Appendix M

Preliminary Hazards Analysis

PROJECT BOOST

Penrith HV BESS – Preliminary Hazard Analysis

AUSCONNEX

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Executive summary

Ausconnex is developing a 100 megawatt (MW)/200 megawatt hours (MWh) grid-scale battery energy storage system (BESS) to connect to the existing high voltage (HV) substation, located at 2235-2249 Castlereagh Road, Penrith, NSW 2750 (the Penrith HV BESS Project). The BESS will utilise lithium-ion, inverter-based batteries capable of performing 1 to 2 cycles per day.

The Penrith HV BESS Project is classified as a State Significant Development (SSD) and requires an Environmental Impact Statement (EIS) in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979.*

This Preliminary Hazard Analysis (PHA) has been prepared to accompany the SSD application for the Penrith HV BESS Project. The report has been prepared in response to the Secretary's Environmental Assessment Requirements (SEARs) issued for the Penrith HV BESS Project (SSD-78368474).

This report provides an assessment of potential hazards and risks from the Penrith HV BESS Project's construction, operational, and decommissioning phases. The assessment is in accordance with Chapter 3 of the *SEPP Resilience and Hazards (Hazardous and Offensive Development)* and the associated *SEPP 33 Guideline*, to determine if the development is potentially hazardous and/or potentially offensive. Additionally, the PHA follows the methodology outlined in *Hazardous Industry Planning Advisory Paper No. 6 (HIPAP 6) – Hazard Analysis*.

The preliminary risk screening determined that the Penrith HV BESS Project is potentially hazardous and potentially offensive due to noise impacts as per the SEPP Resilience and Hazards Guidelines [1].

A qualitative risk assessment (as per the Multi-Level Risk Assessment Guidelines [2]) identified 34 hazards, of which 24 posed potentially significant offsite risks. However, all identified hazards can be effectively managed through appropriate recommended technical and management safeguards, significantly reducing the likelihood of major offsite consequences (refer to the Risk Register in Appendix A).

The recommended technical safeguards for the Penrith HV BESS Project include implementing temperature operation limits, redundant safety systems, electronic safety-related systems, and flood risk considerations. Additionally, it is recommended that a Fire safety Study is conducted for this development.

For lithium-ion batteries installations, adherence to Australian Standards, modular design, cooling systems, fire extinguishers, and fire protection measures are proposed. A comprehensive safety management system, including a work health and safety management plan, an emergency response plan, and asset management plans is recommended for construction and prior to commissioning or operation.

Following from the PHA, it was determined that, subject to the implementation of recommended risk mitigations, and technical and safety measures, the Penrith HV BESS Project will not constitute a hazardous industry.

Contents

Appendices

Figures

Tables

Glossary of acronyms and terms

Term	Description
AS	Australian Standard
AS 2067:2016	Substations and high voltage installations exceeding 1 kV a.c.
AS 5139: 2019	Electrical installations
AS 5577: 2013	Electricity network safety management systems
AS/NZS 1170.2:2021	Structural design actions – Part 2: Wind actions.
BESS	Battery Energy Storage System
CCTV	Closed-circuit television
DG	Dangerous Goods
EES	Electrical energy storage
EIS	Environmental Impact Statement
FRNSW	Fire and Rescue New South Wales
HIPAP	Hazard Industry Planning Advisory Paper
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
IP	Ingress Protection
km	kilometres
kV	kilovolt
LEP	Local Environmental Plan
m	metres
MVA	Megavolt amperes
MW	Megawatt
MWh	Megawatt hours
NFPA	National Fire Protection Association
NSW	New South Wales
OPM	Operating Plant Manual
PGII	Packing Group II
PHA	Preliminary Hazard Analysis
Project footprint	The area that has been assumed for the purpose of the Environmental Impact Statement (EIS) to be directly affected by the construction and operation of the Penrith HV BESS Project. It includes the indicative location of Project infrastructure, the area that would be directly disturbed during construction and during operation. (i.e. the combined construction footprint and operational footprint). The project is located within Endeavour Energy landholdings adjacent and to the east of the existing Transmission Substation. The total area of the proposed site is 0.9ha.
Project Site	The Penrith HV BESS Project is located at Penrith adjacent to the transmission substation, at 2235-2249 Castlereagh Rd, Penrith, NSW 2750 (Lot 5 on DP1017480).
Project Site boundary	The fence line around the Penrith HV BESS site, i.e. the Project Site.
SEARs	Secretary's Environmental Assessment Requirements
Sensitive receptor	Residential or other more sensitive land uses (e.g. hospitals, schools), defined in the *SEPP 33 Guideline*.

Term	Description
Sensitive receiver	Land uses impacted by offensives
SEPP	State Environmental Planning Policy
SEPP Resilience and Hazards	*State Environmental Planning Policy (Resilience and Hazards) 2021*
SSD	State Significant Development
The Penrith HV BESS Project	The proposed grid-scale battery energy storage system (BESS), with 48 M and a capacity of up to 100 Megawatts (MW)/200MWh, along with associated infrastructure.
UN	United Nations

1 Introduction

1.1 Overview

The National Energy Market is experiencing rapid change as existing coal fired power stations across NSW and Australia are reaching the end of their operational life. The NSW government has identified a need for an increase in renewable energy generation projects. To support this transition, Ausconnex is investigating the development of a 100 megawatt (MW)/200 megawatt hours (MWh) grid-scale Battery Energy Storage System (BESS) and associated infrastructure (The Penrith HV BESS Project) to invest in the renewable energy future.

The Penrith HV BESS Project will comprise of 48 battery containers containing Lithium-ion batteries and will utilise the existing 33-132kV to the Penrith Transmission Substation site located at 2235-2249 Castlereagh Road, Penrith, NSW 2750. The general arrangement layout and project layout that inform this assessment are shown in Figure 1-1 and Figure 1-2 respectively.

The Project Site is proposed to be located on the northeastern side of the existing substation. To the south of the Project Site, Ausconnex is seeking a proposed 5 medium-voltage (MV) BESS development, which will be assessed separately by Penrith City Council.

It is to be noted that the two proposed developments are agnostic and independent of each other and are not reliant on each other for construction or operation (including connectivity). The MV BESS development and the adjacent substation have been considered neighbouring sites for this Preliminary Hazard Analysis (PHA).

1.2 Project description

The Penrith HV BESS Project involves the development, construction, operation, and decommissioning of a grid-scale HV BESS with a capacity to supply up to 100MW of power and the ability to store up to 200MWh of energy adjacent to the existing Penrith Substation to meet the growing demands of the local Penrith community.

The Penrith HV BESS Project includes the following key components:

- Electrical infrastructure including:
  - a 100MW/200MWh BESS comprised of 48 battery containers installed in enclosures (thermal cabinet) and associated ancillary infrastructure. Lithium-ion phosphate is the preferred Lithium-ion battery chemistry for reasons of safety and widespread availability from BESS Original Equipment Manufacturers (OEM). The battery container includes an integrated AC power inverter;
  - step up transformers, auxiliary transformer and ring main units (RMUs);
  - 33kV switch room/control room;
  - installation of one (1) x 33kV underground cable and entry point for HV BESS cabling to connect the Project to the Penrith Substation via new and existing conduits; and
  - two harmonic filters.
- Other permanent ancillary infrastructure including:
  - earth grading and levelling works to allow for installation of concrete pads for the BESS containers and associated infrastructure;
  - Operation and Maintenance (O&M) building;
  - car parking;
  - security fencing, lighting, signage and lightning protection;

- fire detection and suppression equipment;
  - internal access road (about 6m wide) and driveway access off Thornton Drive;
  - formalised underground stormwater network, and provision for water detention (for water quality and fire water purposes);
  - vegetation clearance of non-native vegetation; and
  - noise attenuation walls (7m high).
- Temporary construction facilities including:
  - site office;
  - construction compounds and laydown areas; and
  - stormwater and sediment controls for the project site.

During construction and operation of the Penrith HV BESS, vehicular access to the Project site would be from the north via Thornton Drive.

Figure 1-2 shows the concept design for the Penrith HV BESS project. The final general layout for the Penrith HV BESS Project configuration will be confirmed pending connection agreement and detailed design.

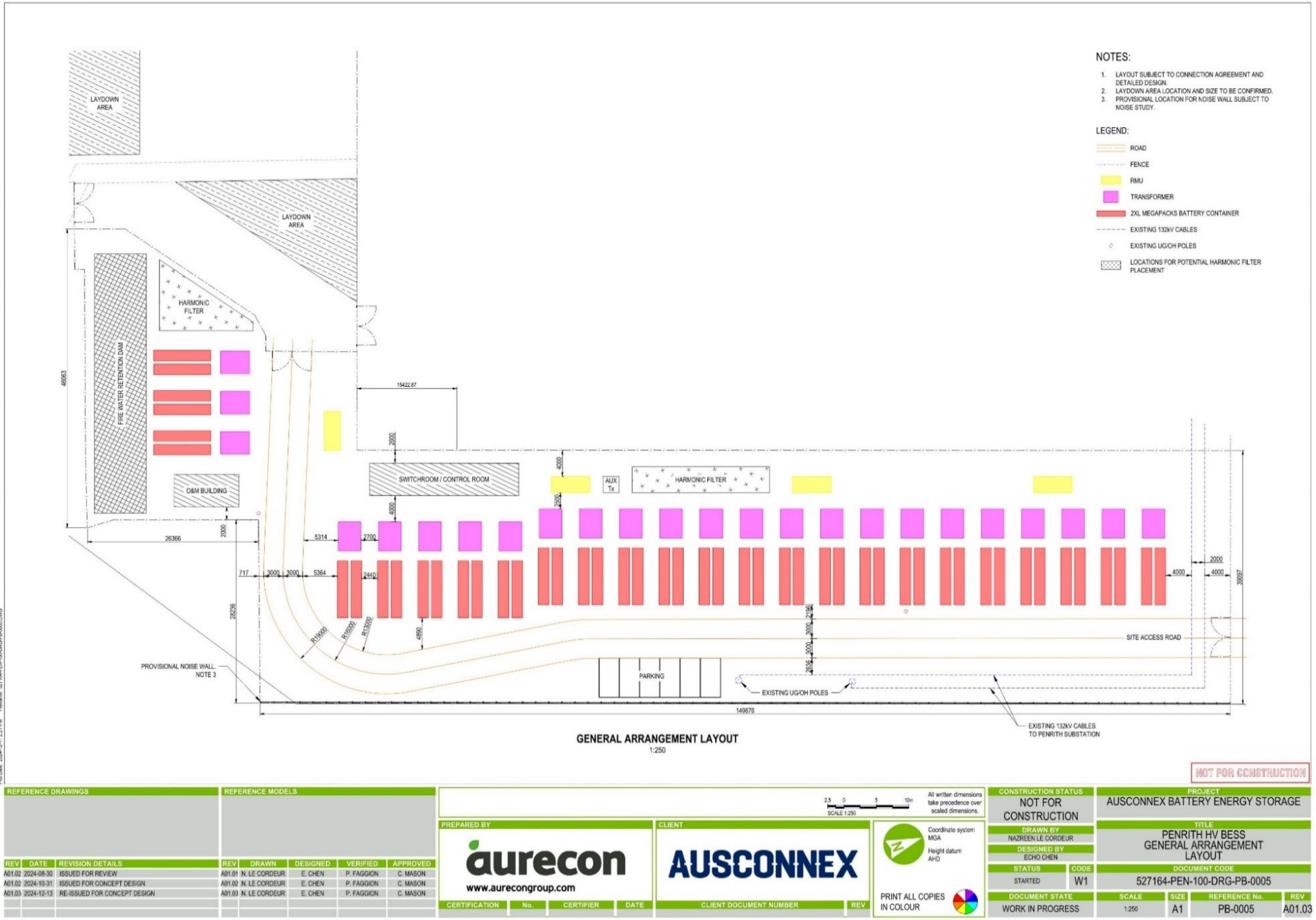

Figure 1-1: Penrith HV BESS general arrangement layout

Figure 1-2: Penrith HV BESS Project layout

1.3 Secretary's Environmental Assessment Requirements

The requirements in relations to hazards and risk as provided in the Secretary's Environmental Assessment Requirements (SEARs) (Application No. SSD-78368474, issued on 19/12/2024) and where they are addressed in this report are detailed in Table 1-1.

Table 1-1: Hazards and Risks - SEARs

SEARs	Where addressed in this Assessment
Hazards and Risks – including:	
▪ **Health** - an assessment of potential hazards and risks including but not limited to fires, 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;	A separate Electric and Magnetic Fields [3] report has been prepared to support the Penrith HV BESS Project EIS and complies with the International Commission on Non-Ionizing Radiation Protection (ICNIRP).
▪ **Bushfire** – identify potential hazards and risks associated with bushfires including the risks that a BESS would cause a bush fire and demonstrate compliance with *Planning for Bush Fire Protection 2019;*	A separate technical report (refer to the Bushfire Assessment Report [4]) has been prepared to support the Penrith HV BESS Project EIS and is excluded from this study. Risk events associated with bushfire and the identified controls have been included in this study to demonstrate that this event has been considered and assessed.
▪ **Dangerous Goods** - a preliminary risk screening completed in accordance with the *State Environmental Planning Policy (Resilience and Hazards) 2021*; and	Section 5 provides the preliminary screening undertaken in accordance with *State Environmental Planning Policy (SEPP Resilience and Hazards)* [1]. The Penrith HV BESS was determined to be both a potentially offensive and a potentially hazardous development.
▪ **Battery Energy Storage System** - a Preliminary Hazard Analysis (PHA) prepared in accordance with *Hazardous Industry Planning Advisory Paper No. 6 – Guideline for Hazard Analysis* (DoP, 2011) and *Multi-Level Risk Assessment*. 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*. The PHA must consider the effect of bushfires on batteries or other components of the BESS.	Section 6 documents the Preliminary Hazard Analysis undertaken. Separation to off-site receptors is addressed in Section 6.1 Recommendations for the on-site separation distances are documents in Section 7.1.3. Following from the PHA, it was determined that, subject to the implementation of recommended risk mitigations, and technical and safety measures, the Penrith HV BESS Project will not constitute a hazardous industry.

