Appendix K

Preliminary Hazard Analysis

PRELIMINARY HAZARD ANALYSIS FOR THE GREAT WESTERN BATTERY, NSW

Prepared for: AECOM Australia Pty Ltd

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Preliminary Hazard Analysis for the Great Western Battery, NSW

Disclaimer

AECOM Australia Pty Ltd (AECOM) has been engaged by Neoen Australia Pty Ltd (Neoen). AECOM commissioned Planager to prepare a PHA for the Project. The material in it reflects Planager's best judgement in the light of the information available to it at the time of preparation. However, as Planager cannot control the conditions under which this report may be used, Planager and its related corporations will not be responsible for damages of any nature resulting from use of or reliance upon this report. Planager's responsibility for advice given is subject to the terms of engagement with AECOM.

The analysis of fire safety within Battery Energy Storage Systems, including the consequences of generation of heat, overpressure or toxic combustion gases during a fire event, is limited to the available data and current hazards analyses on similar / applicable facilities. Much of the available information is still recent and subject to ongoing research, with only few industrial sized Battery Energy Storage Systems having been developed in Australia at the time of this report and with the applicable Australian and International Codes of Practice only a few years into their implementation. As such, the analysis in this report represents the current understanding of the subject matter but is subject to the limitations of available data at the time of this report.

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GLOSSARY AND ABBREVIATIONS

ADGC	Australian Dangerous Goods Code
ALARP	As Low As Reasonably Practicable
APZ	Asset Protection Zone
AS	Australian Standard
BATSO	BESS Safety Organization
BESS	Battery Energy Storage System
BMS	Battery Management System
battery	Li-ion battery with associated infrastructure, located within an enclosure
DG	Dangerous Goods
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (NSW)
ESD	Emergency Shut Down
ESS	Energy Storage System
Ha	Hectare
HIPAP	Hazardous Industry Planning Advisor Paper
HSE	Health, Safety and Environment
HV	High Voltage
IEC	International Electricity Commission
kL	kilolitre
km	kilometre
kV	kilovolts
LFP	lithium iron phosphate
Li-ion	Lithium-ion (battery)
MLRA	Multilevel Risk Assessment (guidelines by the DPIE)
MV	Medium Voltage
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSW	New South Wales
NSW RFS	NSW Rural Fire Service
NSWFR	NSW Fire and Rescue

PG	Packaging Group
PHA	Preliminary Hazard Analysis
PPE	Personal Protective Equipment
Project Area	The combined area of the Site used for the BESS (including the Substation) and the transmission line easement and the connection to the substation
PTW	Permit To Work
RFS	Rural Fire Service
SCADA	Supervisory Control And Data Acquisition
SDS	Safety Data Sheets
SEPP	State Environmental Planning Policy
Site	Location of the BESS and the Substation within the security fencing
SWMS	Safe Work Method Statement
UL	Underwriters Laboratories
UN	United Nations
V	Volt
WHS	Work Health & Safety

EXECUTIVE SUMMARY

E1. Introduction

Neoen Australia Pty Ltd (***Neoen***) is seeking development consent to construct, operate and maintain a battery energy storage system (***BESS***) of approximately 500 megawatts (MW) and up to 1,000 megawatt-hour at 173 Brays Lane, Wallerawang, NSW, as well as a new transmission line that would connect the BESS to the existing Transgrid 330 kilovolt (kV) substation at Wallerawang (***the Project***).

The proposed location of the BESS (***the Site***) is at Lot 4 Deposited Plan (DP) 751651. The Site is located approximately 1.25 km north west of the TransGrid Wallerawang 330 kV substation. This substation is located at Main Street, Wallerawang 2845 (Lot 91 of DP 1043967). The Site, transmission line easement and connection to the substation is referred to as ***the Project Area***.

The Secretary's Environmental Assessment Requirements (***SEARs***) for the Project issued by the NSW Department of Planning, Industry and Environment (***DPIE***) on 4 February 2021 requires that a Preliminary Hazard Analysis (***PHA***) be developed for the Project as part of the Environmental Impact Statement (***EIS***), as follows:

Hazards - including:

- *a Preliminary Hazard Analysis prepared in accordance with Hazardous Industry Planning Advisory Paper No. 6 – Guideline for Hazard Analysis (DoP, 2011)* ***[HIPAP6]*** *and Multi-Level Risk Assessment (DoP, 2011)* ***[MLRA guidelines]***

AECOM, on behalf of Neoen, has appointed Planager Pty Ltd (***Planager***) to prepare this Preliminary Hazard Analysis.

E2. Methodology and scope

The hazard and risk assessment process encompasses qualitative methods to assess the adequacy of the controls and to demonstrate that the Battery Energy Storage System and associated infrastructure (including the primarily undergrounded transmission line) can be developed with the associated hazards kept As Low As Reasonably Practicable (***ALARP***) and that appropriate land use safety planning can be achieved.

The assessment focusses on potential high consequence – low likelihood incidents in construction, commissioning and operation of the Project that may affect the health and safety to people and the environment outside of the boundaries of the Project Area, in accordance with the requirements in HIPAP6 and the MLRA guidelines.

The following risks are included in this assessment:

- Risk from reactions and fires associated with electrical infrastructure and flammable material, including spontaneous ignition from a battery runaway reaction
- Environmental risk from spills causing land contamination
- Health and safety risk to the community and to staff and contractors from major, high consequence process safety incidents.

E3. Findings

Using a risk matrix which has been calibrated to the Department of Planning, Industry and Environment risk criteria (in their HIPAP4 document), the hazard and risk assessment found that the risk profile for the Project is consistently between *Moderate* and *Low* risk, with no *High* or *Very High* risks identified.

The assessment also found that the facilities associated with the Project can be managed in accordance with the established risk criteria and in accordance with ALARP principles, including the risk to the nearby resident. Most hazards can be prevented by employing a combination of standard measures, including following all applicable Australian/New Zealand Standards and Codes and with reference to international Standards, including separation distances and setbacks, physical protection and control systems measures. Mitigation measures are also available within the industry to reduce the severity of the hazards should they occur.

Table E1 provides an overview of the risks assessment results and ALARP conditions.

Project element and hazard	Finding	Risk and ALARP evaluation
Risk of major injury or environmental damage during construction	Construction risks are well known and understood. Existing Codes and Standards are established within the industry to manage construction risk. The risk arises from typical construction activities and the impact of the Project on the risk is minimal.	MODERATE RISK: Can be managed to ALARP principles provided general construction Codes and Standards are adhered to.
Fire and pollution at Project infrastructure as initiated by an internal or external event during commissioning or operation	Codes and Standards provide clear guidance as to how to prevent and protect against a fault in a battery escalating into a fire at a battery enclosure. Key controls include continuous monitoring the state of the battery and protecting it from operating outside its safe operating area (via a so called Battery Management System), inclusive of automatic shut-down system(s); battery fire proven not to propagate, in accordance with international methodologies (e.g. following the requirements in The Underwriters Limited 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*); and establishment of minimum separation distances within the BESS and other Project infrastructure and between Project infrastructure and external boundaries. As a precautionary approach, a fire water tank would be installed at the boundary, for firefighting in the surrounding grassland. The need for external firefighting is unlikely, but will need to be reviewed in the detailed design phase, in consultation with the NSW Rural Fire Service, Fire and Rescue NSW, and DPIE. On-site hazardous effects are possible in case of a battery fire, and the risk associated with generation of toxic gas and toxic combustion products should be minimised in design; safe evacuation from the facility should be established; and the toxicity of such vapours should be considered in emergency response (e.g. by using Self Contained Breathing Apparatus if nearby and through evacuation of the local resident). Environmental pollution may be possible, subject to detailed design, from a failure to pollutants, and the need for secondary containment of a spill should be considered in detailed design.	MODERATE RISK: Can be managed to ALARP principles provided the battery and the enclosure is designed such that a credible fire will not propagate; the requirements in Codes and Standards are adhered to; and the minimum separation distances within the BESS and other Project infrastructure and an appropriate Asset Protection Zone are established and maintained

Project element and hazard	Finding	Risk and ALARP evaluation
Fire and pollution at the electrical infrastructure during commissioning or operation of Project infrastructure	Provided the requirements under the Australian Standards (e.g. AS 2067 & AS 1940) and Neoen's management practices for Low, Medium and High Voltage systems are adhered to, the risk associated with fire and with environmental pollution at the electrical infrastructure associated the BESS, the substation and the transmission line and landing gantries can be managed.	MODERATE RISK: Conforms to ALARP provided the requirements in Codes and Standards & Neoen's management practices are adhered to

Table E1: Overview of risks assessment results and ALARP conditions (concept design stage)

E4. Conclusion and recommendations

The analysis conducted as part of this PHA has found that the Project is not considered *potentially hazardous'* in accordance with the Department of Planning, Industry and Environment's definition, based on the storage and transport of hazardous material. The main hazard is associated with the potential for a battery fire and the possibly with potential for environmental pollution from a spill of oil or other pollutant from the Project (subject to detailed design), with other risks associated with electricity and standard construction related hazards.

