESS units and related infrastructure and the APZ around the external boundary fence, to be managed as an inner protection zone (IPA).
- **Access:** to the BESS facility with fire trail access around the BESS compound perimeter fence
- **Water Supply:** including a supply pipe from the proposed 20 kL static water tank, positioned close to the BESS compound to enable responding fire fighters to access this water supply.
- **Bushfire Emergency Management Plan:** to be developed post-approval.

6.7 BESS Fire Hazard Risk Conclusion

This section has shown that:

- BESS-related fire risk issues can be adequately mitigated. Accordingly, the BESS facility will not itself pose an additional fire hazard that has the potential to increase the extent or severity of a bushfire event on surrounding property, people and the environment, and
- The proposed BESS capacity can be comfortably accommodated within the site space provided.

On the basis of the Risk Matrix shown in **Table 6** SLR considers the residual risk associated with the BESS-initiated fire hazard to be **LOW**, and hence adequately mitigated.

7.0 Case Studies Relevant to BESS Safety Development

Traditionally, the safety of engineering systems (civil, mechanical, electrical, etc) has evolved through three main avenues:

R&D:	especially in the early stages of development of a new product or system;
Standards:	compliance with standards provides an avenue for underpinning safety; and
"Lessons Learned":	typically, through failures, accidents, etc, where low probability failure mechanisms are discovered, and mitigation measures developed to prevent their occurrence in the future.

7.1 Two Important Case Studies

Two important case studies contributing to the body of "Lessons Learned" for BESS incidents are:

- Victorian Big Battery (VBB) Fire – 30 July 2021
- Arizona Public Service (APS) Utility BESS Fire and Explosion – 17 April 2019

The above are detailed in **Appendix B**.

7.2 Key Lessons Learned Relevant to the Panorama Project

Key lessons learned from the **Appendix A** case studies are summarised in **Table 15**.

Table 15 Case Study Key Learnings

Area	Key Weakness/Flaw Identified	PANORAMA Project Response
Victoria Big Battery (VBB) Fire (2021)		
Commissioning	Limited supervision/monitoring of telemetry data during the first 24 hours of commissioning. Use of the keylock switch during commissioning and testing.	The power supply arrangement for the Panorama BESS containers includes an independent low voltage supply for the monitoring and telemetry systems. This ensures data will be available consistently from the commencement of commissioning.
Electrical Fault Protection Devices	Coolant leak alarms not being active. Pyro disconnect being unable to interrupt fault currents when the Megapack was off via the keylock switch. Pyro disconnect likely being disabled due to a power supply loss to the circuit that actuates it.	The independent low voltage supply described above also ensures protection and safety devices are powered even if the main DC power system is isolated.
Fire Propagation	The significant role external, environmental conditions (such as wind) can have on a BESS fire.	The Panorama BESS container design does not include direct ventilation of the battery compartments under normal operation and thus no path for external flames to directly enter the battery bays.

Area	Key Weakness/Flaw Identified	PANORAMA Project Response
	The identification of a weakness in the thermal roof design (unprotected, plastic overpressure vents in the ceiling of the battery bays) that permitted Megapack-to-Megapack fire propagation.	
Emergency Response	Amount of firefighting water used at the site was subsequently deemed excessive by fire and emergency services.	SOLBANK design procedures are in line with the latest best practice, regularly workshopped with fire authorities. This includes clear response plans recommending NOT to apply water directly onto a BESS unit on fire. Application of water to other equipment near a BESS fire (such as transformers) may be used as a tactic to protect that equipment. The Proponent is cognisant of potential contamination of firefighting water and will implement features in the civil design that prevent contaminated firewater from entering the environment. Clean up and disposal of contaminated material, should a fire occur, is also considered in the design.
Battery Chemistry	The VBB fire event BESS units (Megapack) incorporate NMC (Nickel Manganese Cobalt) chemistry.	SOLBANK uses LFP (Lithium Iron Phosphate) battery chemistry due to its superior thermal stability and safety credentials compared to NMC. This is in line with trends across the large-scale battery energy storage industry globally.
Arizona Public Service BESS Fire (2019)		
Fire Suppression “Clean Agent” Systems	The assumption regarding the effectiveness of relying solely on clean agent systems to subdue a BESS fire was made evident.	Clean agent systems may still be appropriate for use in BESS facilities to manage incipient fires, but they must be used in conjunction with additional practices: i.e. ventilation, extinguishing, and cooling - to manage thermal runaway scenarios. Clean agent or aerosol extinguishing methods should not be the only barrier against thermal runaway. For the Panorama BESS container design, the decision to deploy (or not deploy) fire suppression systems will be based on their effectiveness in dealing with a battery fire and thermal runaway.

Area	Key Weakness/Flaw Identified	PANORAMA Project Response
		The SOLBANK approach to BESS fire and thermal runaway is aligned with the latest globally recognised standards. This includes fire and thermal runaway off-gas detectors, battery management system monitoring, automatic system shutdown and isolation, and venting of dangerous gasses (as per NFPA 69).
Project Team Communications	The APS event exposed weaknesses in the communications covering fire safety between the roles of the Individual Equipment Manufacturer, Systems Integrator, EPC Contractor, and Operations and Maintenance (O&M) personnel.	SOLBANK trained and accredited personnel will be employed for the BESS site O&M crew. The BESS will have 24/7 remote monitoring and an O&M crew member will be on-call at all times. The Proponent intends to select an EPC Contractor that has constructed a large-scale BESS (preferably with SOLBANK) previously.
Emergency Response	The APS event also exposed weaknesses in relation to the understanding of hazards and training provided to first responders, critical to the safety of emergency service personnel.	The Proponent will develop clear fire and emergency response plans in conjunction with the local emergency services, SOLBANK and the O&M contractors in line with current best practice. This process will include training and familiarisation with the specific site.

7.3 Panorama Management Pans

The key learnings summarised in **Table 15** will also be considered in relation to the development of the Project's various post-approval management plans covering:

- Emergency Plan (EP).

… to be aligned with:

- Bushfire Management Plan.
- Water Management Plan - which must contain a specific section addressing the containment of firewater.
- Fire Safety Study – focussing on BESS-related hazards and lessons learned from past BESS incidents.
- Risk Management Plan.
- Spill Management Plan.

8.0 BESS Fire Toxic Plume

8.1 SLR Monte-Carlo Simulation Study

In recent years, growing interest has emerged in the potential for toxic air emissions arising from the BESS thermal runaway event, with the focus on HF, HCN, HCl and $PM_{2.5}$.

The latter were the subject of a recently-completed SLR study for a 450 MW/900 MWh BESS project study involving dispersion modelling of potential toxic gas release from a BESS fire.

Dispersion Modelling Inputs

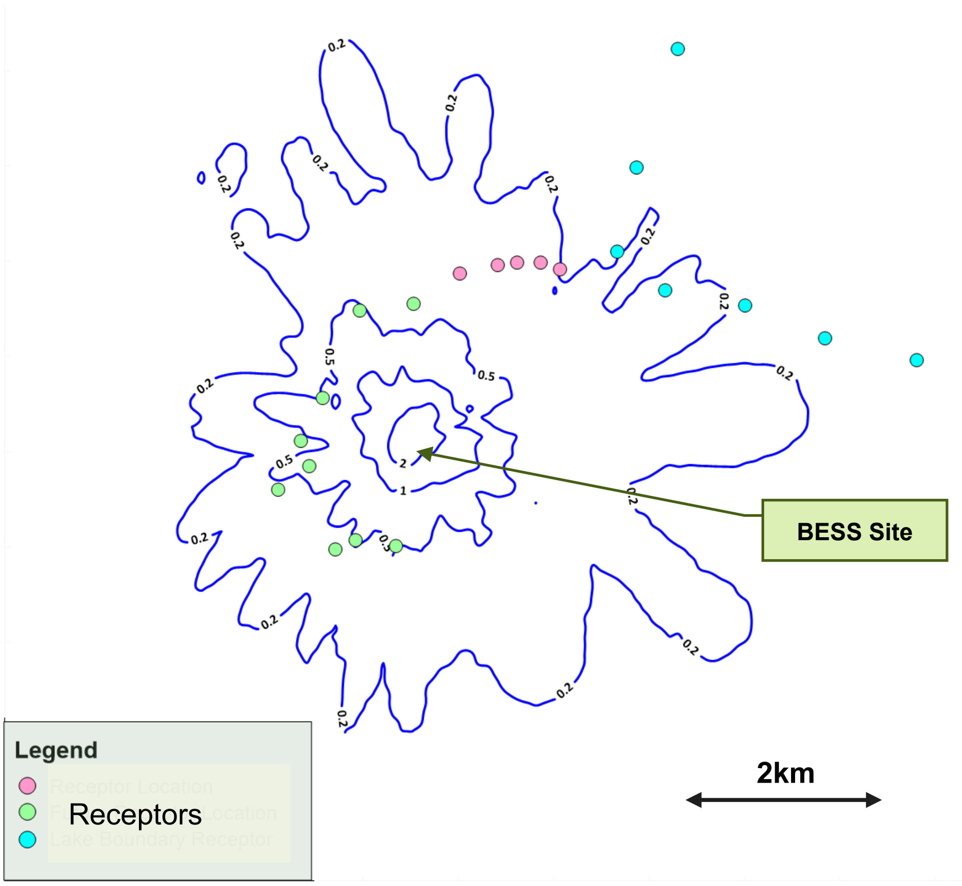
- The SLR Study considered the following three thermal runaway scenarios:
  - Scenario 1: Single Module Release
  - Scenario 2: Single Stack Module Rack Release
  - Scenario 3: 4-Stack Module Unit Release
- The study included the following meteorological inputs:
  - Windrose statistical distribution of wind speed and wind direction, developed for the local site.
  - Atmospheric stability using the Pasquill-Gifford-Turner (PGT) classification and Mixing Height.