1.4 Purpose of this report

This Project is subject to Division 4.7 of the *Environmental Planning and Assessment Act 1979*, which requires an EIS.

This PHA has been prepared by Aurecon on behalf of Ausconnex to accompany the State Significant Development (SSD) application for the Penrith HV BESS Project. The report has been prepared in response to the SEARs the Penrith HV BESS Project (SSD-78368474) issued for the project on the 19/12/2024, specifically to address the Dangerous Goods and BESS subsections under the Hazards and Risks requirements.

This report provides an assessment of potential hazards and risks from the Penrith HV BESS Project's construction, operational, and decommissioning phases, and documents measures to prevent or minimise major hazard incident that could result in significant offsite effects.

1.5 Structure of this report

The structure of the report is outlined below.

- Section 1 provides an overview of the Penrith HV BESS Project and describes the purpose and structure of this report.
- Section 2 provides an overview of the Penrith HV BESS Project context.
- Section 3 provides an overview of the key legislative and policy documents that have been taken into consideration.
- Section 4 outlines the hazard identification and risk assessment methodology applied.
- Section 5 provides a preliminary risk screening for the Penrith HV BESS Project.
- Section 6 provides an analysis of the preliminary hazards and risks associated with the Penrith HV BESS Project.
- Section 7 details the recommendations and mitigation measures to implemented.
- Section 8 provides a summary of the PHA and key conclusions.
- Section 9 lists the references used in this report.

2 Project overview and site context

The Penrith HV BESS Project is located within the property boundary of and co-located adjacent to the Penrith transmission substation site at 2235-2249 Castlereagh Road, Penrith, NSW 2750 and will be connected to the substation with 33kV connections. The high-voltage (HV) BESS development will be located adjacent to the future Ausconnex MV BESS development.

The Project Site is located within the Penrith City Council Local Government Area in the suburb of Penrith, approximately 35 kilometres (km) northwest of Parramatta Central Business District and 50km northwest of Sydney Central Business District.

The Penrith HV BESS Project is located on land zoned as E4 (General Industrial), Penrith Local Environmental Plan (LEP)

Sensitive receivers in the vicinity of the Penrith HV BESS project may experience amenity impacts including noise, air quality and visual during the construction and operation works. Existing ambient noise sources originate from vehicles on Castlereagh Road, Museum Drive and Thornton Drive and industrial activities surrounding the project site. The Museum of Fire has fire engine siren noise from time to time when school groups are visiting the museum. The predominant land uses in the vicinity of the project site are primarily industrial and related to road infrastructure. Sensitive receivers to the construction and operation of the Penrith HV BESS project include:

- the Museum of Fire, around 50m southeast of the Project Site
- medium and high-density residential buildings along Combewood Avenue, Penrith, located around 200m east of the Project Site and
- the closest public recreation area, located 115m to the east of the project site.

Further receivers to the construction and operation of the Penrith HV BESS project include:

- industrial businesses located around 20m east, 35m south and 180m west of the Project Site
- commercial businesses located around 50m north of the Project Site and
- Penrith Train Station and railway line located around 370m southeast and 130m south of the Project Site respectively.

The Project Footprint is affected by the Sydney Trains Corridor Protection Zone – Infrastructure SEPP (Clause 2.99/Concurrence). This applies explicitly to excavation work in, above, below or adjacent to Sydney Trains' rail corridors.

Figure 2-1 presents the land zoning and the sensitive receivers of the Penrith HV BESS Project's surrounding areas.

Figure 2-1: Penrith HV site land zoning and sensitive receivers

A summary of the key Project features considered relevant to the assessment are provided in Table 2-1.

Table 2-1: Project features

Project description – Penrith HV BESS	
Project name, site location and surrounds	▪ Penrith HV BESS. ▪ The BESS installation is proposed on the eastern side of the existing Penrith Transmission Substation within the property boundary located at 2235-2249 Castlereagh Road, Penrith NSW (Lot 5 DP 1017480). ▪ Surrounding land uses include E4 - General Industrial to the north, east and south, and Castlereagh Road SP2 – Infrastructure (Classified Road) directly west of the Project site. Land uses in the broader locality include RE1 Public Recreation, SP2 - Infrastructure (Railway), R1 – General Residential, E1- Local Centre and C3- Environmental Management. ▪ The closest non-associated residences are around 200m east of the Penrith site (Combewood Avenue, Fernandez Lane, and Lord Sheffield Circuit, and surrounds). There are industrial buildings located between these residential receivers and the Project site.
MW/MWh capacity of BESS	100MW/200MWh
Indicative development footprint	Approximately one hectare (ha)
Land use zoning and current use of land, including agricultural land and soil capability class	The land is appropriately zoned E4 – General Industrial under the Penrith Local Environment Plan (LEP) 2010.The Penrith site has an existing transmission substation, associated infrastructure and a grassed area. Two rows of trees originally planted to provide screening in accordance with the development consent for the substation (DA 20/0360) are within the indicative footprint of the Penrith HV BESS site and are subject to removal as part of this project. The Land and Soil Capability Class is 4 – Moderate to severe limitations, a classification that is based on eight limitations (water erosion, wind erosion, salinity, topsoil acidification, shallow soils/rockiness, soil structure decline, waterlogging and mass movement), which assess the physical capacity of the land to sustain practices in the long term without degradation to soil. A class 1 indicates land capable of sustaining most land uses, and class 8 represents land that can only sustain very low impact land uses (e.g. conservation). Based on this scaling of land use capability and the proposals designation of class 4, the proposal is considered acceptable. [5]. The Penrith HV BESS Project is not located in an agricultural area.
BESS and ancillary infrastructure	Based on a concept layout, the Penrith HV BESS Project would include the following key components: ▪ Electrical infrastructure including: – a 100MW/200MWh BESS comprised of 48 x 2.8m x 50m^2 footprint (per container) battery containers installed in enclosures (thermal cabinet) and associated ancillary infrastructure. Lithium-ion phosphate is the preferred Lithium-ion battery chemistry for reasons of safety and widespread availability from BESS Original Equipment Manufacturers (OEM). The battery container includes an integrated AC power inverter; – step up transformers, auxiliary transformer and ring main units (RMUs); – 33kV switchroom/control room; and – installation of one (1) x 33kV underground cable and entry point for HV BESS cabling to connect the Project to the Penrith Substation via new and existing conduits; and – two harmonic filters. Other permanent ancillary infrastructure including: ▪ concrete pads for the HV BESS containers and associated infrastructure; ▪ Operation and maintenance building; ▪ car parking; ▪ security fencing, lighting, signage and lightning protection; ▪ fire detection and suppression equipment; ▪ internal access track (about 6m wide) and access off Thornton Drive; ▪ formalised underground stormwater network, and provision for water detention (for water quality and fire water purposes); ▪ vegetation/tree replacement, as required; and ▪ noise attenuation walls (7m high).

Project description – Penrith HV BESS	
	Temporary construction facilities including: ▪ site office ▪ construction compounds and laydown areas ▪ stormwater and sediment controls for the Penrith HV BESS Project area. During construction and operation of the Penrith HV BESS, vehicular access to the Penrith site would likely be from the north via Thornton Drive.
Proposed connection to grid	The proposed HV BESS would connect to the existing Penrith Transmission Substation via 1 x 33kV underground cable.
Key constraints identified	Based on a desktop feasibility assessment undertaken to inform the Scoping Report [6], the following potential constraints have been identified to date: ▪ Existing underground and/or overhead transmission lines to be relocated. ▪ The Museum of Fire, a local heritage-listed item, is located 75m east of the site, with limited to no screening. Several State heritage-listed fire engines, ladders, fleet, etc., are located within the Museum of Fire building, and an adjoining productivity bootcamp, which is also a heritage item. ▪ The Penrith Footprint is located in flood-prone land mapped under the Penrith LEP. ▪ The site is mapped as having a moderate salinity risk [6]. ▪ High probability of asbestos contamination due to the site history [7]. ▪ Noise and vibration impact of construction and operation upon sensitive receivers [31]. ▪ Impacts of OSOM movements during construction upon existing traffic and road safety conditions [31]. ▪ Negative socio-economic impacts upon both local and regional communities [31]. ▪ Negative visual and landscape character impacts caused by the introduction of permanent electrical infrastructure and BESS components [31]. ▪ Negative impacts upon the existing surface water quality caused by pollution of runoff with sediments or leaked fuels and discharge of water activities on site [31]. ▪ Adjacent electrical infrastructure and development
Proximity to State significant projects	No State significant energy projects are identified within 1km of the site [6].
Adjacent electrical facilities	A medium voltage (MV) BESS with a capacity to store up to 5MW of power is proposed to be developed south of the existing Penrith Transmission Substation, and west of the HV BESS, on the same property (refer to Figure 2-2). Penrith HV BESS and MV BESS development applications are considered separately.

Figure 2-2: Penrith MV BESS and Penrith HV BESS Project Site location

3 Legislative and policy context

3.1 State Environmental Planning Policy (Resilience and Hazards)

Regarding hazardous and offensive development, Chapter 3 of the *State Environmental Planning Policy (Resilience and Hazards) 2021* (SEPP Resilience and Hazards) [1] (which replaced *State Environmental Planning Policy No. 33 Hazardous and Offensive Development* (*SEPP 33*)), the SEPP Resilience and Hazards aims to:

- amend the definitions of hazardous and offensive industries when used in environmental planning instruments;
- render ineffective provision of any environmental planning instrument that prohibits development for the purpose of a storage facility on the ground that the facility is hazardous or offensive if it is not hazardous or offensive storage establishment as defined in Chapter 3 of the SEPP Resilience and Hazards ;
- require development consent for hazardous or offensive development proposed;
- ensure that in determining whether a development is a hazardous or offensive industry any measures proposed to be employed to reduce the impact of the development are taken into account;
- ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact; and
- require the advertising of applications to carry out any such development.

A HV BESS development is considered to be a “potentially hazardous industry” consistent with guidance provided in the *SEPP 33 Guideline 2011* [7], which states that:

> *“A ‘hazardous industry’ under SEPP 33 is one which, when all locational, technical, operational and organisational safeguards are employed continues to pose a significant risk. A proposal cannot be considered a hazardous industry unless it is first identified as potentially hazardous industry and subjected to the assessment requirements of SEPP 33.”*

A HV BESS development is considered to be a “potentially offensive industry” as consistent with guidance provided in the *SEPP 33 Guideline 2011* [7], which states that:

> *“In deciding if a proposal is ‘potentially offensive industry’ consent authorities need to determine whether, in the absence of safeguards, the proposal would emit a polluting discharge which would cause a significant level of offence.”*

The methodology to determine whether the development is potentially hazardous or offensive is detailed in the SEPP Risk Screening assessment (Step 1) in Section 4.

4 Methodology

To determine whether a proposed development is potentially hazardous or potentially offensive in the context of SEPP (Resilience and Hazards) 2021, the *SEPP 33 Guideline 2011* [7], is used to undertake a SEPP risk screening process.

The preliminary screening methodology is confined to the areas within the Project site boundary, including the electrical, permanent ancillary, and temporary infrastructure, all defined as on-site. For the purpose of this study, areas outside of the site boundary, including the existing infrastructure adjacent to the development, have been defined as off-site.

If the proposed development is screened to be potentially hazardous or potentially offensive, a preliminary risk assessment is required to determine appropriate mitigations to ensure the development is not hazardous or offensive.

The methodology of this assessment consists of the following three desktop steps:

- **Step 1:** Conduct a risk assessment and document a preliminary risk screening in accordance with Chapter 3 of the SEPP Resilience and Hazards and the associated *SEPP 33 Guideline*, to determine if the development is potentially hazardous and/or potentially offensive.
- **Step 2:** If the development is potentially hazardous and/or potentially offensive, conduct a PHA using risk prioritisation techniques in the Multi-Level Risk Assessment Guidelines [2] and assess the risk in accordance with the requirements of *Hazardous Industry Planning Advisory Paper No. 6 (HIPAP 6) – Guideline for Hazard Analysis* [8]. The PHA considers all recent standards and codes and verifies separation distances to onsite and offsite receptors to prevent fire propagation and compliance with *Hazardous Industry Advisory Paper No. 4, Risk Criteria for Land Use Safety Planning* (HIPAP 4) [9].
- **Step 3:** Based on the findings of the PHA, provide technical recommendations as management commitments to be included in the Penrith HV BESS Project's approvals conditions.

4.1 Step 1: SEPP Risk Screening

The objective of the preliminary risk screening is to determine whether the proposed development is considered as "potentially hazardous or potentially offensive" in the context of SEPP (Resilience and Hazards) 2021.

Potentially Hazardous Industry

The SEPP defines a potentially hazardous industry as follows:

Potentially hazardous industry' means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

(a) to human health, life or property, or

(b) to the biophysical environment,

and includes a hazardous industry and a hazardous storage establishment.