The analysis found that the facilities associated with the Project can be managed in accordance with the established risk criteria and in accordance with ALARP principles. Most hazards can be prevented by employing a combination of common control measures, including following all applicable AS/NZ Standards, separation distances and setbacks, physical protection and control systems measures.

Mitigation measures are available, to reduce the severity of the hazards should they occur, including specific secondary containment, e.g. as built into the transformers and as part of operational and maintenance personnel training. Provided the commitment for safety and environmental protection, and the recommendations listed below are adhered to, the risk profile for the Project is consistently within the *Low* or *Moderate* risk ranking and ALARP can be established:

1. The separation distance between infrastructure within the BESS is to be determined in accordance with the applicable Codes and Standards and with manufacturer's recommendations so that the preferred strategy of allowing a fire in one battery enclosure, inverter or transformer to burn without the risk of propagating to other infrastructure can be maintained without the need for external firefighting

2. The separation distances between infrastructure within the BESS are to be determined in accordance with Codes and Standards and with manufacturer's recommendations to allow safe escape from the BESS in case of a fire

3. All relevant requirements in the Australian Standard AS5139 (2019) are to be adhered to at the BESS. The BESS should also adhere to the requirements in international Standards applicable to major BESS, for example, to the US National Fire Protection Association Code NFPA855 (2020)

4. Procurement of a battery system that is certified to the requirements of an internationally recognised test method such as that by the Underwriters Limited UL9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, proving that a credible fire within a battery rack or enclosure will not propagate to other battery enclosures

5. Detailed firefighting response and need for fire water containment should be assessed and reported, e.g. in the format of a Fire Safety Study, post development approval, for review by the DPIE, NSW Fire Rescue and the Rural Fire Service

6. Measures to prevent a leak from occurring at the BESS and the transformers, and for containing a spill of pollutant should it occur, should be addressed in the detailed design phase for the Project

7. The specific risk associated with the location of the resident close to the BESS must be integrated into the fire safety of this Site, including evacuation plan in case of a major incident associated with the BESS. Neoen's internal rule, based on other installations, is to provide a typical exclusion zone of 25 m radius during a fire and evacuate a 250 m radius during fire to account for the toxic smoke – such clear advice should be integrated into the emergency response plan and communicated with the emergency services.

8. The register of commitment (Appendix 1 of the PHA) is integrated into the Project. This includes integration of 26 individual commitments, including for the design, installation and maintenance of the BESS; automatic shutdown system on exceedance of safe limits; installation of measures to cope with build-up of gases inside the enclosure; potentially fire protection inside the battery enclosures (subject to manufacturer's recommendations); design of the BESS and transformers such that the risk of pollution from a release is reduced to ALARP; installation of protective barriers if required by Codes and Standards; and application of a rigorous and formal management of change process for the Project and operational phases of the BESS, substation and the transmission line, including detailed hazard identification and risk assessment processes.

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Neoen Australia Pty Ltd (***Neoen***) is seeking development consent to construct, operate and maintain a battery energy storage system (***BESS***) of approximately 500 megawatts (***MW***) and approximately 1,000 megawatt-hour (***MWh***) at 173 Brays Lane, Wallerawang, NSW, as well as a new underground transmission line that would connect the BESS to the existing Transgrid 330 kilovolt (kV) substation at Wallerawang (***the Project***).

The proposed location of the BESS (***the Site***) is at Lot 4 Deposited Plan (DP) 751651. The Site is located approximately 1.25 km north west of the TransGrid Wallerawang 330 kV substation. This substation is located at Main Street, Wallerawang 2845 (Lot 91 of DP 1043967). The Site, transmission line easement and connection to the substation is referred to as ***the Project Area***. The location of the Project at a regional scale, and the regional context of the Project Area is shown in Figure 1.

The Secretary's Environmental Assessment Requirements (***SEARs***) for the Project issued by the NSW Department of Planning, Industry and Environment (***DPIE***) on 4 February 2021 required that a Preliminary Hazard Analysis (***PHA***) be developed for the Project as part of the Environmental Impact Statement (***EIS***), as follows:

> *Hazards - including:*
>
> - *a Preliminary Hazard Analysis prepared in accordance with Hazardous Industry Planning Advisory Paper No. 6 – Guideline for Hazard Analysis (DoP, 2011) and Multi-Level Risk Assessment (DoP, 2011)*

AECOM, on behalf of Neoen, has appointed Planager Pty Ltd (***Planager***) to prepare this PHA. The hazard and risk assessment process encompasses qualitative methods to assess the adequacy of the controls and to determine if the Project can be developed with the associated hazards kept As Low As Reasonably Practicable (***ALARP***) (in accordance with the requirements by DPIE as stated within their guideline documents (Refs 2, 3 and 5) and ensuring appropriate land use safety planning.

Figure 1: Locality map and regional context

1.2 Scope and Purpose

The Project covers the construction, commissioning and operation (including maintenance) of the following major elements:

- A large-scale BESS with a capacity of approximately 500 MW and 1,000 MWh, including battery enclosures, inverters, and step-up medium voltage (***MV***) transformers, installed on the ***Site***
- A 330/33 kV substation, inclusive high voltage (***HV***) transformers and outdoor switchgear (up to 330 kV), installed on the ***Site***
- A new underground transmission line, connecting the Site to the existing TransGrid 330 kV substation at Wallerawang. A small portion of the new transmission line would be constructed above ground, within the existing Transgrid Wallerawang 330kV substation switchyard.

Additionally, the Project scope includes access road(s); carpark, lighting, security fencing and CCTV; Asset Protection Zone (APZ) and noise wall; offices and control room (referred to in the EIS as *permanent operations and management - O&M - buildings*); stormwater controls; two (2) 45 kL metal water tanks; noise walls; landscaping and screening vegetation; and back-up diesel generator, transformer and inverter module. Refer to Chapter 4.0 of the Environmental Impact Statement for further details.

The PHA has been prepared to accompany the Environmental Impact Statement (***EIS***, Ref 1) for the Project. The overall purpose of this PHA is to address the hazards and risks associated with the Project, notably as associated with the following:

- Risk from reactions and fires associated with electrical infrastructure and flammable material, including spontaneous ignition from a runaway reaction at the BESS
- Environmental risk from spills causing land contamination
- Health and safety risk to the community, staff and to contractors from major, high consequence process safety incidents.

The hazard analysis process encompasses qualitative methods to assess the adequacy of the controls. The aim is to demonstrate that the Project can be developed with the associated risks kept As Low As Reasonably Practicable (***ALARP***) and to ensure appropriate land use safety planning can be achieved.

The PHA is prepared in accordance with DPIE methodology in their HIPAP6 *Hazard analysis* (Ref 2) and *Multi-level risk assessment* (***MLRA***, Ref 3) with further discussion in Section 1.4.

As per DPIE requirements, the assessment focusses on potential high consequence / low likelihood incidents during construction, commissioning, operation and decommissioning of the Project that may affect the health and safety of people and the environment outside of the boundaries of the Project Area.

This PHA should be read in conjunction with the bushfire risk assessment prepared for the Project produced by Blackash (Ref 4) (refer to Appendix L of the EIS).

1.3 Exclusions and Limitations

The study exclusions are summarised as follows:

- The Bushfire Risk Assessment was conducted as a separate study (Ref 4) and the outcomes were used to inform this PHA
- The PHA includes an overview of high consequence incidents that may affect the Project infrastructure during construction phase. The PHA does not include a detailed identification and assessment of construction and commissioning risks. If needed, this would be better suited to a Construction Safety Study conducted at the final design stage of the Project
- The PHA was based on concept design and the results depend on the implementation of the commitments made during the study (as listed in Appendix 1) and the recommendations made in the PHA.

1.4 Method and Report Structure

An overview of the methodology employed in the hazard and risk assessments, together with the applicable Sections in the report, is depicted in Figure 2.