Modelling Output

The modelling used a novel Monte-Carlo Simulation technique whereby:

- Literally tens of thousands of years of potential BESS fire incidents were simulated so as to create a database of potential emission results covering the full range of meteorological parameters noted above.
- The BESS fire plumes created in the simulation therefore covered all potential wind directions (according to their wind rose probability of occurrence), the full range of wind speeds at the site, stability class occurrence, daytime/night-time occurrence, etc.
- The results were presented in the form of isopleth plots showing the predicted impacts surrounding the BESS site. An example is shown in **Figure 19**. The underlying Google Earth location of the modelled BESS area has been deleted (for confidentiality reasons), although the diagram scale is shown.
- Note: The isopleth plots do not represent the dispersion pattern for any one individual BESS fire event. They represent the maximum potential concentration predicted to occur at all calculation points surrounding the BESS site representing the full range of meteorological conditions occurring over the modelling period.

Figure 19 Example Air Toxic Isopleth Plot (units µg/m³)



AEGL Criteria for HF

Table 16 shows the relevant HF criteria, expressed as AEGL (Acute Exposure Guideline Levels) **-** source: Hydrogen fluoride Results - AEGL Program | US EPA.

Table 16 Recommended AEGL Criteria for HF (ppm)

	10 min	30 min	60 min	4 hr	8 hr
ppm					
AEGL 1	1.0	1.0	1.0	1.0	1.0
AEGL 2	95	34	24	12	12
AEGL 3	170	62	44	22	22

AEGL 1 Notable discomfort, irritation, or certain asymptomatic non-sensory effects. These effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL 2 Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL 3 Life-threatening health effects or death.

Recommended BESS Fire HF Criterion

- The relevant critical HF criterion would be at AEGL-2 level for one of the longer exposures, i.e. 12 ppm.
  - This would cover the maximum permissible exposure level potentially experienced by firefighting personnel present at a BESS site during a BESS fire event.

Results of the SLR Study

- SLR has taken the results of the Monte-Carlo Simulation study described above and extrapolated the results with an HF emission rate based on a 4-hour BESS fire duration.
- Maximum extent HF isopleth results representing the worst-case individual meteorological scenario event from the simulation covering the full suite of potential meteorological parameters at the site reached the AEGL-2 level of 12 ppm at 50 m.
- Peak concentrations for HCN, HCl and $PM_{2.5}$ were significantly lower.

8.2 Comparison Single BESS Fire Event Prediction

To calibrate the above Monte-Carlo Simulation study, SLR modelled a single-event BESS fire using the Gexcon EFFECTS software suite.

Assumptions

- Chemistry LFP
- Battery size 3.5 MW
- Fire Duration 12 hours (conservative)
- HF mass flowrate 0.018 kg/sec

Results

For a worst-case wind/stability scenario, the following results were predicted:

- AEGL Level 2 critical distance 90 m (in the wake of the plume)

8.3 SFPE Modelling

Reference is made to the following recent SFPE (Society of Fire Protection Engineers) publication:

- McAllister, J.L, McCarrick, B. and Zhao, Z.Q., *“Environmental and Health Impacts of Thermal Runaway events in Outdoor Lithium-Ion Battery Energy Storage System Installations”*, SFPE Foundation, June 2025. https://doi.org/10.64167/3d04-pax1

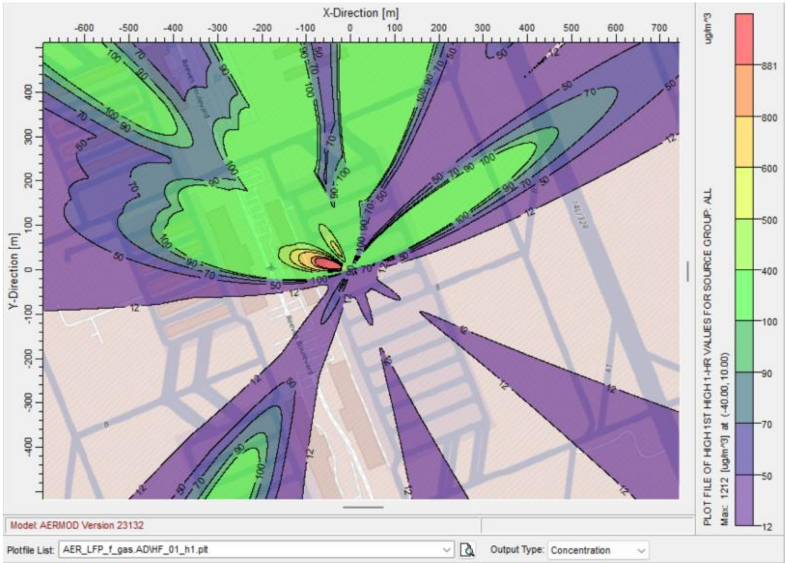
The SFPE study assessed the health and environmental impacts from thermal runaway events in outdoor, large-scale, Li-ion BESS units.

- Representative BESS unit characteristics were gathered from UL 9540A test documentation.
- Data on thermal runaway characteristics of Li-ion batteries, including propagation rates, gas emission composition and yields, heat release rate, mass loss rate, total heat released, total gas produced, and cell gas venting temperatures was collected from peer reviewed studies and historical Li-ion BESS incidents.
- Fire Dynamics Simulator (FDS) was selected for analysis of near-field (up to 200 m) health impacts. AERMOD was selected for analysis of far-field (up to 2.5 km) health and environmental impacts. While AERMOD may be capable of high-level predictions of long-range plume dispersion and grounding, it was note that FDS would likely be more suitable for near-field analysis (up to 200 m) in scenarios involving combustion (and buoyancy driven flow).
- The modelled scenarios involved a generic 3.1 MWh outdoor BESS unit undergoing thermal runaway in a rural area with flat terrain and low-lying vegetation.
- Non-flaming and flaming thermal runaway scenarios were modelled.
- Both LFP and NMC cell chemistry were modelled.
- No fire suppression was modelled.
- For the flaming scenarios, it was conservatively assumed that thermal runaway propagated throughout the full BESS unit. Incident durations for the non-flaming and flaming simulations were based on historical incidents.
- The FDS and AERMOD models were used to predict concentrations of gases at a breathing heigh of 1.5 m.
- The AERMOD model also predicted metal particulate deposition onto ground level surfaces such as soil and water.
- Wind speed variations between 2 m/s and 10 m/s were examined.
- Temperature variations between 7° and 35° were examined.
- Three stability classes were examined: Stable, Neutral, Unstable.
- Human health impact was evaluated by measuring the distance at which occupational or community exposure limits for gases were exceeded, i.e., IDLH and PAC, respectively. Environmental impact was evaluated by determining the relevant LC50 and EC50 values based on the location, as well as the reference depth for soil and water. Deposition at a point of interest was calculated to provide an example of the environmental impact methodology.

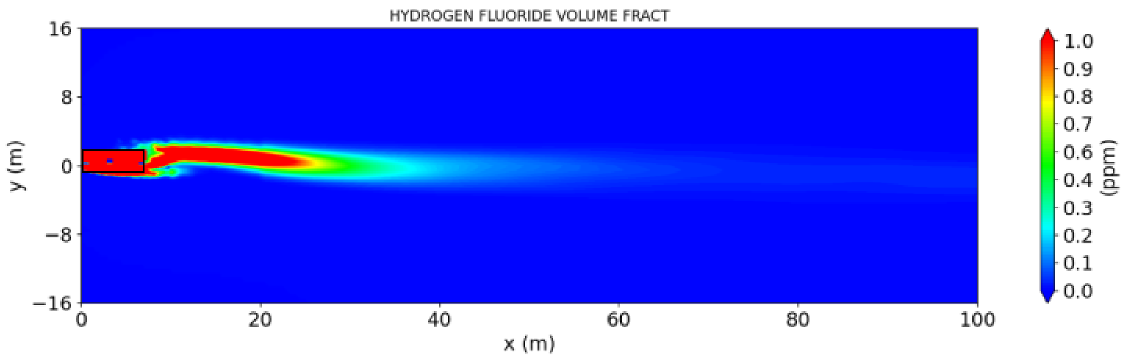
A sample SFPE modelling scenario (involving HF) is shown in **Figure 20** .

Figure 20 SFPE AERMOD and FDS Modelling Examples (HF Emissions)

AERMOD – HF concentration plot for the LFP flaming scenario.



FDS – HF AEGL-1 concentration (10 m/s, 22°C, 4-hour duration) for the LFP flaming scenario



SFPE Summary Results:

- Chemistry: LFP
- Thermal Runaway Scenario: Flaming (entire BESS involved)
- Governing Toxic Compound: HF
- FDS Modelling Critical Distances to relevant health criterion:
  - AEGL Criterion: 16 m
- AERMOD Modelling Critical Distance to relevant health criterion:
  - AEGL Criterion: 83 m

8.4 Conclusion of All Modelling Results

SLR's Monte-Carlo Simulation results, the EFFECTS modelling results and the SFPE results are comparable in relation to HF emissions.

Given the uncertainty surrounding actual HF emissions from a BESS fire event, SLR recommends a precautionary approach using the more conservative EFFECTS-based results.

- It is therefore recommended that only properly trained emergency response personnel with proper PPE should approach a BESS unit on fire when within 90 m of the unit AND in the area of the plume wake behind the BESS unit.
- No constraint would be placed on approaching the BESS unit on fire from the windward side.
- The consequences to surrounding land use, including the nearest residential areas, would be negligible.