Development proposals that are classified as 'potentially hazardous' industry must undergo a PHA as per the requirements set in HIPAP No. 6 *Guidelines for Hazard Analysis* [8] , to determine the risk to people, property and the environment. If the residual risk exceeds the acceptability criteria, the development is considered as a 'hazardous industry' and may not be permissible within NSW.

The risk screening process considers the type and quantity of hazardous materials to be stored on site, distance of the storage area to the nearest site boundary, as well as the expected number of transport movements. ‘Hazardous materials’ are defined within the guideline as substances that fall within the classification of the Australian Dangerous Goods Code, i.e. have a Dangerous Goods (DG) classification. Detail of the DG classification is typically obtained from the materials’ Safety Data Sheet (SDS).

The *SEPP 33 Guideline* [7] is based on the 7th edition of ADG Code [10], and refers to hazardous chemicals by their DG classification. Risk screening is undertaken by comparing the storage quantity and the number of road movements of the hazardous materials with the screening threshold specified in the guideline. The screening threshold presents the quantities below which it can be assumed that significant offsite risk is unlikely.

The methodology outlines that if a development application (DA) comprises dangerous goods at quantities or transport frequencies that exceed the defined thresholds, a PHA must be completed as part of the SEPP process. An overview of the SEPP process can be visualised in Figure 4-1.

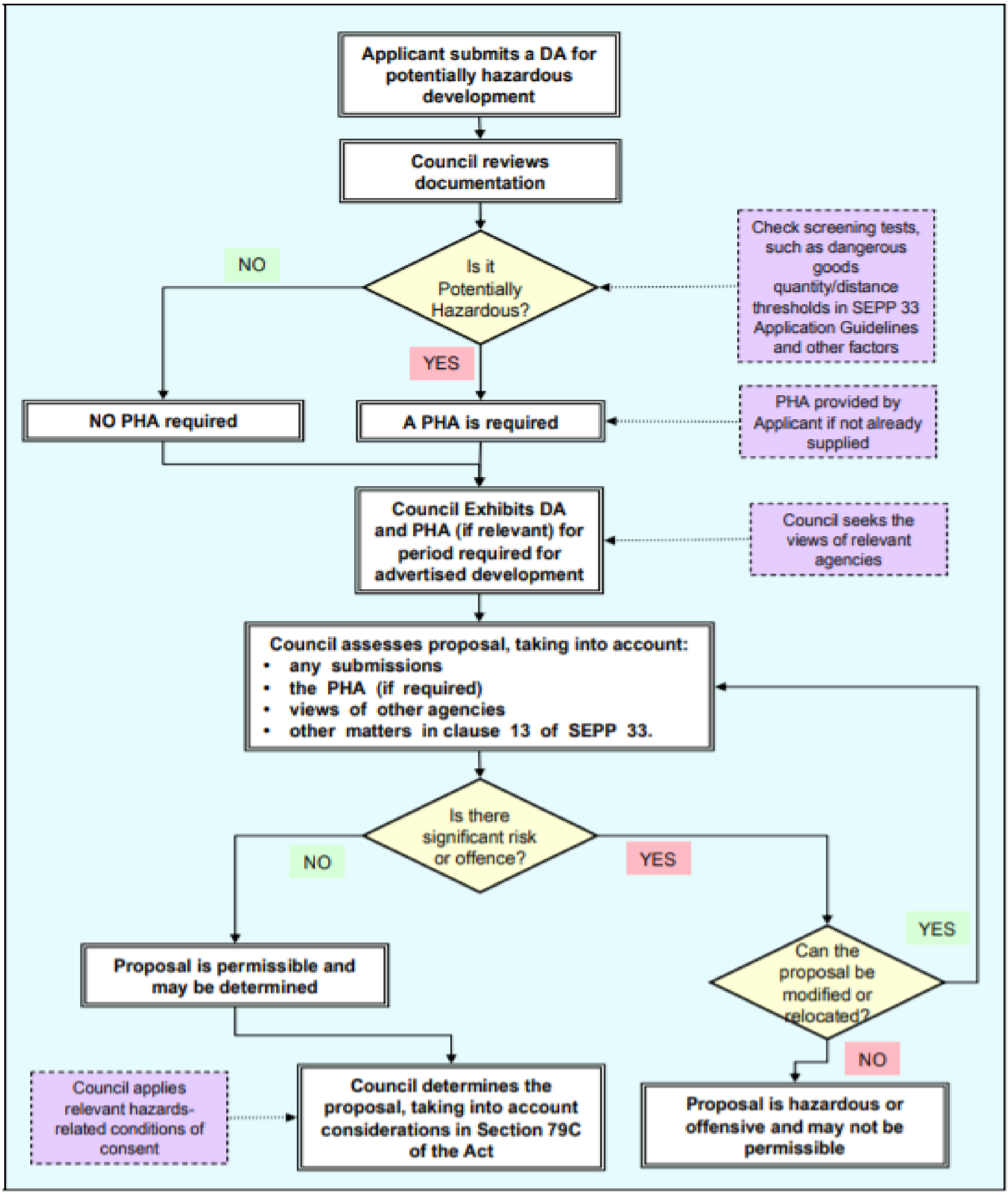

Figure 4-1: SEPP Process [7]

Potentially offensive industry

Additionally, the SEPP Resilience and Hazards defines a potentially offensive industry as follows:

> *Potentially offensive industry' means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment.*

The preliminary risk screening process is essential for determining whether the proposed development is classified as potentially hazardous and/or potentially offensive. This step ensures that all potential risks—both hazardous and offensive—are properly identified and assessed, allowing for the appropriate mitigation measures to be implemented.

This step of the methodology is applied in Section 5: Step 1: SEPP Risk screening.

4.2 Step 2: Preliminary Hazard Analysis

4.2.1 Multi-Level Risk Assessment

The Multi-Level Risk Assessment Guidelines shown in Figure 4-2 is a framework that sets out three levels of risk analysis (i.e. qualitative, semi-quantitative, full quantitative) that may be appropriate for a PHA should it be required. Criteria for determining the appropriate level of analysis is as follows:

- Level 1 (qualitative): the activity does not pose a significant off-site risk.
- Level 2 (semi-quantitative): the likelihood of risk contributors resulting in off-site consequences is low and risk contributors can be quantified to demonstrated that the risk criteria will not be exceeded.
- Level 3 (quantitative): There are significant off-site risk contributors, and a Level 2 analysis is insufficient to demonstrate that the risk criteria will be met.

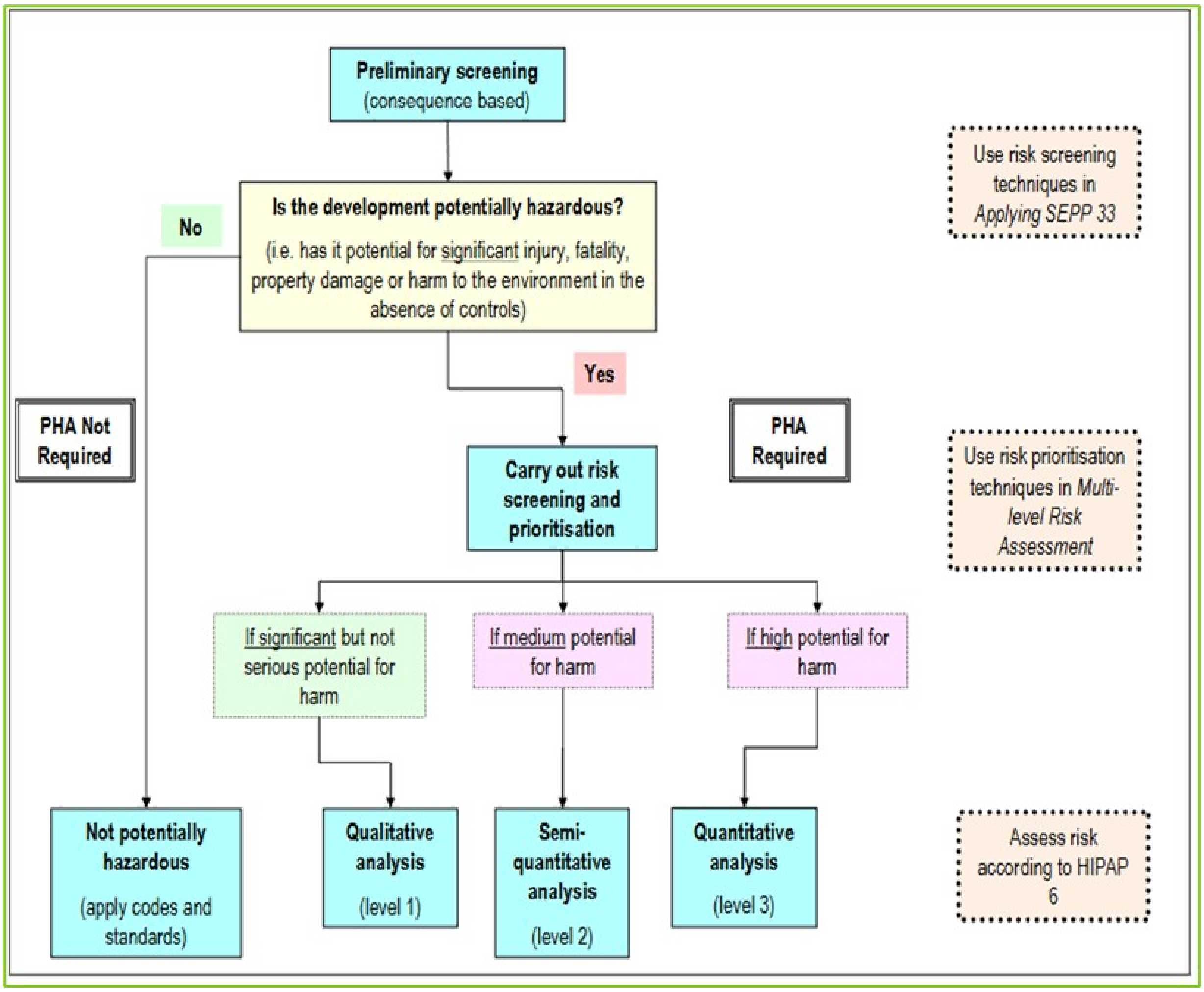

Figure 4-2: The multi-level risk assessment approach [6]

4.2.2 Preliminary Hazard Analysis

Following the preliminary screening assessment, a PHA may be determined as required (or mandated via the SEARs) to identify any additional significant hazards that may pose an offsite risk. This is to be carried out in accordance with the requirements of HIPAP No. 6 Hazard Analysis [8] and as per the Penrith HV BESS Project SEARs. The principle for hazard analysis method described in *HIPAP 6* [8] and detailed in Figure 4-3.

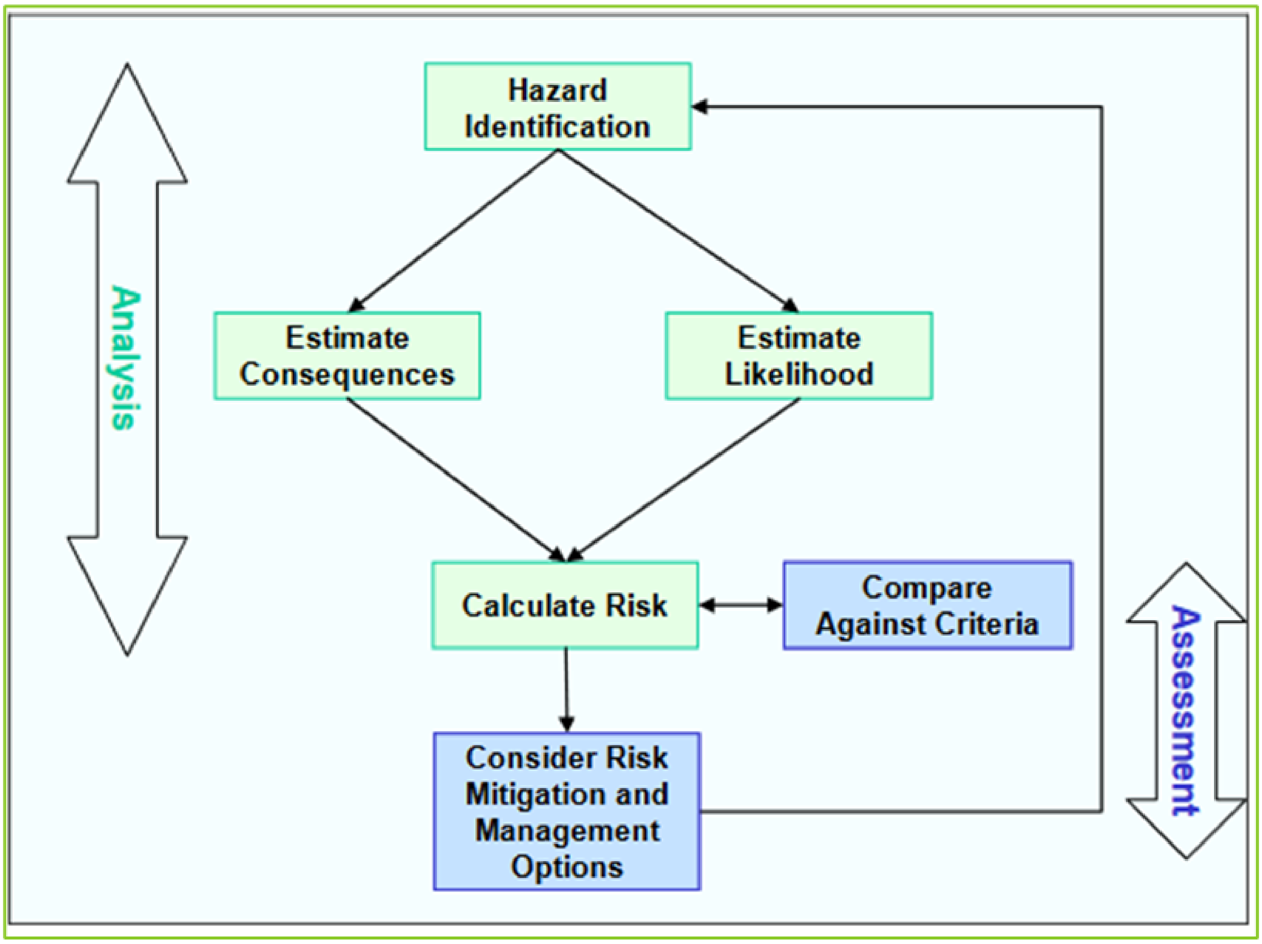

Figure 4-3: HIPAP 6 - Hazard analysis and assessment method

The methodology to undertake a PHA for the Penrith HV BESS Project includes the following:

- Identify and estimate the type and quantity of dangerous goods including any storage, transport, or handling activities.
- Screen the dangerous goods based on anticipated quantities and distance thresholds to sensitive receivers in the *SEPP 33 Guideline* [7].
- Identify additional significant hazards that may pose an offsite risk:
  - Document these key hazards associated with the transportation, installation, operation and maintenance of the Penrith HV BESS Project through the development of a risk register (hazard identification table) as required by *HIPAP 6* [8].
  - Assess the consequences of each identified hazard and determine where consequences may impact adjacent facilities or sensitive receptors. Screen out those hazards with no significant impacts and carry forward only those hazards identified to have a possible impact on adjacent sites or sensitive receptors to meet *HIPAP 4* [9].
  - Assess the frequency of those hazards carried forward from the consequence assessment.

– Assess the risks by evaluating the consequence and frequency analysis for those hazards identified to have an offsite or significant impact recommended as part of the Multi-level Risk Assessment approach [2].

This step of the methodology is provided in Section 6: Step 2: Preliminary Hazard Analysis.

4.3 Step 3: Recommendations

Recommendations and appropriate mitigation measures were identified for inclusion in the EIS.
Based on the findings from the Preliminary Hazard Analysis (PHA), appropriate recommendations will be made. These recommendations will be informed by relevant Australian standards and integrated into the facility design and emergency management plan during the detailed design phase.

This step of the methodology is provided in Section 7: Step 3: Recommendations.

4.4 Key assumptions

For the purposes of this PHA, certain assumptions were made to allow for the preparation of the worst-case scenario. The assumptions made include:

- While the OEM hasn’t been confirmed, Tesla is a well-known battery technology provider. To determine the quantity of hazardous materials on site it has been assumed that Tesla Megapack 2XL are being used as the BESS units.
- The battery product may contain several Lithium-ion battery containers.
- Petrol and diesel tonnage have been estimated by scaling up the petrol and diesel tonnage from a similar project.
- The quantity of transformer oil in Section 5.1 was estimated on the basis of one MV, one earthing, and one auxiliary transformer.

4.5 Criteria adopted

The criteria adopted for the PHA include the following:

- *The Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (State of NSW, Department of Planning, 2011) [7].
- *The Hazardous Industry Planning Advisory Paper No. 6 – Guideline for Hazard Analysis* (State of NSW, Department of Planning, 2011) [8].
- *The Multi-Level Risk Assessment* (NSW Department of Planning & Infrastructure, 2011) [2].
- The *Hazardous Industry Advisory Paper No. 4, ‘Risk Criteria for Land Use Safety Planning* (NSW Department of Planning, January 2011) [9].
- Position statement “Open yard storage of battery energy storage systems (BESS)” (Fire and Rescue New South Wales, 2024) [11].
- *Fire Safety Guideline – Large-scale external lithium-ion battery energy storage systems – Fire safety study considerations* (D22/107002) (Fire and Rescue New South Wales (FRNSW), 2023) [12].

4.6 Limitations and uncertainty

The quantity of dangerous goods has been estimated based on similar projects. Any significant changes in hazardous materials from those listed in Section 5 may require the PHA to be revisited.

5 Step 1: SEPP Risk screening

The assessment involves a preliminary risk screening as per the *SEPP 33 Guideline* to determine whether the Penrith HV BESS Project is a potentially hazardous industry. In Appendix 4 of the *SEPP 33 Guideline* [7], it is stated that potential risk typically depends on five main factors.

- The properties of the substance(s) being handled or stored (refer to Section 5.1).
- The conditions of storage or use (refer to Section 5.1).
- The quantity involved (refer to Section 5.1).
- The location with respect to the site boundary as the nearest possible receptor (refer to Section 5.1).
- The surrounding land use (refer to Section 5.1).

This section identifies the types and quantities of all hazardous goods that may be associated with the Penrith HV BESS Project, screens them against the *SEPP 33 Guideline* [7] thresholds (where applicable) and identifies any outstanding hazards which pose significant offsite risks that may impact on offsite land uses based on the Penrith HV BESS Project location in relation to HIPAP 4.

5.1 Hazardous materials

Table 5-1 details the hazardous materials associated with BESS units. Following the *SEPP 33 Guideline,* the *Australian Dangerous Goods Code* (ADG) and United Nations (UN) Number (the 4-digit unique code assigned to the substance by the UN Committee of Experts on the Transport of Dangerous Goods) is listed for each hazardous material.

Table 5-1: BESS hazardous materials

Hazardous material	Type	UN Number	ADG Class	Estimated quantity	General Screening Threshold Quantity / Distance	Threshold exceeded?
Lithium iron phosphate	Lithium Batteries	3480/3536	9 (Misc.)	48 Battery Containers	N/A	No

It is assumed that Lithium-ion batteries will be utilised for this Project. It is assumed they will be delivered pre-assembled meaning all substances required by the units are built into the system and do not need to be added at the time of installation at the Site.

Table 5-2 lists the non-BESS unit hazardous materials which are expected to be present in various quantities associated with the Penrith HV BESS Project.

Table 5-2: Other possible hazardous materials

Hazardous material and purpose	UN number	ADG Class	Estimated quantity	General Screening Threshold Quantity / Distance	Threshold exceeded?
Refrigerant (R134a, 1,1,1,2-Tetrafluoroethane): Cooling of BESS	3159	2.2 (Non-toxic Compressed Gas)	< 3kg in each battery enclosure. Total 48 battery enclosures.	N/A	N/A
Coolant 50-50 ethylene glycol-water	N/A	N/A	< 400L in each battery enclosure. Total 48 battery enclosures.	N/A	N/A
Petrol: Fuel for minor maintenance machinery	1203	3 (Flammable Liquids)	Minor quantities for refuelling equipment < 5000L	If ≤5 tonnes: Not potentially hazardous If > 5 tonnes: Approx. 5 tonne a 5m (PGII)	No
Diesel: Fuel for minor maintenance machinery	1202	Treated as 3PGIII as stored with Petrol	Minor quantities for refuelling equipment < 5000L	If ≤5 tonnes: Not potentially hazardous If > 5 tonnes: Approx. 5 tonne a 5m (PGII)	No
Transformer Oil (MV, Aux and Earthing Transformers) Transformer coil insulation	N/A	N/A FR3 natural ester with high flash point	87,600L	N/A	N/A
Switchgear Insulator: Sulfur Hexafluoride (SF_6)	1080	2.2 (Non-toxic Compressed Gas)	Minor quantities typical for switchgears	N/A	N/A
Miscellaneous Cleaning Chemicals: Various minor maintenance activities (e.g. cleaning)	Various	5.1 and 8	< 500kg	5.1: 25 tonnes 8: 5 tonnes	No

The largest delivery of dangerous goods will be during construction and commissioning when the batteries are delivered. There is no significant ongoing transport of hazardous materials to the site as part of the operational requirements of the Penrith HV BESS Project. Replacement of battery containers will happen for maintenance purposes. These are not considered hazardous as per the *SEPP 33 Guideline* [7].

It is also assumed that there is no storage tank of petrol and/or diesel onsite and that these chemicals will be stored in portable containers.

All screening distances are below the thresholds to be considered potentially hazardous set out in the SEPP 33 Guideline.

However, the Penrith HV BESS Project may still be screened as a potentially hazardous development due to its associated risks, as elaborated in Section 5.2.

5.2 Outcomes of the screening assessment

Appendix 3 of the *SEPP 33 Guideline* [7] provides a list of industries that may be potentially hazardous. However, it states the provided list is “illustrative and is not exhaustive” and that “hazard arises from factors other than the presence of dangerous goods”. While BESS facilities are not included in the list of example potentially hazardous industries, the risk screening identified electrochemical cells containing ADG Class 9 (Miscellaneous) materials in the form of lithium-ion batteries. As stated previously, lithium-ion batteries do not have a screening quantity to demonstrate the potential impact of the material; however, they do pose risks such as a thermal runaway, overheating and hazards associated with lithium-ion fires, which is explored in further detail in Section 6.1.2.

The SEPP 33 Guideline specifies that even if the quantities of dangerous goods are below the risk screening thresholds as detailed in Section 5.1, the provisions of the SEPP Resilience and Hazards still apply when significant hazards arise from other factors. Given that lithium-ion batteries present a potential thermal overload hazard as discussed, the provisions of SEPP Resilience and Hazards are applicable. Thus, a PHA is required under the SEPP Resilience and Hazards as well as per the Penrith HV BESS Project SEARs.

Additionally, the Penrith HV BESS Project has the potential to be a “potentially offensive industry”, as defined by the *SEPP 33 Guideline* [7], as an industry where “in the absence of safeguards, the proposal would emit a polluting discharge (including noise), which would cause a significant level of offence.”

The Penrith HV BESS Project may produce noise, which could cause offence regarding the sensitivity of the receiving environment as regulated under the *Environmental Planning and Assessment Act 1979*. This potential for offence during construction and operation is being assessed through the Noise and Vibration Technical Assessment as part of the EIS. The assessment considers results from noise monitoring, noise modelling and noise mitigation design measures, where required. This includes a 7m noise wall that has been confirmed to be constructed as one of the mitigations.

6 Step 2: Preliminary Hazard Analysis

6.1 Hazard identification

Hazards were identified through a desktop assessment and documented in a Risk Register (refer to Appendix A). The consequences of each identified hazard were assessed to determine if the consequences may potentially impact offsite adjacent facilities or sensitive receptors. Hazards with no significant offsite impacts were screened from the assessment. Only hazards identified to have a potential significant impact on adjacent sites or sensitive receptors in the screening assessment (recommended as part of the Multi-Level Risk Assessment approach) underwent the preliminary hazard analysis. Hazard identification was grouped into five types:

- natural hazards;
- battery hazards;
- transformer hazards;
- adjacent facilities; and
- other hazards.

6.1.1 Natural hazards

There are several potential natural hazards that pose a risk offsite or to the Penrith HV BESS Project. These hazards include extreme ambient temperatures, bushfires, seismic activity, flooding, wind, subsidence, and lightning as detailed in the Risk Register in Appendix A.

6.1.2 Lithium-ion battery hazards

In reference to DNV's recommended practice for the *Safety, operation and performance of grid-connected energy storage systems, dated 2017* [13], the primary hazard for Lithium-ion batteries is thermal runaway and overheating which is controlled with adequate cooling and management of temperature excursions.

In most cases, the temperature of the Lithium-ion batteries should not be higher than 70°C to prevent thermal runaway, which causes propagation of increasing temperatures, pressures, and fire toward neighbouring cells.

Similarly, the temperature of the Lithium-ion batteries, in most cases, should not drop below 0°C to prevent lithium plating around the anode during charging, which can cause internal shorts. Although the choice of anode-cathode chemistry can result in different thermal stability and volatility, all Lithium-ion batteries are flammable when exposed to fire.

Lithium-ion fires are a unique class of fire and may result in emissions of large volumes of toxic or combustible gases, which need to be managed accordingly. These hazards are described in the Risk Register located in Appendix A.

An internal or external short circuit within battery units can cause significant overheating and provide an ignition source resulting in fire, including surrounding materials or materials within the cell or battery. Under normal conditions of use, the electrode materials and electrolytes they contain are not exposed, provided the battery integrity is maintained, and the seals remain intact. The risk of exposure may occur only in cases of physical damage (mechanical, thermal, or electrical). Generally, battery manufacturers design for these operating conditions. For example, Tesla Megapacks are designed to withstand operating ambient temperatures up to approximately 50°C,storage temperatures up to 50°C for up to 12 months, and withstand up to 100% relative humidity (condensing) [14] [15].

Prolonged exposure of the product to conditions beyond these limits may increase the potential of thermal runaway and result in a fire. Exposure of battery packs to localised heat sources such as flames may result in cell thermal runaway reactions and should be avoided [16].

6.1.3 MVA transformer and switchgear hazards

Access to equipment, safe operation and maintenance, safe personnel egress, equipment clearance, electrical safety and fire safety systems need to be considered for the 4.6 MVA transformer and switchgear installations. AS 2067:2016: *Substations and high voltage installations exceeding 1 kV a.c*. [17] outlines the risks and safety measures for these hazards.