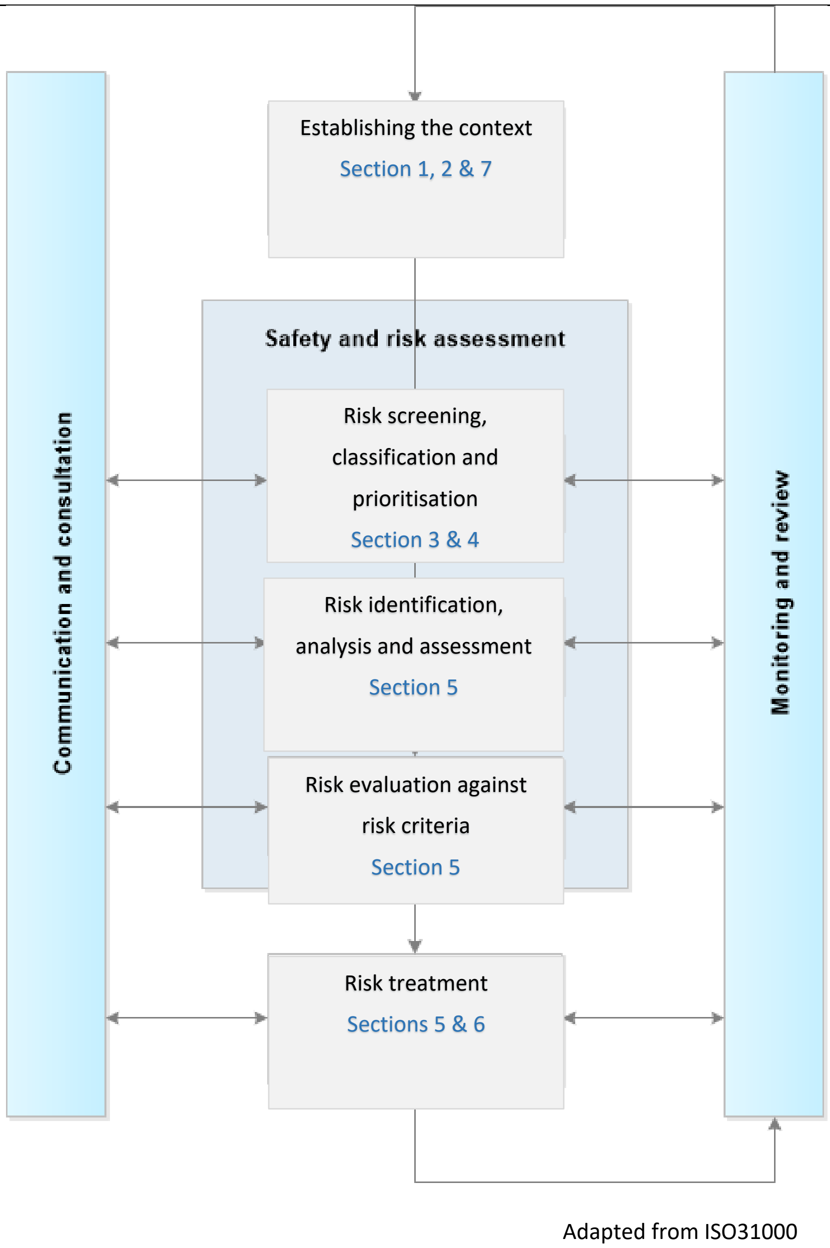

Figure 2: Risk management framework

The process utilised for this assessment follows standard processes established internationally and in Australia for hazard and risk assessments, and outlined in DPIE's guidelines for hazard analysis (Ref 2) and the MLRA (Ref 3), including the tasks outlined in the following Sections of the PHA:

- Sections 1 and 2 establish the context for the PHA, including the background, scope, aim and methodology of the PHA and a description of the Project.,
- Sections 3 and 4 include the risk screening, classification and prioritisation of potential hazards and risk factors associated with the Project. The aim is to determine the focus and format of the subsequent Sections of the PHA. Details of the methodologies for the risk

screening process is provided in Section 3.1 and, for the risk classification and prioritisation, in Section 4.1

- Section 5 provides the detailed hazard identification and risk analysis and assessment of the Project in the context of this PHA. It defines the hazardous incidents potentially associated with the Project, analyses the consequences should an incident occur, evaluates the proposed risk treatment and evaluates the risk against the established risk criteria. The aim is to demonstrate that the risks can be kept ALARP and in accordance with appropriate land use safety planning. Details of the criteria used in the risk assessment are provided in Section 1.5, and of the methodologies for the hazard identification and risk assessment, provided in Section 5.1.

- Section 6 summarises the findings from the analysis in Section 5 and provides the recommendations regarding what items need to be defined in the detailed design phase for the Project to allow an understanding of the Project and assurance that it will not create any conflicts from a land use safety point of view.

- Section 7 lists the references used throughout this PHA.

1.5 RISK CRITERIA

Risk evaluation considers whether the level of risk meets generally acceptable risk criteria and has been reduced ALARP. The risk evaluation has three possible outcomes:

- *Well below the acceptable criteria*: further risk reduction may be impracticable

- *Sufficiently close to or above the acceptable criteria*: further risk reduction controls to be investigated in detail using ALARP principles

- *Well above the acceptable criteria*: further controls need to be found or continued operation questioned.

Qualitative guidelines are given to ensure that risk is eliminated or prevented and where that is not possible, controlled. The risk criteria used for this PHA are provided in Appendix 2 in the form of a risk matrix. The criteria have been calibrated against the DPIE risk criteria in their HIPAP 4 *Risk criteria for land use planning* (Ref 5). Where a hazard has the potential for off-site effects, the consequence levels in the risk matrix apply to both on-site workers and people off-site who are within the range of the effect.

In addition to meeting the qualitative criteria, risk minimisation and use of best practice must be demonstrated. These terms imply (adapted from HIPAP 4, Ref 5):

- *Risk minimisation*: risks should be reduced to ALARP, regardless of calculated risk levels and criteria.
- *Best practice:* industry best practicable should be used in the engineering design, and industry best practice management systems should be used for the operation of new 'plant'.

In the context of the present Project, this applies to the BESS and the electrical connections to the substation and the transmission line, all within the Project Area.

1.6 Safety Management Systems

Risk assessments can only be a valid tool for assisting in the overall assessment of a development if the facility being examined is or will be subject to appropriate management control of hazards. Without such control, the assumptions inherent in the assessment techniques become invalid in two general areas. First, the identification of hazards is based on experience in similar installations and engineering judgement. Without proper management control of safety issues, the range and impact of potential hazards become unpredictable. Second, the likelihood at which incidents of any type may occur cannot be adequately estimated using historical data.

Safety management systems allow the risk from potentially hazardous installations to be managed through a combination of hardware and software factors. It is essential to ensure that the reliability of the hardware systems and management procedures allows for safe operation of the facility.

Neoen have a commitment to workplace health and safety and have numerous policies and procedures to achieve a safe workplace. Those pertaining to the Project include, but are not limited to:

- The operation of the proposed BESS would be continually monitored and controlled from a central control room via a Supervisory Control and Data Acquisition (***SCADA***) system. Similarly for the new the new substation and the new transmission line, whether the control is by Neoen or other (e.g. Transgrid)
- An incident reporting and response system would be established as part of the operation of the Great Western Battery, providing 24-hour coverage

- The elements included in the BESS, substation and transmission line would comply with all relevant Australian Codes and statutory requirements with respect to design and work conditions. Relevant international standards, e.g. (US) National Fire Protection Association Standard (***NFPA***) number 855 *Standard for the Installation of Stationary Energy Storage Systems* and Underwriters Limited (***UL***) 9540 *Energy Storage Systems and Equipment*, would be applied where relevant. Further details are provided in Section 2.8.

- All personnel required to work with Dangerous Goods (***DG***) and other hazardous material and with electricity would be trained in their safe use and handling, and provided with all the relevant safety equipment and documentation, e.g. Safety Data Sheets (***SDS***) and Personal Protective Equipment (***PPE***)

- Emergency procedures, including pollution incident response, would be developed, and personnel would be trained in emergency response

- A person (e.g. with the title *Asset Manager* would be appointed, with overall responsibility of the BESS, and who would be supported by suitably qualified personnel trained in the operation, maintenance and support of the facility. Similarly for the substation and the transmission line, whether by Neoen or another

- A Permit to Work (***PTW***) system, including energy isolation and Hot Work Permit for any work that could provide an ignition source (also during construction), and a system to control modifications, would be in use during construction and operation of the facilities forming part of the development, to control work and to protect plant and structures from substandard and potentially hazardous work and modifications. Safe Operating Procedures will be established and people will work under Job Safety Analysis (JSA) and Safe work Method Statements (SWMS) systems where required. Further details are provided in the bush fire risk assessment (Ref 4)

- Protective systems would be routinely inspected and tested to ensure they are, and remain, in a good state of repair and function reliably when required to do so. This would include scheduled testing of shutdown systems, trips and alarms, and relief devices. Any protective system which is temporarily taken out of service, defeated or bypassed would be managed under a modification control system and may include shutting down the facility until the system is restored

- All personnel working within the Project Area would be provided with the appropriate PPE suitable for use with the specific type of activity, i.e. handling of hazardous substances or electricity, including arc flash

- A first aid station would be installed at the BESS and/or the substation, comprising appropriate first aid kit(s) and first aid instructions, including SDSs, for all hazardous substances kept or handled within the BESS.

2 DESCRIPTION OF THE PROJECT

2.1 LOCATION

The Project is located in the Central Tablelands of NSW, in the suburb of Wallerawang, about 110 km west of Sydney. Wallerawang is located in the Lithgow City Local Government Area (LGA). The Project Area location and its regional context is shown in Figure 1 in in Section 1.1. Land use zones surrounding the Project Area are shown in Figure 3

The BESS would be constructed at a Site at 173 Brays Lane, Wallerawang NSW, 2854 (Lot 4 Deposited Plan (***DP***) 751651), which is located approximately 1.25 km north west of the TransGrid Wallerawang 330 kV substation. Lot 4 is around 16.5 ha in area and the part of it that is included in the Site is about 13 hectares (***ha***) in size. The BESS (inclusive of the battery enclosures, transformers and all associated infrastructure would only occupy a portion of the total area of the Site (around 7 ha).