8.5 Global Context of the RMP Toxic Plume Assessment

The preceding sections have shown the following:

- Safe working distances were derived in terms of PPE requirements for emergency service personnel working in the proximity of a BESS fire.
- It has been demonstrated that the proposed BESS facility will not create an unacceptable health risk in relation to air quality for surrounding residential areas.

The above conclusions can be viewed in the context of the following recent industry-wide survey of BESS Facility Fires:

- Fire & Risk Alliance (FRA) LLC, *"Assessment of Potential Impacts of Fires at BESS Facilities"*, Executive Summary, 29 March 2025.

The FRA report analysed historical BESS fire incidents and, their causes, a review of the types of contaminants released, the extent of environmental impacts, and the extent to which advancements in safety regulations and technology have mitigated risks.

The FRA report covered 35 documented large-scale BESS fire incidents in the United States between 2012 and 2024, occurring in 16 States.

8.5.1 Key Trends

The following key trends emerged from the analysis:

- **Legacy System Involvement:** Many of the incidents involved early-generation BESS units that predate modern safety codes and lacked rigorous testing and integrated safety features.
- **Early Lifecycle Failures**: 51% of the incidents reported the age of the system. Almost half of those incidents occurred within the first six months of operation, highlighting the importance of challenges during the commissioning and initial operational phases of BESS units.
- **Operational State at Time of Incident:** Among incidents where operational status was known, 69% of fires occurred during system use, while 17% took place during assembly, testing, or pre-commissioning.

- **Challenges in Root Cause Analysis:** Investigating BESS fires was found to be complex due to the destruction of components at high temperatures. Available data suggests that failures primarily stemmed from system integration, construction, and assembly issues rather than fundamental battery chemistry concerns.
- **Advancements in Safety and Design:** Newer BESS units benefitted from lessons learned and the associated improved safety measures, such as advanced thermal management, suppression systems, and enclosure design, significantly reducing the likelihood of large-scale incidents.

8.5.2 Analysis of Airborne Emissions from BESS Fires

The FRA report noted that a key concern in BESS fire events is the release of toxic gases. The report found that the emissions from the BESS fires reviewed were confined to the immediate vicinity of the fire, with rapid dissipation and concentration reduction in open-air scenarios. It was noted that BESS fires share many similarities with conventional fires, particularly those involving plastics, in terms of combustion byproducts.

This is because the materials that make up lithium-ion batteries - such as polymer-based separators, electrolytes, and enclosures - contain hydrocarbons and other organic compounds that produce similar combustion emissions when the materials are exposed to high temperatures.

Key findings regarding airborne contaminants measured at the time of the BESS incidents investigated included the following:

- **Common Gases Released:** BESS fires primarily emit CO, CO_2, and volatile organic compounds (VOCs). They may also emit other trace gases such as HF, HCN, or others depending on the battery chemistry and overall materials of construction of the BESS unit.
- **Limited Off-Site Impact:** Air sampling found that contaminant concentrations beyond the immediate fire scene do not pose a public health risk.
  - For example, monitoring of the incidents at the Escondido 120 MWh BESS, CA (2024), East Hampton 40MWh BESS, NY (2023), Lyme-Chaumont 15MWh BESS, NY (2023) and Warwick 54MWh BESS, NY (2023) showed no detectable hazardous concentrations in nearby communities.
- **Flammability and Gas Dispersion:** The rapid dispersion of gases in outdoor BESS fires limits the potential for widespread toxic exposure. Studies show that the local concentration of gases rarely reaches flammability limits in well-ventilated environments and toxic gases are rapidly diluted.

8.5.3 Conclusion Regarding Downstream Impacts of BESS Fire Toxic Emissions

Concerns have been raised about potential downstream soil and/or water contamination arising from firefighting suppression efforts, particularly if large volumes of water are used. However, the FRA review of available data from real-world incidents and testing did not support the possibility of widespread contamination risks.

- **Firefighting Water Runoff:** The consensus best practice and standard Australian Authority recommendations for response to a BESS fire is to allow the BESS to consume itself and provide cooling water only to surrounding equipment if needed.
  - Unless there is direct suppression water applied to the BESS on fire, any cooling water applied will be similar to rain and no potential contaminants will be included in any runoff.

  - While lithium-ion battery fires produce chemical byproducts, studies show that their solubility in water is low, limiting the potential for groundwater contamination if direct suppression efforts are performed.
  - Finally, standard stormwater management practices (detention) prevent runoff from reaching surrounding sensitive areas in the event that the fire authority determines that suppression efforts are required.
- **Environmental Sampling Results:** Where environmental sampling was conducted at the BESS incidents reviewed, water and soil samples did not reveal contaminant concentrations that would pose a public health concern or necessitate further remediation. This finding included contamination sampling conducted on-site, off-site, and within nearby communities, as well as relevant sampling of water from firefighting activities, automatic suppression system run-off, and groundwater testing in specific instances.

This 10-year FRA study is aligned with the results of the Toxic Air Plume modelling discussed in the previous sections.

9.0 EMF Hazards

SLR recognises community concerns regarding the potential for adverse health impacts associated with exposure to Electric and Magnetic Fields (EMFs). The following sections demonstrate that the EMFs associated with the Project at the Project site boundary will be well below the levels commonly encountered in most homes arising from household wiring, household appliances and earth return currents.

9.1 Electric and Magnetic Fields (EMFs)

Electric and Magnetic Fields (EMFs) are part of the natural environment. They are present within the Earth's core and in the atmosphere. Whenever a power line (or household power cord) is energized, an Electric Field is created with a strength that depends directly on the voltage across the line creating it. A Magnetic Field is created whenever current flows through a power line (or household power cord), at any voltage.

EMFs associated with the generation, distribution and use of electricity power systems in Australia are classified by Energy Networks Australia (ENA) as being extremely low frequency (ELF). **Table 17** illustrates the basic features of EMFs.

Table 17 EMF Characteristics

Characteristic	Electric Field	Magnetic Field
Field is produced by …	Voltage	Current
Field is measured in units of …	Volts/metre (V/m) or kV/m	milli-Gauss (mG) or micro-Tesla (μT) 1 μT = 10 mG
The field exists when a source is turned OFF …	YES	NO
Field strength decreases rapidly with distance from source …	YES	YES
Field strength is reduced if shielded by intervening insulation, enclosures, trees, buildings, etc …	YES	NO

Source: (NIEHS 2002)

EMF Observation 1: EMF is not EMR

It is not uncommon for EMF to be confused with electromagnetic radiation (EMR), which is the movement of electromagnetic energy through the propagation of a wave, e.g. light from the sun or a radio-frequency signal from a television station transmitter.

- No such energy propagation occurs with EMFs.

Accordingly, the following is noted:

- EMFs around power lines or household electrical appliances are not a form of radiation. The ELF EMF fields relevant to this Project do not propagate energy away from their source but are fixed in place around it. They bear no relationship, in their physical nature or effects on the body, to EMR such as x-rays or microwaves.

EMF Observation 2: Electrical versus Magnetic Fields

When assessing EMFs, the focus on attention regarding health risk is usually on the magnetic field rather than the electric field.

- Electric fields are shielded by most objects, including trees, buildings and human skin. For this reason, there are negligible electric fields above underground cables.
- Furthermore, electric fields quickly reduce in strength with distance from the source.
- Like electric fields, magnetic fields also quickly reduce in strength with distance from the source. However, unlike electric fields, magnetic fields cannot easily be shielded and pass through most materials.

EMF risk assessments therefore focus on the potential strength of the magnetic field component of an EMF source.

9.2 Typical EMF Strengths

Typical examples of the strength of commonly encountered EMF magnetic fields are shown in **Table 18**.

Table 18 Typical Magnetic Field Strength Examples

Domestic Source	Magnetic Field	Power Source	Magnetic Field
TV, Pedestal Fan	0.2 – 2 mG	Sub-Station (at perimeter fence)	1 - 8 mG
Refrigerator Toaster, Electric Kettle	2 - 5 mG 2 - 10 mG	Suburban power line: . Under the line . 10m away	 2 - 30 mG 0.5 - 10 mG
PC, Laptop	2 - 20 mG	High Voltage power line: . Under the line . Easement (20-25m away)	 10 - 200 mG 2 – 50 mG
Electric Stove, Electric Blanket Hair Dryer	2 - 30 mG 5 - 30 mG 10 – 70 mG	Underground Cables . close to / above cable . 10m away	 5 - 200 mG 1 - 40 mG

Source: (Transgrid & ARPANSA 2006)

9.3 EMF Guidelines – Magnetic Field Exposure Limits

EMF standards and guidelines have evolved over time, and include:

- Energy Networks Association (ENA), *EMF Management Handbook*, January 2016.
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), 2020. *Code for Radiation Protection in Planned Exposure Situations*, Radiation Protection Series C-1 (Rev.1).
- International Commission on Non-Ionizing Radiation Protection (ICNIRP), 2009. *Guidelines on limits of exposure to static magnetic fields*, Health Physics, 96(4):504-514.
- International Commission on Non-Ionizing Radiation Protection (ICNIRP), 2010. *Guidelines for limiting exposure to time-varying electric and magnetic fields (1 HZ – 100 kHz),* Health Physics, 99(6):818-836.
- International Commission on Non-Ionizing Radiation Protection (ICNIRP), 2020. *ICNIRP Statement Principles for Non-ionizing Radiation Protection*, Health Physics, 118(5):477–482.
- IEEE Standard C95.6, *Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz*, 2002.