Contact with live parts, arc flashing, and transformer fires are the most common hazards associated with transformers. As this area involves high voltages, the site must comply with the *Electricity Supply Act, 1995* [18]. The causes of fire hazards relating to transformers are typically categorised as one of the following:

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

Loss of containment and outdoor switchgear failure are the most common hazards associated with switchgears. The possible causes of switchgear failure identified are due to arc-flashing induced fires, operator failure that causes continued arcing, switchgear insulator failure, or surge arrestor failure. These hazards are described further in the Risk Register located in Appendix A.

6.1.4 Adjacent facilities

The Penrith HV BESS Project may be impacted by potential fire and explosion hazards from adjacent facilities. These potential hazards have been identified at the adjacent substation and MV BESS facility.

These hazards are described further in the Risk Register located in Appendix A.

6.1.5 Other

Other hazards associated with the Penrith HV BESS Project for potential offsite risks were also considered, including hazards such as excavation, vehicle collision/congestion during construction and commissioning, loss of containment (e.g. of waste, diesel, contaminated water, and refrigerant within BESS units. These hazards are described further in the Risk Register located in Appendix A.

A medium pressure gas distribution main and regulator is located along Castlereagh Rd and was not identified as a potential hazard due to the adequate separation distance between the medium pressure gas distribution main and regulator set and the Project Site.

Further to this, it is also noted that the gas distribution main:

- is not classified as a gas pipeline as regulated under the *Pipelines Act 1967*
- has a relatively small diameter
- stores a medium pressure of natural gas.

Typical mitigations such as 'dial before you dig' control shall be followed during all phases of the Penrith HV BESS Project.

The Project Footprint is affected by the Sydney Trains Corridor Protection Zone – Infrastructure SEPP (Clause 2.99/Concurrence). This specifically applies to excavation work in, above, below or adjacent to Sydney Trains' rail corridors. Transport for NSW must provide their approval before a development application can be determined by the local council, to ensure that any excavation or development near the rail corridor does not negatively impact the infrastructure's safety, structural integrity, or operation.

6.2 Risk assessment matrices

The risk matrices set out in Table 6-1, Table 6-2, and Table 6-3 were used to complete a qualitative risk assessment of the hazards and hazardous materials identified in Section 6.1. Consistent with standard risk assessment methodology, the risk rating for a given hazard is a product of the frequency and consequence of its occurrence. As such, the estimated consequence for each hazard carried forward due to posing significant offsite risk was first assessed, followed by an assessment of their estimated frequency of occurrence. Finally, the overall current risk rating was then calculated taking frequency and consequence as inputs.

Table 6-1: Hazard Consequence Assessment Matrix

Consequence	Safety	Reputation	Environment
5 – Catastrophic	Fatality	International media exposure, critical impact on business reputation	Destruction of sensitive environmental features
4 – Major	Permanent disabling injury and/or extended time off work	National media exposure, significant impact on business reputation	Long term impact of regional significance on sensitive environmental feature
3 – Moderate	Injury requiring rehabilitation and time off work	State media exposure, moderate to small impact on business reputation	Short term impact on sensitive environmental feature
2 – Minor	Injury requiring medical treatment – no lost time	Some impact on reputation, adverse news in local media	Impacts flora and fauna – immediate regulator notification
1 – Incidental	Minor injury – First Aid treatment	Little public awareness and no concern – no media coverage	Negligible, reporting as routine protocols

Table 6-2: Hazard frequency assessment matrix

Probability	Safety	Reputation	Environment
A – Almost Certain	Expected to occur in most circumstances	Expected to occur in most circumstances	Expected to occur in most circumstances
B – Likely	Could occur in most circumstances	Could occur in most circumstances	Could occur in most circumstances
C – Possible	Has occurred here or elsewhere	Has occurred here or elsewhere	Has occurred here or elsewhere
D – Unlikely	Has not occurred yet but could	Has not occurred yet but could	Has not occurred yet but could
E – Rare	May occur in exceptional circumstances	May occur in exceptional circumstances	May occur in exceptional circumstances

Table 6-3: Risk rating matrix

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

6.3 Risk register

The level of assessment required for the PHA was determined based on the outcomes of the preliminary risk screening (Step 1). According to the *SEPP 33 Guideline* [7] and *Assessment Guideline: Multi-level Risk Assessment* [2], a Level 1 qualitative analysis is sufficient when most or all of the following conditions are met:

- screening and risk classification and prioritisation indicate there are no major offsite consequences and societal risk is negligible;
- the necessary technical and management safeguards are well understood and readily implemented; and
- there are no sensitive surrounding land uses.

Consistent with the approach set out above, a Level 1 (Qualitative Analysis) risk assessment was determined to be appropriate for the Penrith HV BESS Project.

- The risk register (Appendix A) summarises the identified hazards, events and applicable infrastructure, with no major offsite consequences;
- BESS units have well well-understood technical and management safeguards; and
- The assessment of surrounding land uses as detailed in Section 2 shows there are no adjacent sensitive receptors.

6.4 Risk assessment outcomes

Thirty-four (34) different hazards associated with the Penrith HV BESS Project and associated infrastructure have been identified and recorded in the Risk Register in Appendix A and summarised in Table 6-4. Out of the 34 hazards identified, 24 of these hazards were initially identified as having potential offsite risks, with the nearest receptor (an industrial site) located 20m from the Penrith HV BESS Project site.

However, whilst there is potential for significant offsite consequences if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, in-built manufacturer's controls, implementation of recommended risk controls including adequate separation distances will make these consequences unlikely, particularly for offsite effects. The recommended technical and management safeguards set out in Section 7 reduce the residual risk such that no identified hazards pose a significant offsite risk and adequate separation distances to land-uses comply with HIPAP 4 [9].

Table 6-4: Project hazards identified in risk register

Source	Hazard	Cause	Consequence	Potential Offsite Risk	Potential Significant Offsite Risk (as defined in SEPP33)
Lithium-ion battery	Arcing or short-circuit	▪ Cable or equipment fault; ▪ Cable Thermal Failure ▪ Dust ingress	▪ Electrocution resulting in injury or fatality	No (in terms of electrical shock hazard affecting public)	Not assessed further as it is unlikely to pose an electrical shock risk affecting offsite/public
	Battery cell fire hazard	▪ Equipment fault and ignition of combustible materials used in the storage system ▪ BESS container arc flash; ▪ Installation error – reverse polarity connection; ▪ Dust ingress.	▪ Personnel injury due to burns or smoke/chemical inhalation. ▪ Damage/ destruction of battery cell. ▪ Overheating/ electrical fault potentially leading to thermal runaway.	Potential	Unlikely
	Battery cell thermal hazard	▪ Chemical properties of the battery materials and thermal runaway. ▪ Propagation of adjacent battery fire (escalation event).	▪ Personnel injury due to burns or smoke/chemical inhalation. ▪ Damage/ destruction of battery cell.	Potential	Unlikely
	Battery cell equipment failure	▪ Loss of cooling fluid/ Coolant leak from equipment attributable to design fault/error. ▪ Improper installation/ commissioning. ▪ Lack of maintenance or collision or impact on the BESS.	▪ Battery overheat and thermal runaway (refer to thermal hazard).	Potential	Unlikely
	Battery cell operational hazard	▪ Control breakdown from equipment fault; design fault/error; ▪ Discharging/ charging of a unit beyond the state of charge threshold ▪ Improper installation/ commissioning ▪ Lack of maintenance or collision or impact on the BESS.	▪ Battery overheat and thermal runaway (refer to thermal hazard).	Potential	Unlikely
	Battery cell chemical hazard	▪ Fault or failure and release of corrosive and/or toxic materials	▪ Personnel injury from burns or gas inhalation. ▪ Environmental damage.	Potential (biophysical damage)	Unlikely

Source	Hazard	Cause	Consequence	Potential Offsite Risk	Potential Significant Offsite Risk (as defined in SEPP33)
	Explosion hazard	▪ Heating, ventilation, and air conditioning (HVAC) failure (loss of cooling system) and/or overcharging of battery causing rapid expansion and confinement of gases	▪ Personnel injuries or fatalities. ▪ Damage/ destruction of battery cell.	Potential	Unlikely
	Release and dispersion of flammable and toxic gases	▪ Fire arising from combustible materials used in the storage system. ▪ Incomplete combustion of gases generated during initial battery cell thermal runaway phase.	▪ Personnel injury due to burns or smoke/chemical inhalation. ▪ Vapour cloud explosion. ▪ Environmental contamination (Hydrogen Fluoride contacts with water)	Potential	Unlikely
	Exposure to electromagnetic fields	▪ Differences in electric or magnetic fields around the BESS (transformer, powerlines).	▪ Danger to personnel.	No (in terms of hazard affecting public)	Not assessed further as it is unlikely to pose risk affecting offsite/public
	Dropping of battery cell(s) during installation	▪ Faulty equipment or procedure during battery installation	▪ Personnel injury. ▪ Damage to battery cell.	No (anticipated impact on single unit cell)	Not assessed further as it is unlikely to pose risk affecting offsite/public
	Malicious damage to BESS	▪ Unauthorised access, few staff onsite. ▪ Compromised cybersecurity system.	▪ Damage to battery cell and/or other infrastructure. ▪ Electrolyte emission. ▪ Electrocution resulting in injury or fatality. ▪ Mal-operation from external digital access of control systems.	Potential	Unlikely
Core transformer	Transformer arcing/fire/explosion	▪ Insufficient insulating oil maintenance, equipment fault	▪ Electrocution resulting in injury or fatality. ▪ Damage to transformer. ▪ Ignition source for BESS fire.	Potential	Unlikely
	Loss of containment (oil)	▪ Maintenance operations (failure of pipe). ▪ Equipment fault. ▪ Design fault/error.	▪ Pool fire (if ignited). ▪ Personnel injury due to burns or smoke/chemical inhalation.	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public

Source	Hazard	Cause	Consequence	Potential Offsite Risk	Potential Significant Offsite Risk (as defined in SEPP33)
	Live contact with transformer	▪ Insufficient enclosure or barricading	▪ Electrocution causing injury or fatality.	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public
Adjacent substation	Electrical and/or fire hazards at substation	▪ Fire at substation	▪ Damage to infrastructure ▪ Personnel injury /fatality ▪ Impact to MV BESS	Potential	Unlikely
Adjacent MV BESS site	Battery fire	▪ Fire at HV BESS	▪ Damage to infrastructure ▪ Personnel injury/fatality ▪ Impact to HV BESS	Potential	Unlikely
Switchgear	Loss of containment (sulphur hexafluoride [SF_6]).	▪ Maintenance operations (failure of pipe). ▪ Equipment fault. ▪ Design fault/error.	▪ Release of toxic gas. ▪ Personnel injury.	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public
	Outdoor switchgear failure	▪ Arc-flashing induced fire	▪ Damage to infrastructure ▪ Electrocution ▪ Personnel injury/fatality ▪ Impact to MV BESS	Potential	Unlikely
	Outdoor switchgear failure	▪ Switchgear insulator failure	▪ Damage to infrastructure ▪ Electrocution ▪ Personnel injury/fatality ▪	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public
	Outdoor switchgear failure	▪ Operation failure causing continued arcing	▪ Damage to infrastructure ▪ Electrocution ▪ Personnel injury/fatality	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public
	Outdoor switchgear failure	▪ Surge arrestor failure	▪ Damage to infrastructure ▪ Electrocution ▪ Personnel injury/fatality	No (in terms of offsite risk)	Not assessed further as it is unlikely to pose risk affecting offsite/public

Source	Hazard	Cause	Consequence	Potential Offsite Risk	Potential Significant Offsite Risk (as defined in SEPP33)
Natural Hazard	Grass or scrub fire Stray ember induced fire	▪ Bushfire ▪ Hot work ▪ Lightning strike ▪ Vandalism	▪ Damage to BESS. ▪ Significant environmental damage.	Potential	Unlikely
	Extreme temperature/humidity	▪ Extreme temperatures attributable to climate change ▪ Fire propagation due to high winds	▪ Personnel injury due to burns or smoke/chemical inhalation. ▪ Damage/ destruction of battery cell.	Potential	Unlikely
	Seismic events	▪ Failure to design the BESS to the correct earthquake loading code to account for seismic activity	▪ Damage to battery casings, cells and other infrastructure.	Potential	Unlikely
	Flooding	▪ Drainage system failure ▪ Fire-fighting activity ▪ Failure to account for flooding during foundation construction ▪ Location of the site within a flood plain area.	▪ Damage to battery casings, cells and other infrastructure. ▪ Environmental damage	Potential	Unlikely
	Extreme wind	▪ Failure to design the BESS to account for extreme wind or hail events	▪ Damage to battery casings, cells and other infrastructure.	Potential	Unlikely
	Ambient weather (lightning)	▪ Failure to design the BESS to the correct isokeraunic level to account for lightning strikes.	▪ Personnel injuries due to burns or smoke/chemical inhalation and/or fatalities. ▪ Damage/ destruction of battery cell.	Potential	Unlikely
	Subsidence	▪ Underground mining	▪ Ground instability resulting in damage to BESS units and infrastructure.	Potential	Unlikely
Other	Loss of containment (contaminated water)	▪ Spent fire water runoff. ▪ Runoff from site. ▪ Failure of process waste piping.	▪ Harm to the environment (flora and fauna).	Potential	Unlikely
	Exposure to contaminated land	▪ Construction activities exposing contaminated material from legacy works	▪ Harm to personnel and the environment.	Potential	Unlikely

Source	Hazard	Cause	Consequence	Potential Offsite Risk	Potential Significant Offsite Risk (as defined in SEPP33)
	Vehicle collision/congestion	▪ Construction activities (increased heavy vehicles). ▪ Driver fatigue.	▪ Personnel injury/fatality.	Potential	Unlikely
	Loss of containment (waste/fuel)	▪ Commissioning activities.	▪ Harm to personnel and the environment.	Potential	Unlikely
	Loss of containment (refrigerant)	▪ Vandalism of battery units.	▪ Harm to personnel and the environment.	Potential	Unlikely
	Exposure to high voltages	▪ Construction, installation, and commissioning activities in the vicinity of existing substation and switchyard	▪ Electrocution causing injury or fatality.	Unlikely	Not assessed further as it is unlikely to pose risk affecting offsite/public

The complete Risk Register with likelihood and consequence analysis for both current and residual risks for all identified hazards are attached in Appendix A.