This substation is located at Main Street, Wallerawang 2845 (Lot 91 of DP 1043967). The substation is located on freehold land owned by Electricity Transmission Ministerial Holding Corporation (***ETMHC***) and operated by Transgrid.

The alignment of the new transmission line would be located on land that is currently owned and / or managed privately, by Lithgow City Council, Transgrid, Transport for NSW and John Holland Rail (Lots 8 & 9 DP 252472; Lot 2 DP 108089; Lot 1 DP 108089; Lot 10 DP 1168824; Lot 1115 DP 1204803, Lot 91 DP 1043967).

The new transmission line would connect the BESS to the TransGrid Wallerawang 330kV substation, exiting the Site from the eastern boundary, crossing Brays Lane and entering into the vegetated area to the east of Brays Lane. From here, it would travel in a north easterly direction, before passing under Pipers Flat Creek and into the existing rail corridor where it would travel south east along the rail corridor (including its crossing of Main Street) to connect to the south western portion of the Transgrid Wallerawang substation. The new transmission line would also pass under the existing coal conveyor belt that transports coal between the nearby Springvale Colliery, Mt Piper Power Station Springdale Coal Services, and Lidsdale Siding (coal loader). The location of the conveyer belt relative to the Project is shown on **Figure 3**.

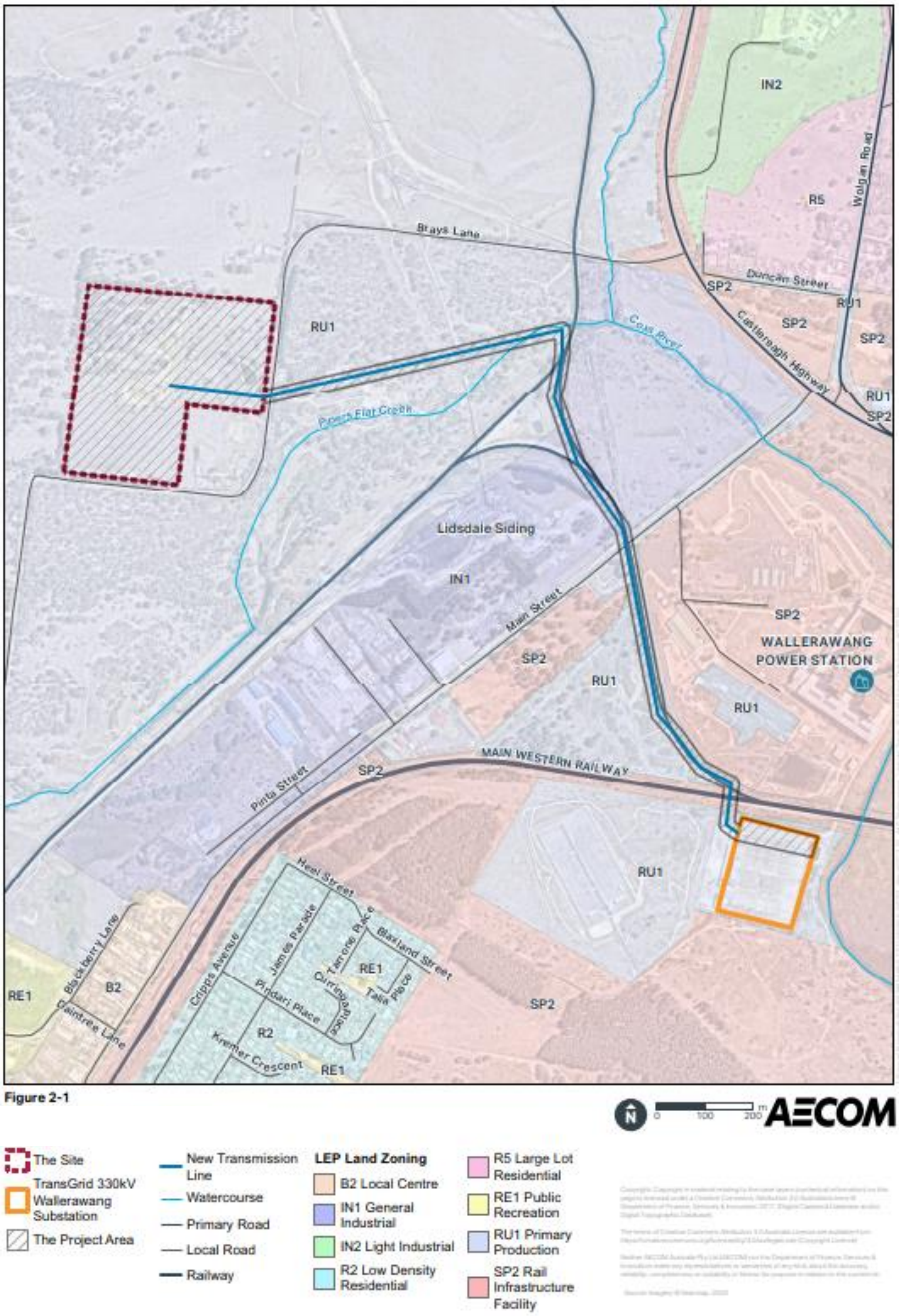

Figure 3: Land use zones

The BESS Site is located on land zoned *RU1 - Primary production*. The alignment of the new transmission line would be located within land use zones: *RU1 – Primary Production; IN1 – General*

Industrial; and *SP2 – Rail Infrastructure Facility.* The Transgrid Wallerawang 330 kV substation is located on land zoned *RU1 – Primary Production* (refer to Section 2.4 in the Environmental Impact Statement, Ref 1).

To delineate the existing residential land use from the proposed BESS it is proposed that Lot 4 DP 751651 would be subdivided as part of the Project. Following the completion of construction, it is proposed that Lot 4 DP 751651 would be subdivided to delineate the existing residential land use at the south east portion of the lot from the proposed BESS. The new Lot 5 would be occupied by the operational BESS (including associated operational equipment and built-elements), and the remaining land, comprising the revised Lot 4, would be returned to the existing rural residential landowner.

The closest sensitive receivers to the BESS include a number of residential receivers:

- 173 Brays Lane located immediately east of the BESS (comprising the residential dwelling in future subdivided land – revised Lot 4). The dwelling itself would be located approximately 90 m to the east of the Site boundary;
- 233 Brays Lane about 80 m to the north of the Site boundary an about 265 m from the nearest proposed part of the Project;
- 137 Brays Lane about 125 m from the south western corner of the Site; and
- 113 Brays Lane about 300 m south west of the BESS.

The Site is located about 1.4 km north of the centre of the township of Wallerawang (measured from the Wallerawang Post Office) and approximately 800 m from the nearest residential property within the township. The township of Wallerawang is comprised of low to medium density housing, with associated infrastructure including schools, sporting fields, places of worship, community centres and clubs, shops, etc. At the time of the 2016 census, Wallerawang had a population of about 1,980 people (ABS, 2016). Wallerawang is located on the Main Western railway line at the junction of the Gwabegar line. Wallerawang train station is located about 1.2 km south of the Site. No regularly scheduled passenger trains are known to operate at Wallerawang. Rail traffic along this line is prominently freight rail.

In addition to rural, residential and agricultural land uses, a number of industrial and extractive industry land uses are also present in the area surrounding the Site. These include: the decommissioned Wallerawang coal-fired power station located about 1.5 km south east of the Site and adjacent to the proposed transmission line easement. Lidsdale Siding coal loading facility is located to the south of the Site (about 400 m) and processes coal from Springvale Colliery, which is located about 3.5 km east of the Site. A series of large conveyer belts cross the landscape to transport coal between coal mines, the nearby Mt Piper Power Station and Lidsdale Siding. Wallerawang ash repository is located about 2 km east of the Site and accepts ash from the retired Wallerawang power station as it continues to be dismantled.

Ben Bullen State Forest is located to the east of the Site and Lidsdale State Forest is located to the south. Both are managed by the Forestry Corporation of NSW and are accessible to the public for hiking and four-wheel driving. However, their primary function is as a forestry resource. Marrangaroo National Park is located about 3.5 km to the south of the Site and is managed by the NSW National Parks and Wildlife Service.

2.2 EXISTING ENVIRONMENT

The Site is privately owned and is currently occupied by a residential property, agricultural buildings and marginal agricultural land. Beyond the residential property the majority of the Site is used for occasional horse grazing. The majority of vegetation on the Site consists of pasture grasses, with a small area of mature vegetation located in the north western corner of the Site.

The topography of the Project Area is typical of the local area, encompassing sections of both elevated rolling terrain and floodplain, as well as severely disturbed landform elements.

A topographical survey of the Site was undertaken on 17 June 2021. The Site has a mostly gently undulating topography. Two broad ridgelines traverse the Site, with the more prominent of the two occupying the north-western portion of the property. The highest parts of the Site associated with these ridgelines occur in the north western and south western corners and are between about 900 metres and 910 metres Australian Height Datum (m AHD). The lowest part of the Site is along the central and south eastern boundary at about 880 m AHD.