ARPANSA (the Australian Radiation Protection and Nuclear Safety Agency) generally adopts the ICNIRP guidelines and advises that …

- *"On balance, the scientific evidence does not indicate that exposure to 50 Hz EMFs found around the home, the office or near power lines is a hazard to human health".*

  and

- *"The majority of scientists and Australian radiation health authorities in particular, do not regard chronic exposure to 50 Hz EMFs at the levels commonly found in the environment as a proven health risk. Moreover, the evidence we have is inconclusive and does not allow health authorities to decide whether there is a specific Magnetic Field level above which chronic exposure is dangerous or compromises human health".*

A simplified set of Magnetic Field exposure limits, termed "Reference Levels" (refer 2016 EMF Management Handbook) , has been reproduced in **Table 19**. ARPANSA aligns with the ICNIRP exposure limits. The Reference Levels have been conservatively formulated such that compliance will ensure protection against biological effects. They include safety factors to ensure that known thresholds for health effects are not reached.

Table 19 Magnetic Field Reference Levels

Exposure Class	ICNIRP (ARPANSA)	IEEE
Members of the Public	2,000 mG (general exposure)	9,040 mG (head/torso exposure) 748,000 mG (arms/legs exposure)
Occupational Worker	10,000 mG (general exposure)	27,100 mG (head/torso exposure) 748,000 mG (arms/legs exposure)

A comparison of the typical magnetic field levels shown in **Table 18** with the Reference Levels given in **Table 19** shows the relatively low EMF levels found at home and close to typical power system equipment, including power lines.

9.4 EMF for the Project

It is a Project Commitment that the Project's electrical equipment will comply with relevant Australian and International Standards for exposure to EMFs.

Accordingly, the magnitude of the EMFs from all equipment types at the Project site, in particular their magnetic fields, will be highly localized and will remain well below the exposure limits shown in Table 17.

9.4.1 Relevant EPRI EMF Study

Reference is made to the following US EPRI-funded study of EMFs at two large-scale solar facilities operated by the Southern California Edison Company in Porterville, CA, and San Bernardino, CA.

- Tell, R.A., Hooper, H.C, Sias, G.G, Mezei, G., Hung, P. and Kavet, R., *"Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities"*, Journal of Occupational Environmental Hygiene, 2015 12(11) pp795-803.

The EPRI study included the measurement of static magnetic fields, power-frequency AC and radio-frequency EMFs. This study is instructive as generally much of the equipment used in solar farms is very similar to that proposed for Panorama BESS facility, including inverters, transformers and reticulation cables from 22-66kV, and high voltage substations.

- None of the equipment surveyed exhibited significant power-frequency electric field levels, due to the housing and enclosures typically deployed in power generation facilities.
- The major sources of magnetic fields were power cables, inverters, transformers and switchgear, ranging up to a maximum of 1,000 mG immediately adjacent to the relevant equipment.
- All measured magnetic fields were within ICNIRP and IEEE exposure limits at equipment compound perimeters.
- The highest magnetic fields were measured immediately adjacent to inverters and fuse boxes, with EMF strength attenuated quickly with distance – in fact they were found to attenuate with the **cube of the distance** from the source.

The above study shows that the magnetic fields associated with all of the equipment within the proposed BESS facility will be:

- comfortably below the exposure limits shown in Table 17 even at close distances from the relevant equipment; and
- at "background" levels at the nearest relevant perimeter fence of the Project (background meaning from the earth's own magnetic field).

9.4.2 BESS Containers

As a general observation, it is not expected that the Wärtsilä **Quantum2** units themselves would be associated with measurable EMFs.

The principle of a Li-ion battery is the chemical reaction that occurs on the electrodes of the individual battery cells within the unit which is then converted to electricity. Such chemical reactions do not produce radiation or EMF. However, the containerised BESS units will have auxiliary electrical systems that are 95% temperature control and would be comparable to a ducted air conditioner.

9.4.3 Inverter (Systems)

Modern grid-scale inverter systems are normally a dual component system comprising a large-scale inverter coupled with a step-up transformer.

The proposed Project inverters have been designed to comply with the international standards and guidelines that ensure their conformance to performance criteria with respect to EMFs, including:

- UL 1741 and UL 1741 Sb, CSA 22.2 No.107.1-16, IEC 62109-1, IEC 62109-2, NEC 2020, IEEE 1547:2018. IEC 621165:2014.

The step-up transformers connected to the inverters are similar to those installed within residential distribution kiosks commonly found in public spaces. All of the inverter stations planned for the Project will be positioned at a sufficient distance from the external security fence such that no further assessment is necessary to confirm that the impact to the public will be negligible.

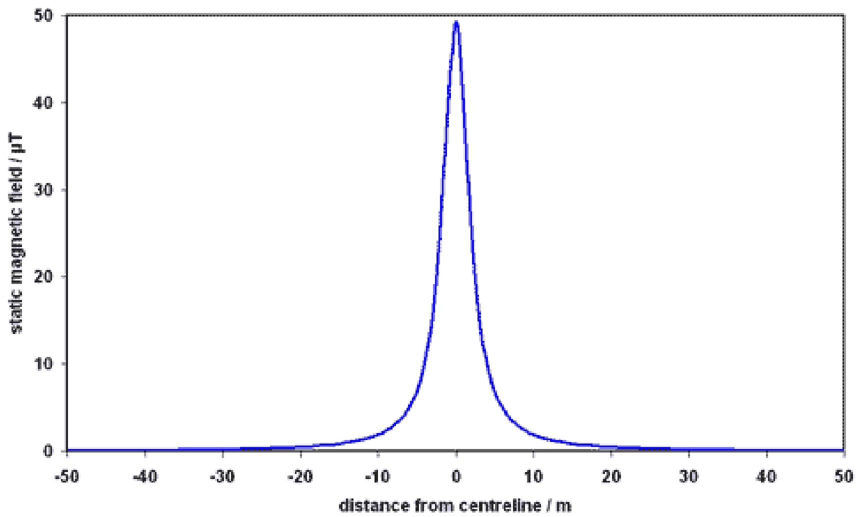
9.4.4 Underground Cabling

Underground HV cables always include a metal sheath which screens the electric field. Given the additional shielding from the surrounding soil mass, an underground cable will only produce a discernible magnetic field i.e. no electric field.

A typical underground cable will produce a maximum magnetic field of about 200 mG immediately at ground level and 100 mG approximately 1 m distance horizontally displaced from the immediate above-ground position.

Figure 20 shows an example field test obtained from the UK's PHE (Public Health England) Radiation Protection Division (formerly an amalgamation of the Health Protection Agency and National Radiological Protection Board). As can be seen in **Figure 20**, the magnetic field falls rapidly to the sides of the cable. At distances beyond about 15 m, the magnetic field strength would be indistinguishable from the earth's own magnetic field.

Figure 21 Typical Underground Cable Magnetic Field Distance Attenuation



9.4.5 Substation Transformer

It is expected that the location of the Project substation compound along with its own security fencing will ensure that EMF exposure to the public is well below the limits found in the guidelines provided in Table 17.

The UK's National Grid Company conducted a 2004 substation survey for PHE involving measurements 0.5 m above ground level and one metre away from substation enclosures.

- Magnetic Field strength averaged 19 mG and became indistinguishable from background levels within 5 m.

9.4.6 Summary

The only measurable EMFs associated with the Project would almost entirely be from the existing transmission lines which bisect the Project Area and run along the northern, eastern and southern boundaries of the project lots.

Despite the above, and in line with a generally precautionary approach, in addition to compliance with the ARPANSA exposure limits shown in **Table 19**, the Project Applicant has made the following commitment:

- The design of the facility will be developed considering Energy Networks Association (ENA), *"ENA Policy Statement on Electric and Magnetic Fields",* adopted by the ESAA Board in 1991 and reconfirmed by the ENA EMF Committee, March 2006; and Nutall, K., Flanagan, P. and Melik, G., *"Prudent Avoidance Guidelines for Power Frequency Magnetic Fields"*, 23rd Annual Conference of the Australasian Radiation Protection Society, 1998; and
- The integrity of all Project site security fencing will be maintained through the lifetime of the Project to ensure adequate exposure separation for all members of the public.

9.5 EMF Hazard Risk Conclusion

This section has shown that:

- EMF risk issues can be adequately mitigated, for both the public and site workers.

On the basis of the Risk Matrix shown in **Table 6**, SLR considers the residual risk associated with the BESS-related EMF hazard to be **Negligible**, and hence adequately mitigate

10.0 Conclusions and Recommendations

Preliminary Risk Screening has found that the quantity (in terms of storage and transport) of dangerous goods and associated potential hazards comply with the screening requirements of the ADG (Australian Code for the Transport of Dangerous Goods by Road and Rail", Edition 7.7, 2020) Code.

The Preliminary Hazard Analysis in this report found that the hazards warranting detailed assessment were:

- Hazards associated with Bushfire.
- Hazards associated with lithium-ion batteries in the BESS, specifically overheating and fire.

Bushfire hazards have been addressed in **Section 5**.

BESS-related hazards have been addressed **Section 6**.

EMI-related hazards have been addressed **Section 7**.

Section 5 of this report dealt with Bushfire Risk.

- The Bushfire Risk Assessment concludes that bushfire risk issues can be adequately mitigated. Accordingly, the Project will be adequately protected from the threat of a bushfire event.
- In relation to the Risk Matrix shown in **Table 6**, SLR considers the residual risk associated with bushfire fire hazard to be **LOW**, and hence adequately mitigated.

Section 6 of this report dealt with BESS-Related Risks.