All ‘Possible’ residual significant off-site risks can be appropriately managed through the recommendations and mitigations listed in Section 7.

7 Step 3: Recommendations

Several international standards govern the best-practice design and installation of BESS facilities and associated infrastructure. The recommended technical safeguards for the proposed Penrith HV BESS Project, set out in the following subsections, will reduce the residual risk so that no identified hazards pose a significant offsite risk.

As the Penrith HV BESS Project is still under development and design, all proposed and existing mitigations are listed as recommendations detailed below.

7.1 BESS (lithium-ion battery) recommendations

7.1.1 General BESS system design

Management of operating temperature is the primary consideration in the design and installation of Lithium-ion battery systems, given that fire and runaway thermal overload are the primary hazards with these systems. Several of the recommendations below contribute to this objective for the protection of both onsite and offsite assets:

- BESS and auxiliary infrastructure should be surrounded by fencing, locked gates, and other security measures as necessary and compliant with relevant standards (also including access control to HV areas). These mitigations are included as part of the concept design.
- The BESS and auxiliary infrastructure should be designed to incorporate redundant safety and fire protective systems wherever necessary, such that no single point of failure will result in a significant hazard event.
- The BESS should be designed to operate between temperature extremes, with allowance for higher maximum temperatures of approximately 1.5 to 2ºC to account for the likely effects of global warming. If chosen, Megapacks can withstand operating ambient temperatures up to approximately 50°C, storage temperatures up to 50°C for up to 12 months, and withstand up to 100% relative humidity (condensing) [14] [15].
- Considering outdoor installations of BESS units, appropriate heating, ventilation, and air conditioning (HVAC) should be designed and installed to keep equipment cool and clean and within a safe operating temperature range. The HVAC system should also prevent the confinement of gases.
- BESS site and infrastructure design should consider wind action and lightning protection. Lightning protection is included as part of the concept design. For lithium-ion batteries specifically, the following recommendations are proposed:
  - BESS is to be designed, manufactured, and installed to Australian Standards, in particular:
    - International Electrotechnical Commission (IEC) 62485-5: Safety requirements for secondary batteries and battery installations – Part 5: Safe operation of stationary lithium-ion batteries.
    - IEC 62933 Parts 5.1 and 5.2 Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid-integrated EES systems – General specification, and Part 5-2 Electrical energy storage (EES) systems - Safety requirements for grid-integrated EES systems - Electrochemical-based systems.
    - AS 5139: 2019 Electrical installations - Safety of battery systems for use with power conversion equipment.
    - AS 4681 The Storage and Handling of Class 9 (miscellaneous) Dangerous Goods and Articles

- Electronic safety-related systems should be installed at both a hardware and software level, designed to applicable standards, to allow for safe isolation of electrical energy in the event of a failure. These systems should be monitored remotely for life of the operation and should be subject to regular annual maintenance checks.
- Design of BESS should consist of detection and prevention system for over temperature/cell overpressure, coolant leak, etc.
- BESS site is to be equipped with smoke, and flammable gas leak monitoring system. The site will be equipped with fire detection and suppression equipment.
- BESS design and spacing should consider local environmental conditions e.g. wind speed to prevent fire propagation.
- BESS units will be installed outdoors, appropriate ingress protection (IP) is required.
- Dry-type MVA transformers instead of oil-insulated type are recommended.
- For transformers and switchgears specifically they should be designed and installed in line with AS 2067:2016*: Substations and high voltage installations exceeding 1 kV a.c.*
- Emergency shutdown should be incorporated into the BESS design
- BESS containers and associated infrastructure should be located to be directly accessible to emergency responders.
- Coolant leak alarms should be installed.
- All telemetry, fault monitoring, and electrical safety protection devices should remain active regardless of keylock switch position or system state.
- The pyro disconnect's power supply circuit should be actively monitored.

7.1.2 Lithium-ion battery

The primary reference Standard is IEC 62485-5: *Safety requirements for secondary batteries and battery installations – Part 5: Safe operation of stationary lithium-ion batteries* [19]. This Standard describes protection measures against all BESS hazards identified in this PHA, and provides safety requirements for the installation, use, maintenance, and disposal of Lithium-ion batteries. Contractors and suppliers should be required to adhere to this Standard for the installation, use, maintenance, and disposal of Lithium-ion BESS components.

Lithium-ion Battery design and commissioning considerations:

- Design of the BESS should consist of modular, insulated battery cells. These units need to account for adequate separation to prevent fire propagation considering the findings from the 2021 Victorian Big Battery fire incident [20] where fire propagation to the roof of the adjacent BESS sub-unit occurred.
- A Lithium-ion battery fire presents multiple hazards including fire damage to buildings and personnel, gas release, chemical damage and reactions, and hazardous material contamination. A fire protection system should be designed and installed to mitigate the consequences of a fire or thermal runaway hazard event.
- A Fire Safety Study should be developed in accordance with the requirements of *Hazardous Industry Planning Advisory Paper (HIPAP) No.2* [21] and to meet the operational requirements of FRNSW [12], focussing on inherent safe design to maintain sufficient separation distances between the BESS and auxiliary infrastructure from the public/boundary, onsite assets (e.g. transformers and between each BESS unit including exposure of adjoining containers within the BESS yard and adjoining exposures during an emergency response in relation to fire). Separation from any sensitive environmental areas that may be impacted by firefighting run-off e.g. water courses. A suitable fire protection system and contaminated firewater system should be designed and installed compliant with the relevant codes, in particular FRNSW guidelines [12].

- A Fire Risk Evaluation should be conducted to provide fire safety recommendation and required firefighting equipment.
- As previously stated, appropriate HVAC for BESS units should be designed and installed to keep equipment cool and clean.
- Considerations should be given to disposal of damaged lithium-ion batteries post-incident.

7.1.3 Separation distances

Additional safeguarding includes designing to Australian Standards and best practice in the industry to minimise the risk of fire through inherent safe design such as on-site separation of BESS units (i.e. obtaining vendor test results for fire propagation is recommended).

The preliminary design includes an allowance for the BESS compound components which will consist of prefabricated battery enclosures arranged into groups, which will be securely anchored mounted on a compacted gravel or concrete slab footings.

Based on the Penrith HV BESS Project footprint, the Penrith HV BESS Project layout is anticipated to encompass the BESS compound, ancillary infrastructure, and buffer zones with an indicative footprint of 0.9ha. The existing 33-132kV substation is adjacent to the BESS site.

- Safe separation distances and limited access to the existing substation and switchyard should be maintained for construction, installation and commissioning workers.
- The design of BESS and auxiliary infrastructure should make consideration of matters under Clause 5.21 flood planning of the Penrith LEP [17] and consider:
  - Surface Water and Groundwater Assessment to determine special flood considerations; and
  - provision for water retention facility.
- The layout should be developed to accommodate the anticipated number of BESS enclosures and the necessary separation distances to mitigate the spread of fires. The BESS installation will also adhere to fire and safety codes and standards such as National Fire Protection Association (NFPA) 855, UL 1976, UL 9540, and UL 9540A and Fire and Rescue NSW (FRNSW) guidelines [12]. FRNSW guideline applies to large-scale external lithium-ion battery storage systems to adapt strategies for fire safety including safe separation. Additionally, comprehensive fire safety studies and emergency response plans will be developed for the project, outlining the appropriate actions in case of smoke or fire incidents.
- The separation of the buildings, including switch rooms, control room and workshop will be in accordance with AS 2067:2016*: Substations and high voltage installations exceeding 1 kV a.c.* outlines [17], the National Construction Code and other relevant standards. Additional discussion on the separation from the transformers is noted within Section 7.2 of this report.
- BESS units will need to be appropriately separated by distance or by physical barrier according to FRNSW Guidelines [12]. If separated by distance, an assessment is required to demonstrate propagation will not occur. If separated by physical barrier, the barrier must be constructed of material of appropriate fire rating as per *AS 1530.4 methods for fire tests on building materials, components, and structures - Fire-resistance tests for elements of construction* [22]. Each BESS enclosure is estimated to have dimensions of approximately 2.8m in height, 1.7m in depth, and a length of up to 8.8m. Manufacturer recommendations regarding spacing between BESS units should also be followed in line with regulation. The separations are to cater to safe maintenance access. Typical BESS unit's front to front clearance is to be at least 2.44m, and back-to-back clearance minimum of 0.46m [14].
- Lithium-ion batteries are considered Dangerous Goods while in storage and not connected to the grid. *AS/NZS 4681 The Storage and Handling of Class 9 (miscellaneous) Dangerous Goods and Articles* [23] outlines requirements for Class 9 Dangerous Goods (i.e. Lithium-ion batteries) which should be followed while BESS units are on site and not connected to the grid.

- There is a comprehensive guideline (Country Fire Authority (CFA) Guideline [24]) for the design and development of renewable energy facilities such as BESS facilities in Victoria. This guideline is recommended as best practice to be followed e.g. in terms of separation requirements.

Since the final dimensions of the enclosures and associated clearances may vary depending on the selected supplier and product type and the final detailed design, the supplier appointed will be required to finalise the detailed design in accordance with the above design considerations for the appropriate management and minimisation of fire risk. The BESS supplier will advise the safe separation demonstrated by tests within BESS units to prevent fire propagation should an incident occur in battery cells.

7.2 MVA transformer and switchgear recommendations

AS 2067:2016*: Substations and high voltage installations exceeding 1 kV a.c*. [17] outlines the risks and safety measures for primary hazards presented by the 4.6 MVA transformers and switchgears which includes live contact, arc flashing, and fire and explosions.

The BESS (including the transformers) should be designed in line with and comply with this standard. All transformers should have separation distances away from other transformers, control rooms and office complexes that exceed the required distances in the standard. Details of the requirements for this standard are listed below:

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

- To mitigate the risks associated with transformer fire, the following steps should be followed:
  - Minimise the risk of a fire starting:
    - The transformer specification should consider, appropriate it its rating, insulation levels, operating temperatures, cooling systems, protection systems, operation (including the effect of prolonged overloading) and maintenance practices.
  - Minimise the risk of transformer failure developing into an oil fire:
    - Consideration should be given to insulating liquid type, tank strength, low explosion risk bushings, and pressure relief.
  - Minimise the impact of a transformer fire on the environment, other assets, and humans.
- If a transformer failure has developed into a transformer fire, the following control measures should be in place to minimise the damage resulting from the fire.
  - Minimise risk of loss of life and injury to humans by:
    - providing adequate clearance around transformers, particularly those with sound enclosures;
    - providing adequate access for firefighting equipment; and
    - providing adequate egress routes.
- Minimise the risk of the fire spreading or causing damage to adjacent transformers, control building, structures and other items of plant and equipment. Fire damage can be minimised by:
  - providing passive protection systems in the form of adequate separation distances, fire barriers, construction buildings of fire resisting materials; and
  - providing active suppression systems such as deluge, water mist, or gas flooding.
- Minimise contamination and damage to the environment by provision of oil containment systems and bunding.
- Given the transmission substation is existing for the Penrith HV BESS Project, other safeguards are also required for working in the close vicinity of the HV areas during construction, installation, commissioning and operations:
  - safe separation of the working area to the HV area;
  - Safeworks system; and
  - fencing around switchyard and substation and signage.
- To eliminate the risk of transformer oil fire, using dry-type transformer is recommended. If a dry-type transformer is not chosen, it is recommended that a mineral oil, or a synthetic oil-insulated transformer is chosen instead.

7.3 Natural hazards recommendations

It is anticipated that no natural hazards will impact the BESS and pose a significant offsite risk once appropriate controls are implemented (refer to Table 7-1).

Table 7-1: Natural hazards

Hazard	Description
Extreme temperatures	The temperature data in Penrith (as recorded at site: 067113) from 1995-2024 were as follows: annual maxima and minima were 48.9°C in January 2020 and -1.8°C in July 2018, respectively [25]. The BESS should be designed to operate beyond these temperature extremes, with allowance for higher maximum temperatures of approximately 1.5 to 2°C to account for the likely effects of global warming.
Bushfires	The Project is not located within a bushfire prone area [26]. Therefore, the risk that bushfire could occur is minimal. A separate bushfire report has been prepared to further examine the threat of bushfires [4].
Seismic activity	According to the National Seismic Hazard Assessment 2018, the peak ground acceleration for a 10% exceedance in 50 years of mean hazard levels is 0.03-0.04m/s^2 [27]. Risk of seismic activity is assumed to be minimal. Seismic information should be monitored to detect any increase in risk. Setback distances from falling objects (e.g. trees and powerlines) should be considered.
Flooding	The BESS and auxiliary infrastructure should be located outside the extent of the 1% Annual Exceedance Probability flood event or designed to be above the 1% Annual Exceedance Probability flood level [28]. A Flood Impact and Risk Assessment is being prepared for the Penrith HV BESS Project to determine the special flood considerations to be required [29]. Implementation of a stormwater management plan should be considered.
Excessive wind	Penrith is located within the A2/A3 Wind Region as per Figure 3.1 of *AS/NZS 1170.2:2021* [30], The BESS should be designed in accordance with *AS/NZS 1170.2:2021: Structural design actions – Part 2: Wind actions.*
Lightning	The average annual ground lightning flash density in Penrith NSW is around 2-3km^2/yr [31]. Notwithstanding, a lightning study for the proposed site should be conducted with the lightning mitigation measures implemented in the design.
Subsidence	The Penrith BESS is not located within any mining subsidence areas. A subsidence assessment to determine if there is a possibility of subsidence in areas where an abandoned/active mine is located is not required.