A series of small man-made dams are located on the Site. The dams are fed by two ephemeral drainage lines that enter the Site on the western boundary and generally flow to the east before entering the largest dam onsite and becoming one drainage line. This drainage line passes through one more dam before leaving the Site along the southern part of the eastern boundary before draining to Pipers Flat Creek, approximately 50 metres offsite. Pipers Flat Creek is a tributary of Cox River. The Cox River is located about 2 km north of the Site. Waterways that occur within proximity of the Project are shown in Figure 1 and Figure 3. Management of surface waters is d iscussed in the EIS (Ref 1, Section 14 and Appendix H of the EIS). A concept level stormwater design has been developed, including drainage arrangements directing water to the dams on the Site

The Bushfire risk assessment was completed for the Project (Ref 4) and defines a series of possible initiators (or threats) for bush and grass fires and the required control mechanisms to minimise the risk of a bushfire threatening Project infrastructure and of an incident at the Project infrastructure initiating a bush or grass fire. A fire at the BESS also presents unusual risks to fire fighters such as electrocution and inhalation of toxic fumes which may be generated in a fire. The battery enclosures being installed on hardstand and with combustible materials reduced as far as possible contribute to a low risk of fire initiated within the BESS. Further, the APZ would be contained within the Site where possible and the APZ would be established for the Site whereby essentially the whole site would be established and managed as an APZ. Further details, refer to the bushfire risk assessment (Ref 4).

The Geoscience earthquake risk map (Ref 6) indicate a moderate earthquake risk at the Project Area in Wallerawang, NSW. The Australian Standard AS 1170 Part 4 would apply ensure structural integrity of the Project in accordance with the local earthquake hazard requirements.

The EIS (Ref 1) indicates that the Project would not be located within a known mapped mine subsidence district.

The Bureau of Meteorology lightning-ground flash density (Ref 7) indicate 3 to 4 flashes per km^2 per year (20 to 25 thunder day per km^2 per year), which is similar to that in the Sydney areas. The Australian Standard AS/NZS 1768 Part 4 would apply for the design and installation of the Project to ensure protection of persons and property from the hazards of lightning in the local area.

2.3 PROJECT OVERVIEW

2.3.1 Battery energy storage system and 330/33 kV substation

An indicative Site layout is provided in Figure 4.

BESS: Lot 4 DP 751651 on which the BESS is proposed to be located occupies approximately 16 hectares of land. Following subdivision the BESS would occupy approximately 7 ha of land, with the remaining 9 ha occupied by the existing residential property on the south east corner (comprising revised Lot 4). The BESS would be located within a security fenced area with a new site entrance from the south-western boundary of the Site.

The Site would consist of a series of containerised or stacked Lithium-ion (***Li-ion***) type battery cells located within enclosures (or *units*) together with associated control systems.

The battery enclosures would be arranged in rows, and connected the new 330/33 kV substation also on the Site, via inverters and medium voltage (***MV***) step-up transformers and using electrical cabling and collector units. The indicative number of battery enclosures is 376 and about 94 medium voltage

(22kV) transformers - these numbers are indicative only and would be defined in the detailed design of the BESS.

Two O&M buildings, one control room and three switch rooms would also be included as part of the Project (further details, please refer to Chapter 4 in the EIS).

330/33 kV substation: An on-site substation comprising up to three (3) high voltage transformers would occupy around 1 ha of the Site. This substation would be constructed on gravelled hardstand and be bounded by security fencing that would be delineate the substation from the BESS. The maximum height of the infrastructure (the lightning rods) within the substation would be 20 metres, whereas the transformers would have a height of approximately 8 metres. This substation would connect the battery enclosures to the new transmission line.

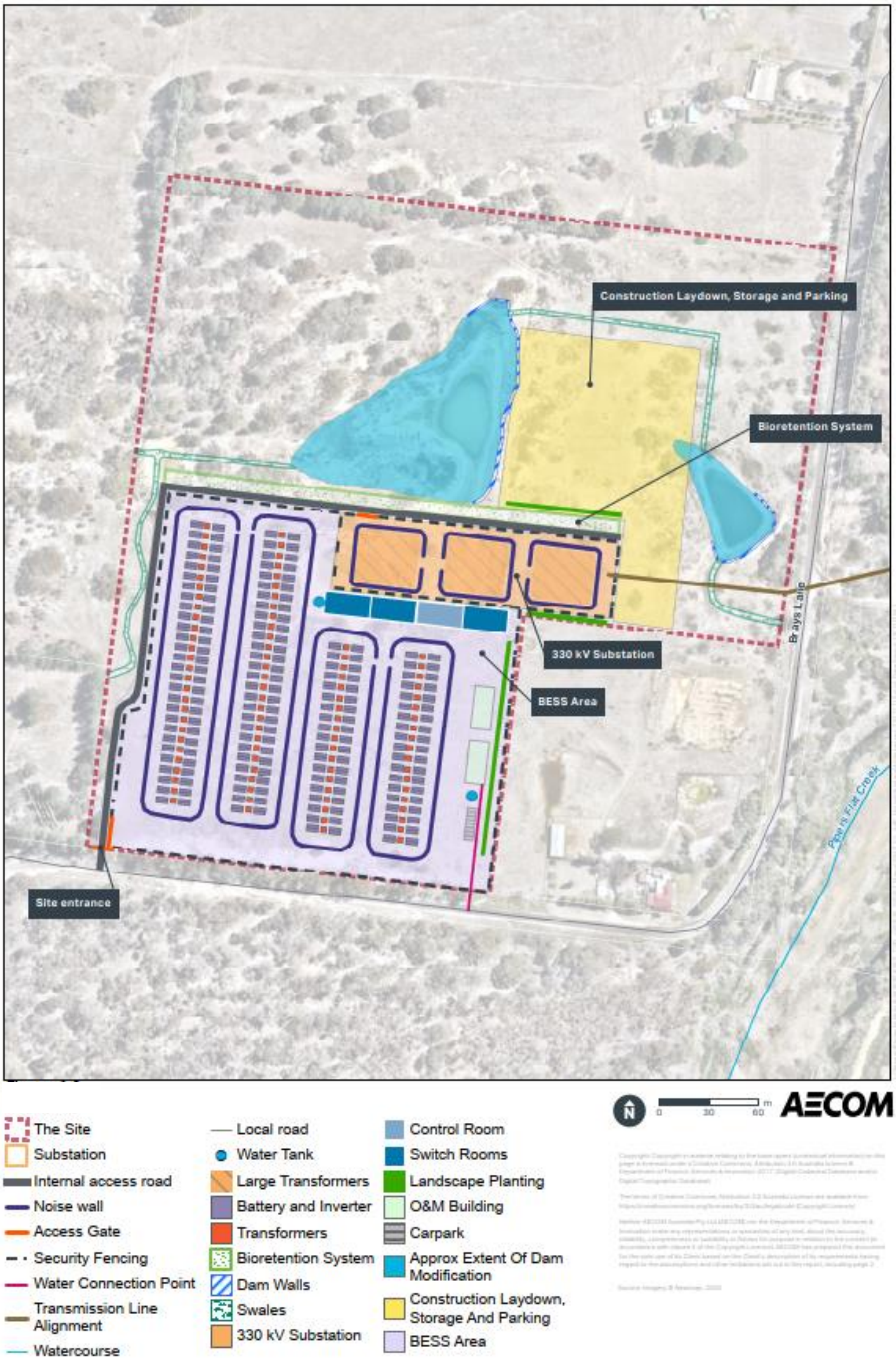

Figure 4: Indicative Site layout

2.3.2 Underground transmission line

The location of the new (up to) 330 kV transmission line is shown on the Project Area map in Figure 3. It would be installed underground and connect the BESS substation to the Transgrid Wallerawang 330kV substation. Within the boundary of the Transgrid Wallerawang 330 kV substation, the new transmission line would transition to an above ground arrangement to allow for connection.

2.4 Typical operating scenario

The BESS is expected to operate on a 24 hour per day, seven days per week basis, undergoing approximately one charge and discharge cycle per day, averaging 365 full cycles per year. A cycle is defined by the full depth of discharge plus the full depth of charge.

For a 500 MW facility this would mean that up to 2 GWh could be exchanged through the battery in a day. This will likely change depending on whether the battery is contracted to provide specific services.

2.5 Occupancy and operational workforce

The BESS managed remotely from the off-site control centre located in Neoen's office in Canberra, to ensure systems are working correctly, investigate alarms and monitor system performance. The BESS would be monitored on a 24 hours per day, seven days per week basis from the remote located control room using SCADA.

Routine inspections and maintenance of the Project infrastructure would be undertaken on a regular basis in accordance with the manufacturer's recommendations, with repairs, undertaken on an as needs basis. Between five to six employees would be required to attend the Site periodically for maintenance activities.

Maintenance equipment associated with the BESS will be stored within the buildings on the Site.