- **Section 6** showed that BESS-related and other equipment-related fire risk issues can be adequately mitigated.
- Accordingly, the facility will not it itself pose an additional fire hazard that has the potential to increase the extent or severity of a bushfire event on surrounding property, people and the environment.
- Finally, the proposed BESS capacity can be comfortably accommodated within the site space with separation distances that provide adequate protection to personnel and property.
- In relation to the Risk Matrix shown in **Table 6**, SLR considers the residual risk associated with the BESS-initiated or other equipment-related fire hazard to be **LOW**, and hence adequately mitigated.

Section 7 of this report dealt with EMF-related Risk.

- **Section 7** demonstrated that EMF hazard issues can be adequately mitigated, for both the public and site workers.
- On the basis of the Risk Matrix shown in **Table 6**, SLR considers the residual risk associated with the EMF hazard to be **LOW**, and hence adequately mitigated.

It is the overall conclusion of this Hazard Analysis Report that the risks associated with the proposed development would be adequately managed, with suitable engineering controls, operational controls and management controls in place.

It is expected that all of the above controls will be enabled by the post-approval development of comprehensive management plans covering the following:

- Bushfire Emergency Management Plan (BEMP)
- Fire Safety Study (FSS).
- Emergency Response Plan (ERP).

Appendix A Vegetation Descriptions from AS3959:2018

Hazard and Risk Assessment

Panorama Battery Energy Storage System (BESS) – SSD 50587460

Panorama BESS SubCo Pty Ltd

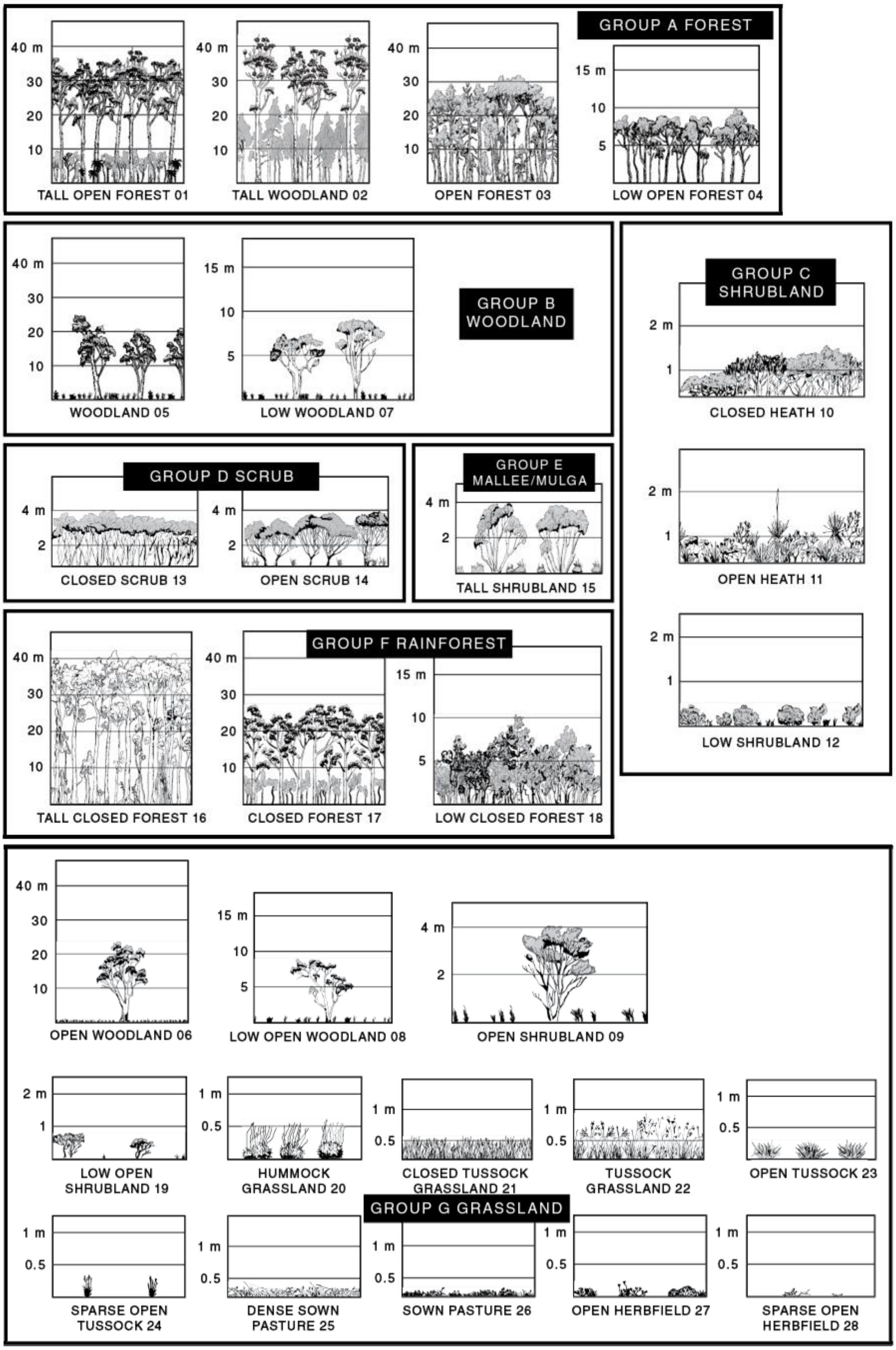
SLR Project No.: 660.30234.00007
Revision: R06-v1.8

23 January 2026

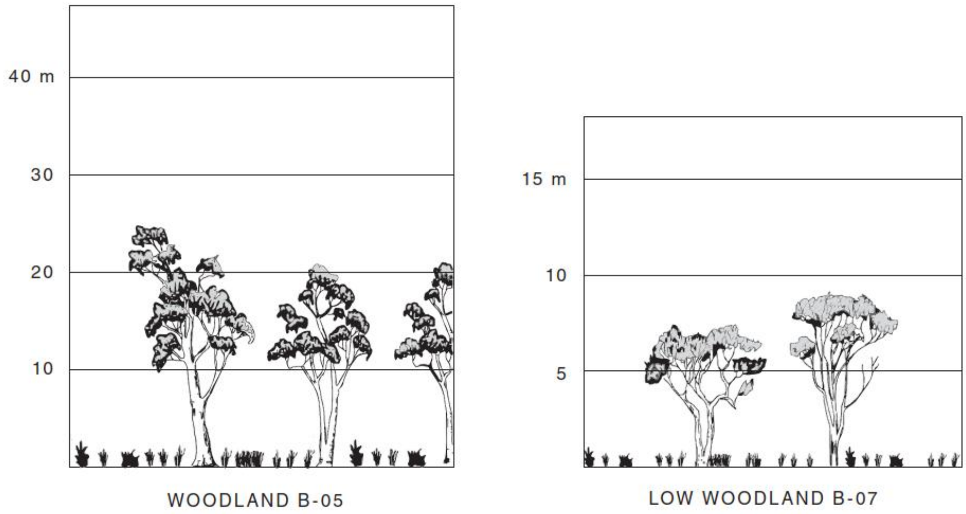
AS3959:2018 - Table 2.3 CLASSIFICATION OF VEGETATION

Vegetation classification	Vegetation type	Figure No. in Figures 2.4(A) to 2.4(H)	Typical characteristics
A Forest	Tall open forest Tall woodland	01 02	Trees over 30 m high; 30%–70% foliage cover (may include understorey ranging from rainforest species and tree ferns to low trees and tall shrubs). Found in areas of high reliable rainfall. Typically dominated by eucalypts with a sub-dominant tree layer.
	Open forest Low open forest	03 04	Trees up to 30 m high; 30%–70% foliage cover (may include understorey of sclerophyllous low trees or shrubs). Typically dominated by eucalypts, melaleuca or callistemon (may include riverine and wetland environments) and callitris. Includes eucalypt plantations.
	Pine plantation	Not shown	Trees 30 m in height at maturity, generally comprising Pinus species or other softwood species, planted as a single species for the production of timber.
B Woodland	Woodland Low woodland	05 07	Trees up to 30 m high; 10%–30% foliage cover dominated by eucalypts and/or callistris with a prominent grassy understorey. May contain isolated shrubs.
C Shrubland	Closed (low) heath Open heath	10 11	Found in wet areas and/or areas affected by poor soil fertility or shallow soils. Shrubs 1 m–2 m high. Wet heaths occur in sands adjoining dunes of the littoral (shore) zone. Montane heaths occur on shallow or water-logged soils.
	Low shrubland	12	Shrubs <2 m high; greater than 30% foliage cover. Understoreys may contain grasses. Acacia and Casuarina often dominant in the arid and semi-arid zones.
D Scrub	Closed scrub (Tall heaths)	13	Found in wet areas and/or areas affected by poor soil fertility or shallow soils; >30% foliage cover. Dry heaths occur in rocky or sandy areas. Shrubs >2 m high. Typical of coastal areas and tall heaths up to 6 metres in height. May be dominated by Banksia, Melaleuca or Leptospermum with heights of up to 6 metres.
	Open scrub	14	Shrubs greater than 2 m high; 10%–30% foliage cover with a mixed species composition.
E Mallee/Mulga	Tall shrubland	15	Vegetation dominated by low trees or tall shrubs (especially eucalypts and acacias) some with a multi-stemmed habit (mallee); usually greater than 2 m in height; <30% foliage cover. Understorey of widespread dense low shrubs or sparse grasses and generally found in the arid and semi-arid zones, but not within the rangelands.
F Rainforest	Tall closed forest Closed forest Low closed forest	16 17 18	Trees >90% foliage cover; understorey may contain a large number of species with a variety of heights. Not dominated by eucalypt species.
G Grassland	Open woodland Low open woodland Open shrubland Low open shrubland Hummock grassland Closed tussock grassland Tussock grassland Open tussock Sparse open tussock Dense sown pasture Sown pasture Open herbfield Sparse open herbfield	06 08 09 19 20 21 22 23 24 25 26 27 28	All forms (except tussock moorlands), including situations with shrubs and trees, if the overstorey foliage cover is less than 10%. Includes pasture and cropland. NOTE: Grassland managed in a minimal fuel condition and non-curing cropland is regarded as low threat vegetation for the purposes of Clause 2.2.3.2.
H Tussock Moorland	Tussock Moorland	Not shown	All forms of vegetation where the overstorey is dominated by the species Buttongrass (*Gymnoschoenus sphaerocephalus*). Only occurs as a significant vegetation type in Tasmania.