7.4 Other recommendations

7.4.1 Construction phase recommendations

- The construction contractor is to prepare an adequate safety management system and documentation for the Penrith HV BESS Project construction phase e.g. various management plans, emergency plans, traffic management plans, procedure for removal of contaminated land and remediation and such.
- Always “Dial Before You Dig” during construction activities.

7.4.2 Operational and maintenance recommendations

- The BESS should be installed correctly and commissioned/tested to ensure safe function.
- The safety testing of the Lithium-ion BESS should be conducted under the guidance of IEC 62619: Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

- Operators and maintainers of the facility should be adequately trained.
- Transformers and the switchgear should be maintained as their OEM recommended regime, including regular insulation and function testing.

7.4.3 Safety management plan recommendations

The assessment recommends that a safety management system is implemented prior to the commencement of commissioning or operation of the Penrith HV BESS Project:

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

- Work Health and Safety Management Plan, compliant with AS 5577: 2013 Electricity network safety management systems;
- Emergency Response Plan inline with FRNSW Guidelines [12], including:
  - safe operating conditions for temperature;
  - details of the electrical safety hazards;
  - details of the effects of fire on the BESS;
  - details for mitigation and management measures of gases that may be produced from batteries during a fire;
  - SDS, personnel protective equipment and breathing apparatus requirements for emergency response crews;
  - shut down and isolation procedures if the batteries are involved in fire;
  - a plan for partial and full shutdown of the BESS in the event of an emergency incident that renders the facility inoperable or unsafe, prior to its anticipated end-of-life; and
  - provisions for emergency response to incidents such as fire and smoke arising from nearby gas/oil pipelines (e.g. BESS shutdown, using deluge system/cooling water);
- Asset Management Plans and assurance activities. A comprehensive and regular program of maintenance and inspections, covering the BESS and related infrastructure (i.e. transformers, HVAC, civil structures) to ensure the system is serviced and maintained as per the manufacture requirements, including measures to vet contractor appointments to ensure batteries are designed and installed to appropriate standards.
- storm water and contaminated firewater management plan is to be developed;
- waste management plan for construction and operation of the Penrith HV BESS Project are to be developed
- provisions for spill containment of hazardous materials is required;
- provisions are to be in place for the identification and removal of any contaminated land during construction;
- housekeeping procedures are to be developed for construction and operation;
- development and implementation of plant operating and maintenance procedures;
- pest control/management is to be implemented; and
- adequate safeguards are to be implemented for hazards related to working close to HV substation.

An audit system should also be developed to ensure regular review and update of the safety management plans.

7.5 Standards applicable to the design and operation of the project

A list of standards and codes applicable to the identified hazards to be applied to the design of the Penrith HV BESS Project are listed below:

- *AS 153.4 Methods for fire tests on building materials, components, and structures – Fire-resistance tests for elements of construction.*
- *AS 1554.1 Structural steel welding - Welding of steel structures.*
- *AS 1603 Automatic fire detection and alarm systems.*
- *AS 1670 Fire detection, warning, control and intercom systems.*
- *AS 1725 Chain-link fabric security fences and gates.*
- *AS 1768 Lightning protection.*
- *AS 1940 The storage and handling of flammable and combustible liquids.*
- *AS 2067 Substations and high voltage installations exceeding 1 kV a.c.*
- *AS 2374.1 Power transformers Part 1: General.*
- *AS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).*
- *AS 3008 Electrical installations – Selection of cables.*
- *AS 3011.2 Electrical installations - Secondary batteries installed in buildings Sealed cells.*
- *AS 3786 Smoke Detectors.*
- *AS 4086.1 Secondary batteries for use with stand-alone power systems General requirements (where applicable).*
- *AS 4086.2 Secondary batteries for use with stand-alone power systems Installation and maintenance (where applicable).*
- *AS 4417 Regulatory compliance mark for electrical and electronic equipment.*
- *AS 4428 Fire detection, warning, control and intercom systems Control and indicating equipment.*
- *AS 4681 The Storage and Handling of Class 9 (miscellaneous) Dangerous Goods and Articles.*
- *AS/IEC 60076 Transformer.*
- *AS 61558.1 Safety of Power Transformers, Power Supplies, Reactors and Similar Products - General requirements and test.*
- *AS/IEC 62271-200 High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.*
- *IEC 63056, Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems.*
- *AS 60529 Degrees of protection provided by enclosures (IP Code).*
- *AS 61439 (Series)- Low-voltage switchgear and control gear.*
- *NFPA 855 Standard for the Installation of Stationary Energy Storage Systems.*
- *UL 1642 Lithium Batteries.*
- *UL 1741 Inverters, converters, controllers and inter-connection system equipment for use with distributed energy resources.*
- *UL 1976 Crimp Tools for Use with Connecting Devices*

- *UL 9540 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.*
- *FRNSW Guidelines – Fire and Rescue NSW Large-scale external lithium-ion battery energy storage systems – Fire safety study considerations (D22/107002*).
- *NFPA 70 National Electrical Code.*

8 Conclusion

The preliminary risk screening process concluded that the Lithium-ion battery technology may be considered potentially hazardous and may also be considered potentially offensive due to noise impacts. The noise impact is being assessed and mitigated through the Noise and Vibration Technical Assessment. As a result a 7m noise wall will be constructed.

Subsequent hazard identification and the PHA were conducted through the means of a Level 1 qualitative risk assessment in accordance with the *SEPP 33 Guideline*. The process identified 34 hazards associated with the Penrith HV BESS Project, of which 24 potential hazards had potentially significant offsite risks. All identified hazards can be controlled through appropriate technical and management safeguards which reduce the residual risk so far as is reasonably practicable and make it unlikely that a significant offsite risk is posed.

Following from the PHA, it was determined that, subject to the implementation of recommended risk mitigations, and technical and safety measures, the Penrith HV BESS Project will not constitute a hazardous industry.

The PHA recommends key technical and safety recommendations regarding the:

- Design of the BESS systems;
- Lithium-ion battery design;
- Transformers and switchgear design; and
- The separation distances required to prevent escalation of potential consequences.

The assessment recommends that a safety management system is implemented that includes the following safeguards prior to the commencement of commissioning or operation of the Penrith HV BESS Project.

- Comprehensive, documented installation and operating procedures, with a regular audit/review system;
- Comprehensive, documented inspection and maintenance procedures with a regular audit/review system;
- Work Health and Safety Management Plan;
- Emergency Response Plan and Emergency Planning Program informed by a Fire Safety Study; and
- Asset Management Plans and assurance activities.