2.6 Access and egress

From the north, the Site can be accessed via the Castlereagh Highway, which feeds traffic directly onto Brays Lane. The Site is located about 1.5 km from the intersection of the Castlereagh Highway and Brays Lane. From this intersection to the bridge crossing of Cox's River, Brays Lane is a dual lane road.

The bridge crossing is one-lane wide. Between the bridge and the Site, Brays Lane narrows and comprises a sealed, bi-directional road.

From the south, traffic can turn from the Great Western Freeway to Barton Avenue, which provides access into the township of Wallerawang. From Barton Avenue, traffic would turn onto Pipers Flat Road, which then leads to Brays Lane, and the Site. The Site is located about 1.35 km from the intersection of Pipers Flat Road and Brays Lane. This stretch of Brays Lane comprises a sealed, bi-directional road. Two road culvert crossings occur over Pipers Flat Creek, and over a small unnamed tributary of Pipers Flat Creek.

A new access point on to the Site would be constructed off Brays Lane, at the south western most corner of the land (refer to Figure 4). This new access point would be used for construction and eventually operation. This access point would connect to an internal road that would have separate access gates for the BESS compound and the substation compound.

The proposed new transmission line easement located outside the boundaries of the Site would be accessed via Brays Lane and / or Main Street, and via the existing rail corridor, in which it would be part located.

2.7 Security

An approximately 2.7-metre-high security fence would be constructed around the perimeter of the BESS. All access to the BESS would be controlled through an access point off Brays Lane.

In addition, movement-triggered security lighting and security devices such as closed circuit television (CCTV) cameras would be installed around the perimeter of the BESS compound for the operation of the Project.

The substation, also located on the Site, including the landing gear for the new underground transmission line, would be within an approximately 2.7 m-high fence which would comprise a cyclone wire chain link fence (or similar).

2.8 Significant design Standards, guideline documents and regulatory compliance

The significant statutory framework that applies to ensuring the safety of Project infrastructure, and that forms the basis of this PHA, is listed below[1] (only those that are directly related to the PHA are included):

Acts and Regulations:

- *NSW Work Health* and *Safety Act* 2011 *and Regulation* 2017
- *NSW Electricity Supply Act 1995, Electrical Supply (General) Regulation 2014 and Electricity Supply (Safety and Network Management) Regulation 2014*
- *NSW Environmental Planning and Assessment Act 1979* and *Regulation 2000*

Governmental Policy and guideline documents:

- *Hazard Analysis* guidelines*,* 2011 (Ref 2)
- *Multilevel Risk Assessment* guidelines*,* 2011 (Ref 3)
- *Planning for Bushfire Protection,* 2019
- *State Environmental Planning Policy No 33,* 1992 (SEPP33, Ref 8)
- Guidelines for *Applying SEPP33,* 2011 (Ref 9)

Codes and Standards

While large-scale BESSs, such as the one proposed for the Great Western Battery, are relatively new in Australia, there are numerous Australian Codes and Standards and protocols that apply, with a listing of significant Australian Codes and Standards provided in Table 1 below.

In addition, a number of international Codes and Standards may apply, including those from the (US) National Fire Protection Association (***NFPA***), (US) Underwriters Laboratories (***UL***), Institute of Electrical

[1] The full list of Acts, Codes, Standards and guidelines would be identified by the Neoen Engineering Contractor selected for each element of this Project, with the Engineering Contractor ultimately responsible for nominating the applicable Codes and Standards.

and Electronics Engineers (***IEEE***), National Electrical Manufacturers Association (***NEMA***), International Electrotechnical Commission (***IEC***), United Nations (***UN***), and Battery Safety Organization (***BATSO***). The reference to such international codes and standards have been listed here for reference only, and their applicability to the present Project will be defined in the detailed design of the facilities.

Safety aspect	Significant Codes and Standard
Australian Standards	AS 1418 *Cranes (including hoists and winches)* 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 1768 *Lightning protection* AS/NZS 1851 *Maintenance of fire protection equipment* AS/NZS 1850 *Portable fire extinguishers*
	AS/NZS 1851 *Maintenance of fire protection equipment* AS/NZS 1850 *Portable fire extinguishers*
	AS 1940 *The storage and handling of flammable and combustible liquids*
	AS/NZS 2430.3 *Classification of hazardous areas (all parts)*
	AS 3439 *Low voltage switchgear and control gear assemblies*
	AS 2067 *Substations and high voltage installations exceeding 1 kV a.c.*
	AS 2374.1 *Power transformers Part 1: General*
	AS 2444 *Portable fire extinguishers and fire blankets Selection and location* 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 3012 *Electrical installations – Construction and demolition sites* AS 3786 *Smoke Detectors* AS 3959-2009 *Construction of buildings in bushfire prone areas*
	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* ASC/ESC 5000: *The Australian Battery Guide by the Energy Storage Council*
	AS/NZS 5139 *Electrical installations — Safety of battery systems for use with power conversion equipment* (Ref 10)
	AS/ IEC 60076 *Transformer*
	AS/ IEC 60364 *Low Voltage Installation - Fundamental principles, assessment of general characteristics, definitions*
	AS 60529 *Degrees of protection provided by enclosures (IP Code)* AS/ IEC 61439-1 & 2 *LV switchgear*
	AS 61508 *Functional safety of electrical/electronic/programmable electronic safety-related system*

Safety aspect	Significant Codes and Standard
	AS 61558.1 *Safety of Power Transformers, Power Supplies, Reactors and Similar Products - General requirements and test*
	AS/ IEC 62271-200 *MV switchgear*
	AS / IEC 62619 *Safety requirements for secondary lithium cells and batteries, for use in industrial applications* (Ref 11)
	IEC 63056, *Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems* (recently published)
	National Network *Safety Code* ENA DOC 001 – 2008
Australian Codes of practice and guidelines	National Guideline for *Safe Approach Distances to Electrical Apparatus* ENA NENS 04 - 2006
	National Guideline for *Safe Access to Electrical and Mechanical Apparatus* ENA NENS 03 - 2006
	Safe Work Australia Code of Practice *Managing Electrical Risks in the Workplace*
	Work Cover Guide *Work Near Underground Assets* 2007
	The Blue Book 2017: *Code of Practice on Electrical Safety for the work on or near high voltage electrical apparatus*
International Codes, for reference	NFPA 855 *Standard for the Installation of Stationary Energy Storage Systems* (Ref 12)
	NFPA 68 *Standard on Explosion Protection by Deflagration Venting*
	IEC 60076 *Power transformers*
	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*
	IEC 62933 *Electrical energy storage (EES) systems* (including *IEC 62933-5-1 Safety Considerations for Grid-integrated EES Systems – General)*
	IEC 62116 *Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures*
	IEC 62897, *Stationary Energy Storage Systems with Lithium Batteries – Safety Requirements*
	EN 13501-2 *Fire classification of construction products and building elements. Classification using data from fire resistance tests, excluding ventilation services*
	IEEE 80IEEE *Guide for safety in AC substation grounding*
	UL 1642 *Lithium Batteries*
	UL 1741 *Inverters, converters, controllers and inter-connection system equipment for use with distributed energy resources*
	UL 1973 *Batteries For Use In Stationary, Vehicle Auxiliary Power And Light Electric Rail (Ler) Applications*
	UL 9540 Standard for Energy Storage Systems and Equipment
Testing and evaluating BESS to ensure the design prevent propagation in a fire	UL method: - UL 9540 *Standard for Energy Storage Systems and Equipment*, for the basis for documenting and validating the safety of an Energy Storage System (including a BESS) as an entire system or product - UL 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, for a test method for evaluating thermal runaway propagation in battery ESS

Safety aspect	Significant Codes and Standard
	IEC method: - 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* - IEC 63056 *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems* (recently published)

Notes:

- The Australian Standard AS 5139 (2019) provides the basis for the safety and installation of the BESS in Australia where the individual unit is equal to or less than 200 kWh, signifying a much smaller BESS than the present Project. The requirements under AS 5239 (2019) must be adhered to, where applicable, including Section 6 which refers to IEC 62619 (Ref 11).
- The US National Fire Protection Association Code NFPA 855 (2020) provides the minimum requirements for mitigating the hazards associated with Li-ion BESS of at least 20 kWh. The requirements under NFPA 855-2019 and AS 5239-2019 align in many important areas.

Table 1: Significant Standards and Codes of practice for Project design and operation

2.9 Main Design Parameters

The Project design parameters are presented in Table 2.

Project element	Design parameter
BESS storage and discharge capacity	Peak capacity of 500 MW and storage capacity of up to 1,000 MWh
BESS components	Containerised or stacked Lithium-ion (***Li-ion***) type batteries installed within battery modules and arranged within approximately 376 enclosures (or ***units***) with integrated BMS and HVAC units. (Number provided for indicative purposes only). Inverters and medium voltage (***MV***) transformers to be integrated with each group of battery units. MV cable connecting the BESS to the substation on the Site. Ancillary infrastructure including a workshop area, lightning protection, security fencing, CCTV, internal roads, car park. Single-storey O&M office building, control room, switch rooms and workshops would also be included within the BESS.
BESS dimensions	Footprint of the Site is 13 hectares but the BESS would only occupy part of this (approximately 7 ha). The integrated battery enclosures are anticipated to be approximately 2.5 m tall and have a footprint of approximately 3.5 m by 7 m each. Dimensions of step-up MV transformers and inverters will be determined in the detailed Project design process.