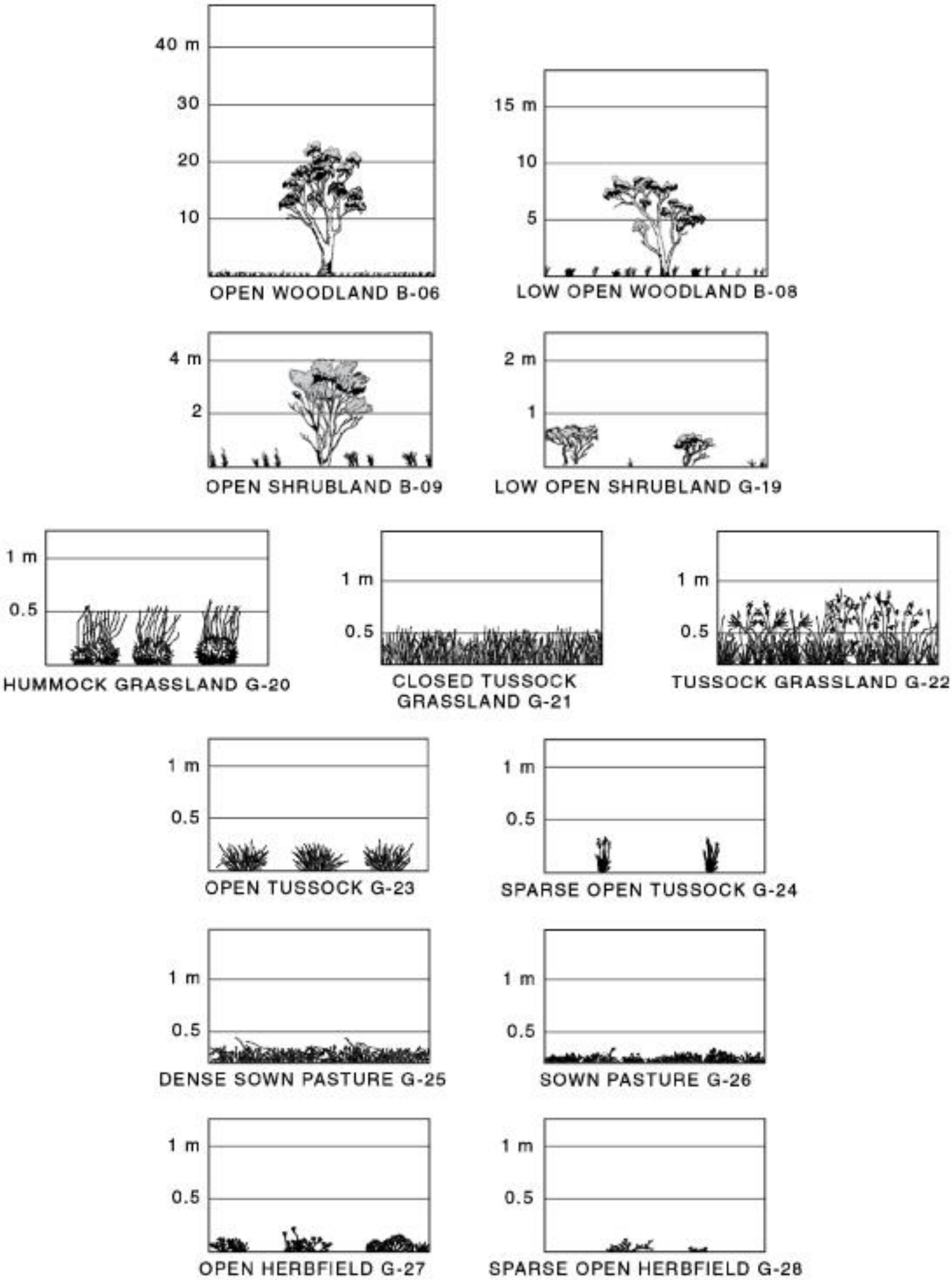
AS3959:2018 – Figure 2.4(A) Classification of Vegetation - SUMMARY



AS3959:2018 – Figure 2.4(C) Classification of Vegetation – WOODLAND (Group B)



AS3959:2018 – Figure 2.4(H) Classification of Vegetation – GRASSLANDS (Unmanaged)



Appendix B Case Studies – Lessons Learned

Hazard and Risk Assessment

Panorama Battery Energy Storage System (BESS) – SSD 50587460

Panorama BESS SubCo Pty Ltd

SLR Project No.: 660.30234.00007
Revision: R06-v1.8

23 January 2026

B-1 Victorian Big Battery (VBB) Fire – 30 July 2021

Neoen's VBB is a 300MW/450MWh BESS facility located in Geelong, Victoria, fitted with 212 Tesla Megapacks, each measuring approximately: 7.2 m (length) x 1.6 m (width) x 2.5 m (height).

On Friday, 30 July 2021:

- A single Megapack (MP1) caught fire and spread to a neighbouring Megapack (MP2) during the installation and commissioning phase of the facility.
- At that time, approximately half of the Megapacks had been installed at the site and some were undergoing testing and commissioning.
- MP1 was NOT scheduled for testing that day and was shut down manually at around 7:20 am. When it was shut down, it was not displaying abnormal conditions to site personnel.
- At around 10:00 am, smoke was observed emitting from MP1 by site personnel, who then electrically isolated ALL the Megapacks on-site and called emergency services.
- Victoria's Country Fire Authority (CFA) arrived shortly thereafter and set up a 25 m perimeter around MP1.
- They also began applying cooling water to nearby exposures (e.g., transformers) as recommended in Tesla's Lithium-Ion Battery Emergency Response Guide (ERG).
- At around Noon, the fire spread to the neighbouring MP2, which was installed 15 cm behind MP1. Wind was the dominant contributory factor in this case. At the time of the fire, sustained winds of over 50 km/hr impacted the site from the north. These pushed the flames exiting out of the top of MP1 towards the roof of MP2 leading to direct flame impingement on the thermal roof of MP2.
- The CFA permitted MP1 and MP2 to burn themselves out and did not directly apply water into or onto either Megapack, as recommended in Tesla's ERG.
- The fire did not spread beyond MP1 and MP2, which burned themselves out over the course of approximately six hours.
- There were no injuries to the general public, to site personnel or to emergency first responders as MP1 and MP2 failed "safely", ie they slowly burned themselves out with no explosions or deflagrations, as they are designed to do in the event of a fire, and as per the guidance in Tesla's ERG.
- By around 4:00 pm, visible fire had subdued, and a fire watch was instituted.
- The CFA monitored the site for the next three days before deeming it under control on 2 August 2021, at which time, the CFA handed the site over for a formal fire investigation to begin.

B-1.1 Lessons Learned

The VBB fire exposed a number of unlikely factors that, when combined, contributed to the fire initiation as well as its propagation from unit MP1 to MP2. This collection of factors had never before been encountered during previous Megapack installations, operation and/or regulatory product testing.

Below is a summary of the lessons learned from the incident and the new safety mitigation measures since implemented.

Commissioning

- Key weaknesses identified: (i) limited supervision/monitoring of telemetry data during the first 24 hours of commissioning, and (ii) use of the keylock switch during commissioning and testing.
- These two factors prevented MP1 from transmitting telemetry data (internal temperatures, fault alarms, etc) to Tesla's control facility and placed critical electrical fault safety devices (such as the pyro disconnect) in a state of limited functionality, reducing the Megapack's ability to actively monitor and interrupt electrical fault conditions prior to them escalating into a fire event.
- Since the VBB fire, Tesla has modified their commissioning procedures to reduce the telemetry setup connection time from 24 hours to 1 hour and to avoid utilizing the Megapack's keylock switch unless the unit is actively being serviced.

Electrical Fault Protection Devices

- Key lessons learned covered the following: (i) coolant leak alarms not being active, (ii) the pyro disconnect being unable to interrupt fault currents when the Megapack is off via the keylock switch, and (iii) the pyro disconnect likely being disabled due to a power supply loss to the circuit that actuates it.
- These factors prevented MP1's pyro disconnect from actively monitoring and interrupting the electrical fault conditions before escalating into a fire event.
- Since the VBB fire, Tesla has implemented a number of firmware mitigations that keep all electrical safety protection devices active, regardless of keylock switch position or system state, and actively monitor and control the pyro disconnect's power supply circuit.
- Furthermore, Tesla has added additional alarms to better identify and respond (either manually or automatically) to coolant leaks. Additionally, although this fire event was almost certainly initiated by a coolant leak, potential unexpected failures of other internal components of the Megapack that could create similar damage to the battery modules have been explored.
- Accordingly, the new firmware mitigations do not ONLY address damage from a coolant leak. They also permit the Megapack to better identify, respond, contain and isolate issues within the battery modules due to failures of other internal components, should they occur in the future.