9 References

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Appendices

Appendix A

Hazard Identification table/risk register

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
1.	Lithium-ion Battery	Arcing or short-circuit	Cable or equipment fault; Cable Thermal Failure Dust ingress	Electrocution resulting in injury or fatality	No (in terms of electrical shock hazard affecting public)	-	-	-	-	-	-	-	-	-
2.	Lithium-ion Battery	Battery cell fire hazard	Equipment fault and ignition of combustible materials used in the storage system BESS container arc flash; Installation error – reverse polarity connection; Dust ingress.	Personnel injury due to burns or smoke/chemical inhalation. Damage/ destruction of battery cell. Overheating/ electrical fault potentially leading to thermal runaway. Potential impact on control room and O&M building and potential injury due to burns or smoke/chemical inhalation	Potential	C – Possible	4 – Major	High	HVAC systems Australian Standards compliant. Battery enclosures will be located outdoors Battery enclosure includes a thermal management system that provides active cooling and heating to the internal Battery enclosure components. Battery systems modular and compartmentalised to minimise damage. Battery enclosures minimum distancing applied. Adequate spacing of battery containers. Batteries and associated balance of plant certified and designed to Australian Standards. Electronic safety-related systems should be installed at both a hardware and software level, designed to applicable standards, to allow for safe isolation of electrical energy in the event of a failure. BESS design location with sufficient distance from other infrastructure. Emergency shutdown incorporated into BESS design. Containers/infrastructure for BESS located to be directly accessible to emergency responders. Thermal overtemperature detection and prevention in Battery enclosure design. Cell overpressure detection and protection in Battery enclosure design. Remote monitoring. Access controls for MV areas (arc flash risk). Storage and handling of BESS/Li-batteries according to AS 4681. Fire Safety Study to be conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure. Fire Risk Evaluation to be conducted to provide fire safety recommendation and required firefighting equipment.	HVAC systems correctly installed and maintained. Safety system maintenance, testing and inspections. Safety Management Plans. Trained operators/maintainers. Plant operating and maintenance procedures. Remote isolation for non-manned facility.	E – Rare	4 – Major	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
3.	Lithium-ion Battery	Battery cell thermal hazard	Chemical properties of the battery materials and thermal runaway. Propagation of adjacent battery fire (escalation event).	Personnel injury due to burns or smoke/chemical inhalation. Damage/ destruction of battery cell.	Potential	C – Possible	4 – Major	High	HVAC systems Australian Standards compliant. Battery containers chemistry is LFP (higher temperature to trigger thermal runaway) Battery enclosures will be located outdoors Battery enclosure includes a thermal management system that provides active cooling and heating to the internal Battery enclosure components Battery systems modular and compartmentalised to minimise damage. Adequate spacing of battery containers. Battery enclosures minimum distancing applied Batteries and associated balance of plant certified and designed to Australian Standards. Electronic safety-related systems should be installed at both a hardware and software level, designed to applicable standards, to allow for safe isolation of electrical energy in the event of a failure BESS design location sufficient distance from other infrastructure. Emergency shutdown incorporated into BESS design. Containers/infrastructure for BESS located to be directly accessible to emergency responders. Thermal overtemperature detection and prevention in Battery enclosure design. Cell overpressure detection and protection in Battery enclosure design. Remotely accessible flammable gas monitoring to detect presence of flammable gases. Access controls for MV areas (arc flash risk). Fire Safety Study to be conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure. Fire Risk Evaluation to be conducted to provide fire safety recommendation and required firefighting equipment	HVAC systems correctly installed and maintained. Safety system maintenance, testing and inspections. Safety Management Plans. Trained operators/maintainers. Plant operating and maintenance procedures. Remote isolation for non-manned facility. Lessons learnt from previous battery fire incidents.	E – Rare	4 – Major	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
4.	Lithium-ion battery	Battery cell equipment failure	Loss of cooling fluid/ Coolant leak from equipment attributable to design fault/error. Improper installation/ commissioning. Lack of maintenance or collision or impact on the BESS.	Battery overheat and thermal runaway (refer to thermal hazard).	Potential	C – Possible	4 – Major	High	Installation of coolant leak alarms. Ensure all telemetry, fault monitoring and electrical safety protection devices remain active regardless of keylock switch position or system state. Active monitoring and control of the pyro disconnect's power supply circuit. Required clearance between Battery enclosures for maintenance access as per BESS provider recommendations.	Development and implementation of commissioning procedures in accordance with manufacturer's procedures. Safety system maintenance, testing and inspections. Development and implementation of safety management plans. Trained operators/maintainers. Plant operating and maintenance procedures. Implementation of operating plant manuals (OPM).	E – Rare	4 – Major	Medium	Unlikely
5.	Lithium-ion battery	Battery cell operational hazard	Control breakdown from equipment fault; design fault/error; Discharging/ charging of a unit beyond the state of charge threshold Improper installation/ commissioning Lack of maintenance or collision or impact on the BESS.	Battery overheat and thermal runaway (refer to thermal hazard).	Potential	C – Possible	4 – Major	High	Ensure all telemetry, fault monitoring and electrical safety protection devices remain active regardless of keylock switch position or system state. Active monitoring and control of the pyro disconnect's power supply circuit. Required clearance between Battery enclosures for maintenance access as per BESS provider recommendations.	Development and implementation of commissioning procedures in accordance with manufacturer's procedures. Safety system maintenance, testing and inspections. Development and implementation of safety management plans. Trained operators/maintainers. Plant operating and maintenance procedures. Implementation of OPM.	E – Rare	4 – Major	Medium	Unlikely
6.	Lithium-ion Battery	Battery cell chemical hazard	Fault or failure and release of corrosive and/or toxic materials	Personnel injury from burns or gas inhalation. Environmental damage.	Potential (biophysical damage)	D – Unlikely	4 – Major	Medium	Equipment designed to be compliant with applicable Australian/International Standards. Preferably modular design. Spill containment design.	Material SDS to be consulted. Emergency Response Plan to be developed to define actions in unlikely event of potential hazards. Trained operators/maintainers. Plant operating and maintenance procedures.	E – Rare	4 – Major	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
7.	Lithium-ion Battery	Explosion hazard	HVAC failure (loss of cooling system) and/or overcharging of battery causing rapid expansion and confinement of gases	Personnel injuries or fatalities. Damage/ destruction of battery cell.	Potential	D – Unlikely	5 – Catastrophic	High	Batteries and associated balance of plant certified to relevant international standards (e.g. UL1976, UL9540). BESS installed outdoors with sufficient distance from infrastructure and people. HVAC system to prevent the confinement of gases Electronic safety-related systems should be installed at both a hardware and software level, designed to applicable standards, to allow for safe isolation of electrical energy in the event of a failure Emergency shutdown incorporated into BESS design. Containers/infrastructure for BESS located to be directly accessible to emergency responders. Thermal overtemperature detection and prevention in Battery enclosure design. Cell overpressure detection and protection in Battery enclosure design. Remote monitoring.	HVAC systems correctly installed and maintained. Safety system maintenance, testing and inspections. Safety Management Plans. Trained operators/maintainers. Plant operating and maintenance procedures.	E – Rare	5 – Catastrophic	Medium	Unlikely
8.	Lithium-ion battery	Release and dispersion of flammable and toxic gases	Fire arising from combustible materials used in the storage system. Incomplete combustion of gases generated during initial battery cell thermal runaway phase.	Personnel injury due to burns or smoke/chemical inhalation. Vapour cloud explosion. Environmental contamination (Hydrogen Fluoride contacts with water)	Potential	C – Possible	5 – Catastrophic	Critical	HVAC systems AS compliant. BESS installed outdoors. Battery cooling systems. Battery components isolated. Battery systems modular and compartmentalised to minimise damage. Adequate spacing of battery containers and heat shields. Remote emergency shutdown and monitoring of the BESS. Fire detection and protection/suppression included in the design of the BESS. BESS designed in accordance with UL 9540. Batteries and associated balance of plant certified and designed to Australian Standards. Electronic safety-related systems should be installed at both a hardware and software level, designed to applicable standards, to allow for safe isolation of electrical energy in the event of a failure BESS design location sufficient distance from other infrastructure. 24-hour monitoring and installation of alarms. Access controls for HV areas (arc flash risk). Storage and handling of BESS/Li-batteries according to AS 4681. Fire Risk Evaluation to be conducted to provide fire safety recommendation and required firefighting equipment.	HVAC systems correctly installed and maintained. Safety system maintenance, testing and inspections. Development and implementation of safety management plans. Trained operators/maintainers. Plant operating and maintenance procedures. Implementation of OPM. Develop and implement strategy for life of plant. Pest control/management.	E – Rare	5 – Catastrophic	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
9.	Lithium-ion battery	Exposure to electromagnetic fields	Differences in electric or magnetic fields around the BESS (transformer, powerlines).	Danger to personnel.	No (in terms of hazard affecting public)	-	-	-	-	-	-	-	-	-
10.	Lithium-ion Battery	Dropping of battery cell(s) during installation	Faulty equipment or procedure during battery installation	Personnel injury. Damage to battery cell.	No (anticipated impact on single unit cell)	-	-	-	-	-	-	-	-	-
11.	Lithium-ion Battery	Malicious damage to BESS	Unauthorised access, few staff onsite. Compromised cybersecurity system.	Damage to battery cell and/or other infrastructure. Electrolyte emission. Electrocution resulting in injury or fatality. Mal-operation from external digital access of control systems.	Potential	D – Unlikely	5 – Catastrophic	High	BESS and auxiliary equipment to be surrounded by fencing as per AS 1725, locked gates and other security measures as necessary (e.g. CCTVs, continuous remote monitoring). Consultation with cybersecurity experts should also be conducted to implement appropriate security measures for the computer control systems.	Regular and appropriate operations and maintenance covering inspections of the facilities.	E – Rare	5 – Catastrophic	Medium	Unlikely (except for unauthorised person from public)
12.	Core transformer	Transformer arcing/fire/explosion	Insufficient insulating oil maintenance, equipment fault	Electrocution resulting in injury or fatality. Damage to transformer. Ignition source for BESS fire.	Potential	D – Unlikely	5 – Catastrophic	High	Transformers have been designed to AS2067:2016. Sufficient separation between transformers and the BESS, other transformers, and structures. Core transformers are self-bunded. Using dry type transformer is recommended Fire modelling to be conducted as part of the Fire Safety Study to ensure fire radiation effects do not impact on adjacent infrastructure.	Maintain transformer as per OEM recommended regime, including regular insulation and function testing.	E – Rare	5 – Catastrophic	Medium	Unlikely
13.	Core transformer	Loss of containment (oil)	Maintenance operations (failure of pipe). Equipment fault. Design fault/error.	Pool fire (if ignited). Personnel injury due to burns or smoke/chemical inhalation.	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
14.	Core transformer	Live contact with transformer	Insufficient enclosure or barricading	Electrocution causing injury or fatality.	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
15.	Adjacent substation	Electrical and/or fire hazards at substation	Fire at substation	Damage to infrastructure Personnel injury /fatality Impact to MV BESS	Potential	D – Unlikely	5 - Catastrophic	High	Substation is designed to standards e.g. AS 2067:2016. Provisions to use cooling water on the battery enclosures when there is fire in surrounding areas Adequate separation from MV BESS to the substation site	Development and implementation of safety management plans.	E – Rare	5 - Catastrophic	Medium	Unlikely
16.	Adjacent MV BESS site	Battery fire	Fire at HV BESS	Damage to infrastructure Personnel injury/fatality Impact to HV BESS	Potential	D – Unlikely	5 - Catastrophic	High	MV BESS site is designed to standards Provisions to use cooling water on the battery enclosures when there is fire in surrounding areas Adequate separation between HV BESS and MV BESS site	Development and implementation of safety management plans.	E – Rare	5 - Catastrophic	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
17.	Switchgear	Loss of containment (sulphur hexafluoride [SF_6]).	Maintenance operations (failure of pipe). Equipment fault. Design fault/error.	Release of toxic gas. Personnel injury.	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
18.	Switchgear	Outdoor switchgear failure	Arc-flashing induced fire	Damage to infrastructure Electrocution Personnel injury/fatality Impact to MV BESS	Potential	D – Unlikely	5 - Catastrophic	High	Adequate separation between switchgear and BESS. The design should comply with the Electricity Supply Act 1995 and AS 62271 High-voltage switchgear and controlgear. AS 5139: 2019 Electrical installations - Safety of battery systems for use with power conversion equipment should be consulted for design. Fire modelling to be conducted as part of the Fire Safety Study to ensure fire radiation effects do not impact on adjacent infrastructure.	Regular maintenance and testing of switchgear functionality	E – Rare	5 – Catastrophic	Medium	Unlikely
19.	Switchgear	Outdoor switchgear failure	Switchgear insulator failure	Damage to infrastructure Electrocution Personnel injury/fatality	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
20.	Switchgear	Outdoor switchgear failure	Operation failure causing continued arcing	Damage to infrastructure Electrocution Personnel injury/fatality	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
21.	Switchgear	Outdoor switchgear failure	Surge arrestor failure	Damage to infrastructure Electrocution Personnel injury/fatality	No (in terms of offsite risk)	-	-	-	-	-	-	-	-	-
22.	Natural Hazard	Grass or scrub fire Stray ember induced fire	Bushfire Hot work Lightning strike Vandalism	Damage to BESS. Significant environmental damage.	Potential	D – Unlikely	4 – Major	Medium	10 m wide defendable space surrounding the BESS development footprint. Minimum 20kL water tank or other reticulated water source designed in accordance with the requirements of AS 2419.1 and in consultation with NSW Rural Fire Service for fire-fighting purposes. Remote monitoring. BESS and auxiliary equipment to be surrounded by fencing as per AS 1725, locked gates and other security Lightning protection design for BESS and electrical equipment, transformers etc Fire Safety Study to be conducted as part of design to ensure fire radiation effects do not impact on adjacent infrastructure. Fire Risk Evaluation to be conducted to provide fire safety recommendation and required firefighting equipment.	Development and implementation of safety management plans (e.g. permit to work).	E – Rare	4 – Major	Medium	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
23.	Natural Hazard	Extreme temperature/humidity	Extreme temperatures attributable to climate change Fire propagation due to high winds	Personnel injury due to burns or smoke/chemical inhalation. Damage/ destruction of battery cell.	Potential	D – Unlikely	4 – Major	Medium	Batteries designed to operate beyond maximum temperature range with allowance for higher maximum temperatures of approximately 1.5 to 2ºC to account for the likely effects of global warming. BESS units are generally designed for environmental conditions of ambient temperatures up to 50°C., and 100% outdoor relative humidity (non-condensing). Wind speed to be considered in BESS design and safe separation	-	E – Rare	4 – Major	Medium	Unlikely
24.	Natural Hazard	Seismic events	Failure to design the BESS to the correct earthquake loading code to account for seismic activity	Damage to battery casings, cells and other infrastructure.	Potential	D – Unlikely	4 – Major	Medium	Monitoring of seismic information to be informed of any increase in risk Setback distances from falling objects (trees and powerlines)	Emergency response plan	E – Rare	4 – Major	Medium	Unlikely
25.	Natural Hazard	Flooding	Drainage system failure Fire-fighting activity Failure to account for flooding during foundation construction Location of the site within a flood plain area.	Damage to battery casings, cells and other infrastructure. Environmental damage	Potential	D – Unlikely	4 – Major	Medium	Surface Water and Groundwater Assessment to determine special flood considerations Provision for water retention facility Consideration of matters under Clause 5.21 Flood planning of the Penrith LEP.	Schedule construction during dry season, account for light and heavy vehicles in heavy rain/flooding events.	E – Rare	4 – Major	Medium	Unlikely
26.	Natural Hazard	Extreme wind	Failure to design the BESS to account for extreme wind or hail events	Damage to battery casings, cells and other infrastructure.	Potential	D – Unlikely	4 – Major	Medium	The BESS should be designed in accordance with AS/NZS 1170.2.2021.	-	E – Rare	4 – Major	Medium	Unlikely
27.	Natural hazard	Ambient weather (lightning)	Failure to design the BESS to the correct isokeraunic level to account for lightning strikes.	Personnel injuries due to burns or smoke/chemical inhalation and/or fatalities. Damage/ destruction of battery cell.	Potential	D – Unlikely	4 – Major	Medium	Conduct a lightning protection study. Ensure no BESS equipment is located underneath powerlines. Implement an earthing system. Design the BESS facility in accordance with AS 1768:2021.	-	E – Rare	4 – Major	Medium	Unlikely
28.	Natural Hazard	Subsidence	Underground mining	Ground instability resulting in damage to BESS units and infrastructure.	Potential	D – Unlikely	4 – Major	Medium	Geotechnical studies. Other design mitigations (e.g. grouting) will be determined during detailed design if infrastructure cannot be located away from such areas	-	E – Rare	4 – Major	Medium	Unlikely
29.	Other	Loss of containment (contaminated water)	Spent fire water runoff. Runoff from site. Failure of process waste piping.	Harm to the environment (flora and fauna).	Potential	C – Possible	3 – Moderate	Medium	Installation of oily water interceptors. Design and Installation of containment infrastructure/impervious retention facilities, ponds and such with adequate capacity. Bunded transformers. Use of mineral oils. Use of synthetic insulating oils (Non-Dangerous Goods, less environmentally hazardous).	Stormwater Management Plan. Operations and maintenance of retention facilities/ponds. Continuous monitoring and alarms. Emergency response plan/procedure	E – Rare	3 – Moderate	Low	Unlikely

No.	Source	Hazard	Cause	Consequence	Does the hazard pose a potential offsite Significant Risk?	Current Risk			Proposed Controls – Technical/Design	Proposed Controls – Safety Management	Residual Risk			Does the hazard pose a potential offsite Significant Risk?
						Likelihood	Consequence	Risk Rating			Likelihood	Consequence	Risk Rating	
30.	Other	Exposure to contaminated land	Construction activities exposing contaminated material from legacy works	Harm to personnel and the environment.	Potential	D – Unlikely	3 – Moderate	Medium	-	Identification and testing of any contaminated land. Development and implementation of procedure for removal of contaminated land and remediation. Removal of contaminated land before construction. Tracking of contaminated land removal.	E – Rare	3 – Moderate	Low	Unlikely
31.	Other	Vehicle collision/congestion	Construction activities (increased heavy vehicles). Driver fatigue.	Personnel injury/fatality.	Potential	D – Unlikely	5 – Catastrophic	High	-	Traffic Management Plan, including fatigue management.	E – Rare	5 – Catastrophic	Medium	Unlikely
32.	Other	Loss of containment (waste/fuel)	Commissioning activities.	Harm to personnel and the environment.	Potential	D – Unlikely	3 – Moderate	Medium	BESS and auxiliary equipment to be surrounded by fencing as per AS 1725, locked gates and other security Fuel storage and handling as per AS 1940	Waste Management Plan Construction Waste Management Plan Emergency response plan	E – Rare	3 – Moderate	Low	Unlikely
33.	Other	Loss of containment (refrigerant)	Vandalism of battery units.	Harm to personnel and the environment.	Potential	D – Unlikely	3 – Moderate	Medium	BESS and auxiliary equipment to be surrounded by fencing as per AS 1725, locked gates and other security Enclosures doors locked	Waste Management Plan Construction Waste Management Plan	E – Rare	3 – Moderate	Low	Unlikely
34.	Other	Exposure to high voltages	Construction, installation, and commissioning activities in the vicinity of existing substation and switchyard	Electrocution causing injury or fatality.	Unlikely	-	-	-	-	-	-	-	-	-

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