Project element	Design parameter
BESS control and safety features	Fully-integrated operating system for comprehensive control, asset management, and system visibility BMS for safety functions including detection and response to abnormal operation and emergency shutdown. BMS or separate control system for fire and gas detection and shut down. Physical safety functions including deflagration panels, lockable disconnect switch, open door sensor, gas spring damper, and sliding door lock.
Design environment	Maximum and minimum design temperatures to be defined during the detailed design stage IP ratings such that the battery enclosures would be protected against dust ingress that could be harmful for the normal operation of the battery, against solid objects and water spray or jets (level of protection is to be defined in detailed design)
Substation components	MV electrical cabling connecting the BESS to the substation. Three (3) high voltage (***HV***) transformers and outdoor switch gear. The three transformers would occupy around 1 ha of the Site. The substation would connect to the 330 kV underground transmission line.
Transmission line	Transmission line connecting the substation to the Transgrid Wallerawang 330kV substation Installed underground for the full length except for the landing gear at the Site and at the Transgrid Wallerawang 330kV substation The transmission line would have a voltage of up to 330 kV Approximately 1.5 kilometres of length

Table 2: Design parameters

3 RISK SCREENING

3.1 OVERVIEW OF THE RISK SCREENING PROCESS

The objective of risk screening as per the MLRA guideline document (Ref 3) is to determine whether a proposed development or facility is considered as *potentially hazardous* as per the following definition by the DPIE:

'Potentially hazardous 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 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 rigorous PHA as per the requirements set in HIPAP No. 6 (Ref 2) to determine the risk to people, property and the environment.

Additionally, and irrespective of the outcome of the risk screening process, the DPIE can request that a PHA be developed for a proposal, based on other criteria.

If the residual risk exceeds the acceptability criteria, the development is regarded as *hazardous industry* and may not be permissible within NSW.

The risk screening process in the MLRA (Ref 3) considers the type and quantity of *hazardous materials storage* and the distance of the storage area to the nearest site boundary; the expected number of transport movements associated with hazardous material; and *other types of hazards,* refer below:

- *Hazardous materials* are defined within the guidelines as substances that fall within the classification of the Australian Dangerous Goods Code (ADGC, Ref 13), i.e. have a DG classification. Detail of the DG classification is typically obtained from the materials' safety data sheet (SDS). The screening threshold in the MLRA methodology presents the quantities below which it can be assumed that significant risk to adjacent land use is very unlikely.

As such, those aspects of a proposed development that are unlikely to present significant risk to adjacent land use can be filtered out from the rest of the PHA, and the PHA can focus on those risks that may have significant risks to adjacent land use.

- *Other types of hazards* are evaluated following the definitions in the MLRA, and include: material incompatibility, reactivity and instability; hazardous wastes; hazardous activities or process conditions; known past incidents (and near misses) in similar industries; and environmental sensitivity in the local area.

The results of the MLRA screening for the proposed Project can be found in the following tables:

- Table 3: Hazardous materials storage
- Table 4: Transport of hazardous material
- Table 5: Other types of hazards

Hazardous material	DG Class	Category	Proposed quantities	SEPP33 threshold	Proposal exceeds SEPP33 threshold?
Lithium ion (Li-ion) batteries	DG Class 9	Miscellaneous dangerous goods	Exact weights of the materials are not known at the concept design stage of the Project. However, the weight is not expected to impact on the findings and outcomes of or risk screening	DG Class 9 material is excluded from screening process	NO
Coolant may be used in HVAC	Not expected to be a DG	Not expected to be combustible or toxic		Non-DG material is excluded from screening process	NO
Refrigerant compressed gas (maybe in battery racks)	Expected to be DG Class 2.2	Non-Flammable, Non-Toxic Gases		DG Class 2.2 material is excluded from screening process	NO
Potential use of an inert gas for fire suppressant inside the battery enclosure	Expected to be DG Class 2.2 e.g. carbon dioxide	Non-Flammable, Non-Toxic Gases		DG Class 2.2 material is excluded from screening process	NO
Oil and other petroleum products	Not a DG	Combustible liquid C1 (AS1940)		Combustible liquid is excluded from screening process	NO
Poisons such as weedicides / herbicides	DG Class 6	Toxic Substances	Assumed not to exceed 1 tonne	2.5 tonnes	NO

Legend: Not potentially hazardous as per MLRA; Potentially hazardous as per MLRA

Table 3: SEPP33 risk screening summary – Storage of hazardous materials

Hazardous material	DG Class and Packaging Group	Category	Vehicle movements applicable for the Project		SEPP33 threshold (vehicles carrying Dangerous Goods)	Proposal exceeds SEPP33 threshold?
			Cumulative annual	Peak weekly		
Li-ion batteries (BESS)	DG Class 9	Miscellaneous dangerous goods	*Ongoing operations*: Zero *During construction*: Much less than the threshold of 1,000 vehicles	*Ongoing operations: Zero* *During construction: Much less than the threshold of 60 vehicles*	>1,000 (annual) >60 (peak weekly)	NO
Coolant may be used in HVAC (BESS)	Not expected to be a DG	Not expected to be combustible or toxic				NO
Refrigerant compressed gas may be used in the battery rack (BESS)	Expected to be DG Class 2.2	Non-Flammable, Non-Toxic Gases				NO
Oil and other petroleum products (in transformers at the BESS and the substation and at the transmission line landing gantries)	Not DGS	Combustible liquid C1 (AS 1940)				NO

Legend: Not potentially hazardous, as per MLRA; Potentially hazardous, as per MLRA.

Table 4: SEPP33 risk screening summary – Transport of hazardous materials

Other Types of Hazards	Applicable (Yes or No)	Results of the screening	Proposal exceeds SEPP33 threshold?
Any incompatible materials (hazardous and non-hazardous materials)	No	No incompatible materials identified for this Project	NO
Any wastes that could be hazardous	Yes	No significant hazardous wastes identified for the operation of Project infrastructure.	NO
Types of activities the dangerous goods and otherwise hazardous materials are associated with (storage, processing, reaction) – if different to table above	No	No significant hazardous activities associated with DGs identified for this Project	NO
Incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition	Potentially yes	Runaway reaction associated with Li-ion batteries has occurred in other similar industry in the past	YES: potential exists for runaway reaction in a battery cell which may become a precursor for a battery fire
Storage or processing operations involving high (or Very Highly low) temperatures and/or pressures	No	No Very High conditions with high (or Very Highly low) temperatures and/or pressures identified as associated with Project infrastructure	NO
Details of known past incidents (and near misses) involving hazardous materials and processes in similar industries	Potentially yes	Runaway reaction associated with Li-ion batteries has occurred in other similar BESS industry in the past	YES: past runaway reaction incidents have occurred in similar BESS
The Project may threaten the particular qualities of the environment (for example, the likely presence of rare or threatened species, water courses)	No	Information available for the Project is such that no significant rare or threatened species, water courses are likely to be affected, and any management is included in the Biodiversity Development Assessment Report in the EIS (Ref 1)	NO
The nature of the hazards that the environment will be exposed to, and the likely response of the environment to such a hazard, and the reversibility of any hazardous impact	Potentially yes	Information available for the Project is such that environmental pollution cannot be ruled out at the concept design stage	YES: subject to selection of battery manufacturer and detailed design

Legend: Not hazardous, as per SEPP33 Potentially hazardous, as per SEPP33

Table 5: SEPP33 risk screening summary - Other types of hazards

3.2 Results of the Risk Screening

The results of the risk screening, providing a focus for the PHA, are summarised below:

- The expected storage of hazardous materials associated with the Project would not exceed the relevant risk screening threshold
- The expected transport of hazardous materials associated with the Project would not exceed the relevant risk screening threshold

On the basis of storage and transport alone, the development would not be considered *potentially hazardous* following the definition by the DPIE).

However, as the DPIE also require assessment of *other types of hazards*, the following potential hazards require further assessment in a PHA:

- Uncontrolled runaway reaction or decomposition within the Li-ion batteries at the BESS potentially leading to propagation to other infrastructure
- Environmental impact or health and safety impact from exposure if there is a spill of pollutant from the battery enclosures, transformers or landing gantries , e.g. cooling medium or oil. This risk may partially be ruled out once the battery manufacturer and further project details become known.

The results of the MLRA risk screening indicate that the Project is not 'potentially hazardous' (as per DPIE definition) based on the storage or transport of hazardous material. The hazards associated with a battery fire and the potential for environmental pollution from a spill of oil or other pollutant from Project infrastructure may be 'potentially hazardous' and therefore must be carried forward for further assessment.