Fire Propagation

- Key lessons learned included: (i) the significant role external, environmental conditions (such as wind) can have on a Megapack fire, and (ii) the identification of a weakness in the thermal roof design (unprotected, plastic overpressure vents in the ceiling of the battery bays) that permitted Megapack-to-Megapack fire propagation.
- These two factors led to direct flame impingement on the plastic overpressure vents that seal the battery bay from the thermal roof. With a direct path for flames and hot gases to enter into the battery bays, the cells within the battery modules of MP2 failed and became involved in the fire.
- This weakness had not been identified previously during product or regulatory testing as the relevant UL9540A tests are undertaken with wind speeds reaching only up to 20 km/hr. The fire therefore did not invalidate the Megapack's UL9540A certification, as the fire occurred as result of an environmental condition that is not captured by the UL9540A test method.

- Since the VBB fire, Tesla has devised (and validated through extensive testing) a hardware solution that protects the overpressure vents from direct flame impingement or hot gas intrusion via the installation of new, thermally insulated, steel vent shields.
- The vent shields are placed on top of the overpressure vents and NOW COME STANDARD on all NEW Megapack installations.
- For EXISTING Megapacks, the vent shields can be easily RETROFITTED in the field.

Megapack Spacing

- Investigation of the VBB fire concluded that NO changes were required to the installation practices of the Megapack ONCE the vent shield mitigation (as described above) was in place.
- Based on an analysis of MP2's telemetry data during the VBB fire, a Megapack's thermal insulation provides significant thermal protection in the event of a fire within an adjacent Megapack installed 15 cm away. The internal cell temperatures of MP2 only increased by 1°C, from 40°C to 41°C, before communication was lost to the unit, presumably due to fire, around 11:57 am (approximately 2 hours into the fire event). Fire propagation was triggered by the weakness in the thermal roof, as described above, and NOT due to heat transfer via the 150 mm gap between Megapacks.
- With the new vent shield mitigation in place, the weakness has been addressed and since validated through unit level fire testing (i.e., tests involving the ignition of the Megapack's thermal roof).
- These tests have confirmed that, even with the thermal roof fully involved in a fire, the overpressure vents will not ignite, and the battery modules remain relatively unaffected with internal cell temperatures rising less than 1°C.

Emergency Response

Lessons learned from the emergency response to the VBB fire:

- Effective pre-incident planning is invaluable and can reduce the likelihood of injuries;
- Coordination with "Subject Matter Experts" (SMEs), either on site or remotely, can provide critical expertise and system information for emergency responders to draw upon;
- The effectiveness of applying water directly to adjacent Megapacks appears to provide limited benefits. However, water application to other electrical equipment, with inherently less fire protection built into their designs (such as transformers), can be a useful tactic to protect that equipment;
- The fire protection design approach of the Megapack was shown to be very robust;
- Victoria's EPA indicated that there was "good" air quality two hours after the fire, demonstrating that no long-lasting air quality concerns arose from the fire event;
- Water samples indicated that the likelihood of the fire having a material impact on firefighting water was minimal; and
- Prior community engagement during the project planning stages proved to be invaluable as it enabled Neoen to quickly update the local community and address immediate questions and concerns. Early, factual and where possible, face-to-face engagement with the local community is essential when a fire event is unfolding to keep the general public informed.

Summary

- The VBB fire event proceeded in accordance with its fire protection design and pre-incident planning.
- It presented no unusual, unexpected, or surprising characteristics (ie explosions).
- It did not result in any injuries to site personnel, the general public or emergency responders.
- It was isolated to the units directly involved and had minimal environmental impact.
- It did not adversely impact the electrical grid and had appreciably short mission interruption.

B-2 Arizona Public Service (APS) Utility BESS Fire and Explosion – 17 April 2019

On Friday, 17 April 2019, a fire and explosion occurred at a BESS facility owned by Arizona Public Service (APS), injuring four firefighters. This occurred while the four hazmat firefighters were working to extinguish a BESS fire that had already commenced at the facility.

The BESS had been installed in late 2016 as part of an agreement between APS and AES Energy Storage involving AES Advancion battery arrays.

The event has become known as the "McMicken BESS Event".

In summary:

- The BESS was commissioned and integrated by AES, on behalf of APS.
- The BESS was assembled with Lithium ion (Li-ion) batteries manufactured by LG Chem using NMC (Nickel Manganese Cobalt) chemistry.
- On 19 April 2019, 25 months after the BESS was placed into service, a suspected fire was reported at the BESS.
- At 17:48 local time, first responders arrived to investigate.
- Several hours later, at approximately 20:04, an explosion occurred from inside the BESS.
- The explosion injured several firefighters and essentially destroyed the BESS and its container.

A detailed investigation into the incident was carried out by APS and a far-ranging report completed in 2020, in partnership with DNV GL. This investigation included experts from APS, the manufacturers and third-party engineering and safety experts.

The report led to several important new safety requirements aimed at preventing future failures and fires at BESS facilities.

Key Event Elements:

- The suspected fire was actually an extensive cascading thermal runaway event, initiated by an internal cell failure within one battery cell in the BESS: cell pair 7, module 2, rack 15 (battery 7-2).
- It is believed to a reasonable degree of scientific certainty that this internal failure was caused by an internal cell defect, specifically abnormal Lithium metal deposition and dendritic growth within the cell.
- The total flooding clean agent fire suppression system installed in the BESS operated early in the incident and in accordance with its design. However, clean agent fire suppression systems are designed to extinguish incipient fires in ordinary combustibles. Such systems were not, at the time, capable of preventing or stopping cascading thermal runaway in a BESS.
- As a result, thermal runaway cascaded and propagated from cell 7-2 through every cell and module in Rack 15, via heat transfer.
- This propagation was facilitated by the absence of adequate thermal barrier protections between battery cells, which may have stopped or slowed the propagation of thermal runaway.

- The uncontrolled cascading of thermal runaway from cell-to-cell and then module-to-module in Rack 15 led to the production of a large quantity of flammable gases within the BESS.
- Analysis and modeling from experts in this investigation confirmed that these gases were sufficient to create a flammable atmosphere within the BESS container.
- Approximately three hours after thermal runaway began, the BESS door was opened by firefighters, agitating the remaining flammable gases, and allowing the gases to make contact with a heat source or spark, leading to the explosion.

Key Contributing Factors Leading to the Explosion:

- #1: Internal failure in a battery cell initiated thermal runaway.
- #2: The fire suppression system was incapable of stopping thermal runaway.
- #3: Lack of thermal barriers between cells led to cascading thermal runaway.
- #4: Flammable off-gases concentrated without a means to ventilate.
- #5: The facility's Emergency Response Plan (ERP) did not have an extinguishing, ventilation, and entry procedure.

Conclusions:

The report concluded that the then-current (i.e., 2020) standards had improved and were able to better address hazard assessment and training for first responders, although the industry expectation should go even further and require that hazard assessments and training take place before and during the commissioning of energy storage systems.

The report stated the following:

- *Today's standards better address hazard assessment and training for first responders, although the industry expectation should go even further and require that hazard assessments and training take place before and during the commissioning of energy storage systems.*
- *In today's practice, the systems integrator and EPC contractor typically coordinate safety response plans on behalf of the owner, and then train the operations and maintenance (O&M) personnel to execute them.*
- *While today's energy storage safety codes and standards acknowledge cascading thermal runaway as a risk, they stop short of prohibiting it, and fail to address the risk of non-flaming heat transfer to neighbouring cells, modules, and racks. Standards today (referring to 2020) focus on the means to manage a fire, but have so far avoided prescribing solutions that restrict or slow cell-to-cell and module-to-module thermal runaway propagation.*
- *Standards today (again referring to 2020), therefore, also fall short in addressing the issue and risks associated with off-gassing. However, there are commercially available technologies and design methods available that can address thermal runaway propagation, and the standards should be appropriately updated to acknowledge these methods and technologies. The main codes examined in this report are National Fire Protection Agency (NFPA) 855 and past and current versions of the International Fire Code, along with Underwriters' Laboratories (UL) 1973, UL 9540 and the UL 9540A test method.*
- *In addition, better practices for ventilation, extinguishing, and cooling thermal runaway scenarios exist today and should be implemented in future energy storage systems.*

- *Finally, clean agent systems may still be appropriate for use in energy storage facilities to manage incipient fires, but they must be used in conjunction with additional practices: i.e., ventilation, extinguishing, and cooling—to manage thermal runaway scenarios. Clean agent or aerosol extinguishing methods should not be the only barrier against thermal runaway.*

B-2.1 Fire Protection System Observations

The BESS was equipped with a Novec 1230 "total flooding" clean agent fire suppression system. At the time of commissioning, clean agent systems were a common method for managing fire suppression in energy storage containers because clean agents are electrically nonconductive and do not leave a residue.

- When the fire detection system detects a fire, the fire suppression system discharges the agent through a piping system with nozzles mounted on the BESS container ceiling, which emits the agent in a fine mist, dispersing and evaporating in the atmosphere.
- Clean agents are typically used to extinguish incipient (i.e., small) fires before significant damage occurs to the remaining equipment.

In an August 2017 letter to the NFPA 855 committee during drafts of the next edition of the NFPA standard, clean agent manufacturer 3M stated that:

- *Clean agents cannot prevent or suppress cascading thermal runaway in Li-ion battery systems.*

While this statement was made more than a year after the design of the McMicken BESS, it was not widely circulated.

Following the commissioning of the McMicken BESS, the comment did serve to inform future designs and standards development.

The McMicken BESS also contained a Very Early Smoke Detection Apparatus (VESDA) laser-based smoke detection system. The VESDA could detect fine particles and diminishing visibility (due to smoke) within a room, by monitoring for any interference of a laser beam. The sensors were placed evenly along the ceiling of the BESS container and were fed to a central power unit with data storage. Upon smoke detection, the VESDA system sent a signal to a Honeywell Notifier RP 2002 fire alarm control and releasing panel, which in turn sent a signal to discharge the Novec 1230 system, manufactured by Kidde.

The ultimate failure in the design of the fire suppression system was the decision to rely solely on a clean agent fire suppression system to combat thermal runaway.

The Novec 1230 clean agent was inadequate and inappropriate to stop or prevent cascading thermal runaway of multiple battery cells or modules. As noted above, a 3M representative, the developer of the Novec 1230 fire suppression agent, publicly acknowledged this limitation in August 2017.

In the McMicken BESS, the Novec 1230 properly discharged shortly after the first battery cell failed, but over time, the agent-air mixture began to dissipate, negating its fire suppression effectiveness. At the same time, thermal runaway continued to propagate through Rack 15 emitting large quantities of flammable gases into the container.

One of the investigation experts from CP Fire proposed that the Novec 1230 suppressant may have played a role in preventing the ignition of flammable gases as they were released from the thermal runaway in Rack 15, thus allowing these gases to accumulate in the BESS and create an explosion hazard.

Lesson Learned

In relation to CURRENT BESS DESIGN, clean agent fire suppression systems can play an important role in BESS facilities, because they are effective at extinguishing incipient fires and could potentially prevent the initiation of thermal runaway by external (non-thermal runaway) fire hazards.

However, these clean agent systems should be used in conjunction with other fire protection measures and firefighting practices, including ventilation and cooling systems designed to handle thermal runaway and potential explosion

Another outcome of the above consideration has been the advent of flammable gas concentration meters which are now routinely installed in BESS facilities. These allow operators to continuously monitor any flammable mixture or vapor accumulation, and ensure that flammable gas concentrations remain well below the lower flammable limit.

B-2.2 Emergency Response

The emergency response plan (ERP) provided by AES to APS did not have instructions on how to respond to a potential explosion or how to enter the system after the fire suppression system had been discharged.

Most of the detail in the ERP was associated with electrical shut down procedures and roles and responsibilities between APS and Fluence (as the O&M contractor), as well as when/if to notify the fire department. A smoke alarm and fire suppression trigger procedure was in place, but it did not address when or how to initiate entry into the system.

At the time of the development of the ERP, none of the BESS suppliers (including AES and LG Chem) had conveyed that a large flammable gas hazard or cell-to-cell and module-to-module cascading thermal runaway was possible.

Lesson Learned

A key lesson learned from the McMicken Event was that there has to be open and full communication of BESS hazards and risks between ALL parties involved in the design, installation, commissioning and operation of a BESS, operators, maintenance personnel and emergency/firefighting responders.

The apparent breakdown which occurred in relation to the McMicken Event can be understood using a technique called the “Johari Window,” which is used in risk analysis and hazard identification exercises to heuristically identify the known-knowns, known-unknowns, and unknown-unknowns of a technology, process, or operation.

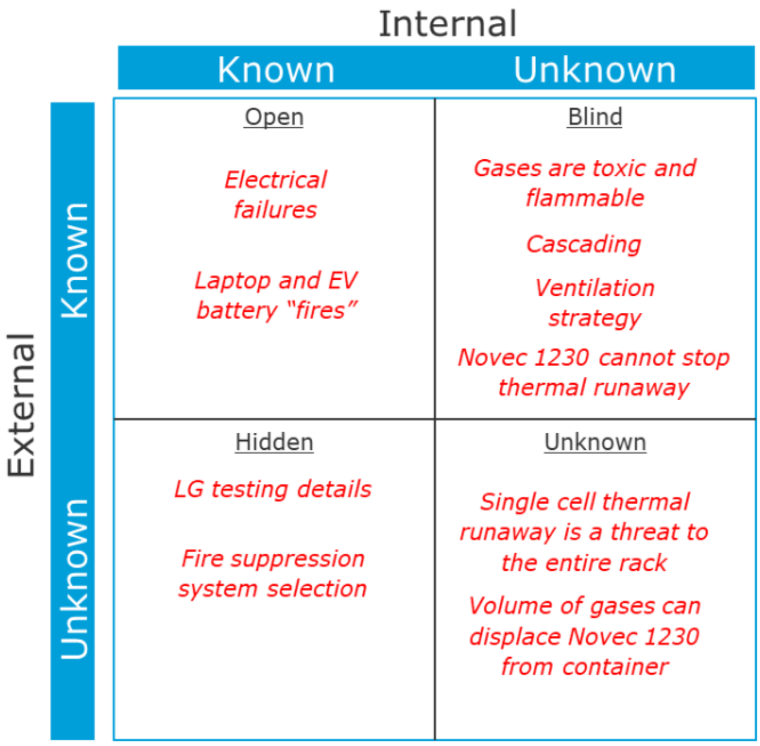
Figure 10 shows a Johari window used to analyze the state of knowledge (both known and unknown) by APS (via its EPC contractor and their subcontractors), at the time the ERP was drafted. In this simplified Johari window:

- “Internal” refers to APS’ collective knowledge as an organization
- “External” is the realm of knowledge available to APS from their supplier and subcontractors.

In Figure A-2.1:

> **“Open”** hazards and risks were known by all parties at the time the ERP was drafted. All parties (including APS) were likely aware of common electrical hazards and risks, as well as commonly cited public battery fire hazards from other industries. Indeed, electrical hazards were addressed in the ERP. These hazards are depicted in the upper left quadrant of Figure 10 and represent the known-knowns.

Figure B-2.1 Johari Window Covering the McMicken Event



"Hidden" hazards and risks were known by APS at the time the ERP was drafted, but disclosure of information was limited or incomplete. APS was likely aware that LG Chem had test data with regard to battery thermal runaway, such as UL 1973 or UL 1642 and UN 38.3; however, it is highly likely that information presented from these tests was limited to a pass/fail notification without detail. In other words, it is highly doubtful that AES was provided any information about the condition of the cells and modules after the tests. Because these details were not shared with AES, they could not be shared with APS. Similarly, APS likely knew there was a process that AES was following to design the fire suppression system, but the details of that analysis were evidently not shared with APS. These hazards are depicted in the lower left quadrant of Figure 10 and represent the known-unknowns.

"Blind" hazards and risks may or may not have been known to external parties but were unknown to APS at the time the ERP was drafted. It cannot be stated with any degree of certainty what any party knew or did not know regarding the threat of cascading thermal runaway when the BESS was commissioned. However, it can be inferred through interviews and design documentation that APS was unaware of the threat of cascading thermal runaway - including the risk of flammable off-gases, the need for ventilation, and whether clean agents and aerosols could stop thermal runaway. These "blind" hazards are depicted in the upper right hand quadrant of Figure 10 and represent the known-unknowns in the external world, yet blind unknowns to APS - these are areas where APS likely did not know what they didn't know.

"Unknown" hazards and risks were unknown to all parties at the time the ERP was drafted. It is not possible to conclusively say what each party knew during the design and commissioning of the McMicken BESS. However, based on a review of the design documentation, it is unlikely that, at the time, either APS or AES were aware of the fact that a single cell thermal runaway was a threat to the entire rack, and the volume of gases from that thermal runaway event could displace Novec 1230 from container.

However, it is possible AES (and perhaps APS) could have recognized the cascading thermal runaway threat if LG Chem had shared more information concerning their battery cell and module testing. The collection of gases and displacement of Novec 1230, as demonstrated by the analyses from experts in the investigation, would have been much more difficult to predict. These hazards are depicted in the lower right quadrant in Figure 10 and represent the unknown-unknowns to APS and AES

Summary

Although AES drafted the ERP, had APS known of all the hazards and risks associated with the BESS, it could have better analysed the sufficiency and adequacy of the ERP prior to commissioning.

Many (most?) of the above shortcomings would likely NOT occur today, given the advances that have taken place in the management of BESS risks, involving extensive two-way dialogue between the various parties involved in the development of a BESS Project including, importantly, the emergency and fire services charged with responding to emergency events at such facilities.

As was the case for the VBB Fire, today's BESS risk management practices have evolved to a significant degree thanks to failure events such as the McMicken Event.

B-2.3 Key Lesson Learned Re Stakeholders

The McMicken Event has led to an understanding of the need to have ALL parties kept informed of BESS hazards and risks, especially in relation to the response to a potential fire and/or thermal runaway event.

In relation to key stakeholders, the following is now expected to occur with the development of BESS facilities.

First Responders

First responders, emergency services, fire fighters and ambulance, must receive training as to how to respond, assess, and extinguish BESS fires and treat the injured.

They therefore need to be informed and hence understand the operating and risk characteristics of BESS facilities.

Firefighters in particular must safely mitigate the hazard and stay at the scene as long as necessary to deem the hazard under control, so that they can then relinquish the scene to the parties who have control over it.

Operations and Maintenance (O&M) Staff

O&M staff monitor BESS management systems and make decisions based on system status and public and personnel safety risk. O&M staff are already on call and are typically expected to respond to a site within a limited time depending on location. The response staff from the O&M party are expected to be knowledgeable of the site, able to access the site, and provide guidance to the first responders. They should be in possession of the applicable documents that constitute an emergency response approach. O&M staff typically take control of the site after first responders depart.

Staff Representing the Owner

The “Owner” staff, if applicable and local, may also be involved in response to the site. In the case of the McMicken Event, APS, a utility not unfamiliar with managing, maintaining, and responding to calls involving project sites, had a response to the event that would have been uniquely different than, for example, a private equity firm or project owner that may not have the technical staff or capability to respond.

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