Planager
Risk Management Consulting

4 RISK CLASSIFICATION AND PRIORITISATION

4.1 OVERVIEW OF THE METHODOLOGY

The risk classification and prioritisation method informs, out of three levels, the level of assessment required for the PHA. The process, as demonstrated in Figure 5, begins by prioritising risks with any significant potential to harm people, property or environment for further analysis.

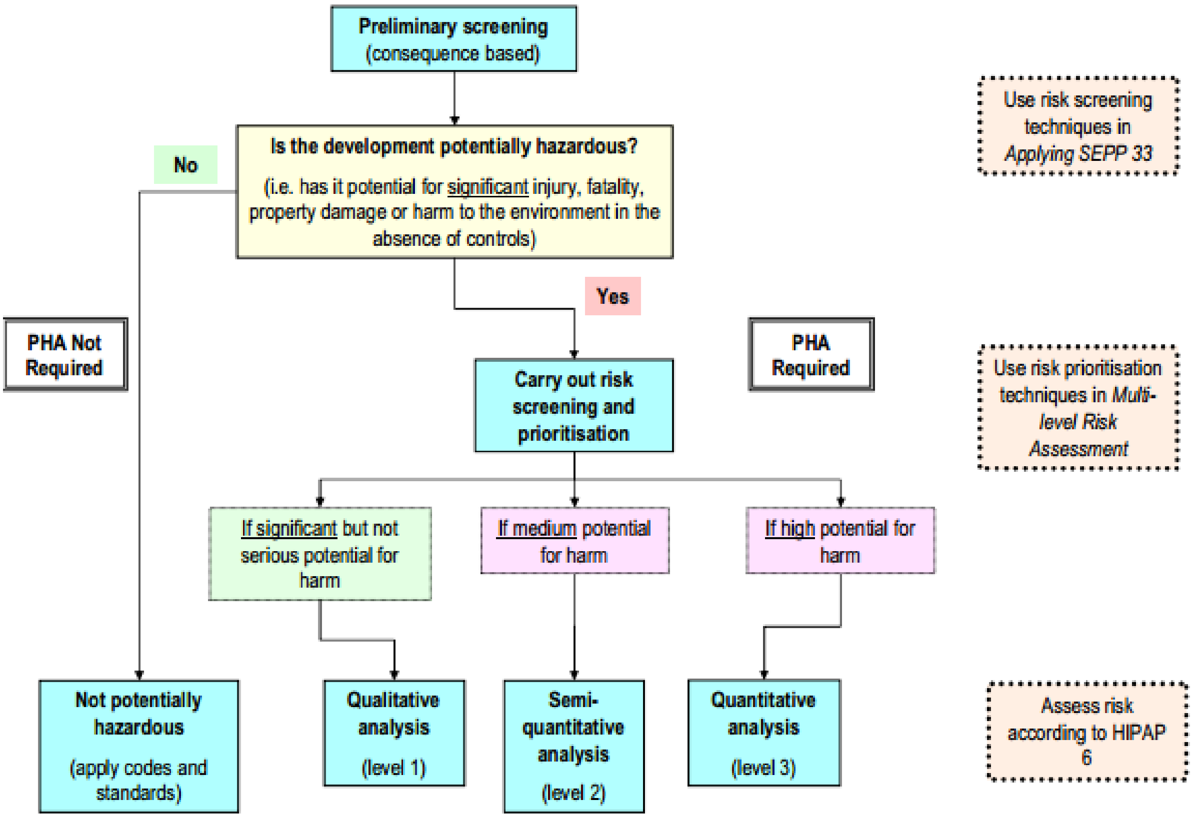

Figure 5: Multi-level Risk Assessment process as presented (Figure 3 of DPIE MLRA)

The MLRA method is based on the *Manual for the classification and prioritisation of risks due to major accidents in the process and related industries* (IAEA, Rev. Ed. 1996). This method is risk-based and relies on broad estimations of the consequences and likelihoods of accidents. The outputs may be expressed in terms of individual and societal fatality risk, which can be compared against criteria for determining the appropriate level of further assessment.

Using these criteria, the indicative level of risk, as determined in the risk classification and prioritisation stage, may lead to three possible outcomes:

- *Level 1 assessment*: Can be justified if the analysis of the facility demonstrates societal risk in the negligible zone and there are no potential accidents with significant consequences to adjacent land use

- *Level 2 assessment*: Can be justified if the societal risk estimates fall within the middle ALARP zone and the frequency of risk contributors having consequences to adjacent land use is relatively low

- *Level 3 assessment*: Required where the societal risk from the facility is plotted in the intolerable zone or where there are significant risk contributors to adjacent land use, and a level 2 assessment is unable to demonstrate that the risk criteria will be met.

4.2 Results

Based on the information on hazardous materials storage and transport in the risk screening in Section 3, the development would be *Not potentially hazardous* and a PHA would not strictly be necessary (as per the dotted blue arrow in Figure 6). However, due to the potential for harm caused by a fire at the BESS, and potentially due to environmental pollution from spills of oil and other pollutants, e.g. from the transformers, further analysis is required (as per the orange arrow in Figure 6).

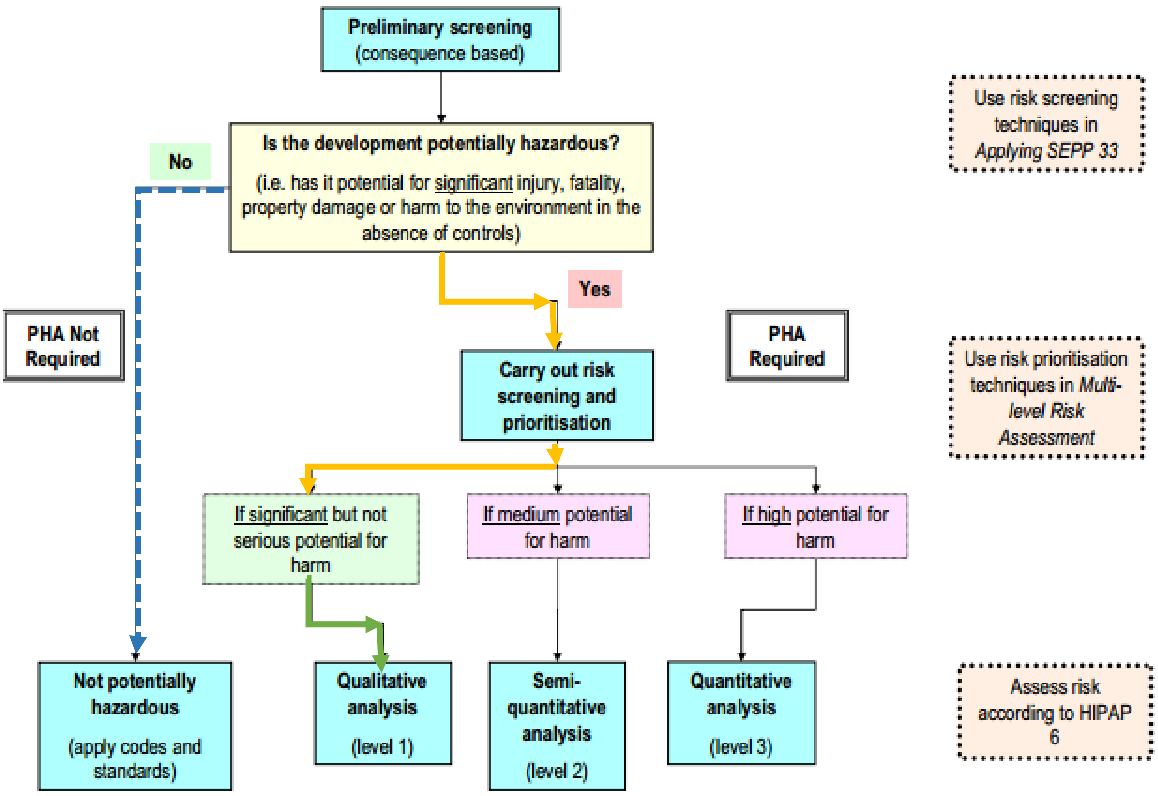

Figure 6: Multi-level Risk Assessment results

The MLR decision tool is based on quantities of DGs and their distance to the site boundary. With low volumes of DGs associated with this Project and with the need for further assessment being triggered by *other types of hazards* (see Section 24), a simple comparison against the criteria established in the MLRA process is not sufficient and further (detailed) analysis of the potential individual and societal risk is required. Therefore, the justification of the level of analysis required for this PHA (green arrow in Figure 6) is based on the following:

- The analysis carried out in Section 5 of this report demonstrates that the worst-case consequence for the identified events is a fire event associated with the BESS. Such a fire may be initiated through a thermal runaway or an electrical fault within the battery, or potentially from an external event such as a nearby fire or impact/crushing of the battery.

- A battery fire would generate heat, toxic gas and combustion products. A major fire associated with a BESS technically has the potential to propagate to areas outside of the Project Area and initiate a brush/bushfire. It may affect the nearby land uses including the nearby residential area(s).

- However. as demonstrated in Section 5.2 and detailed in the Assumptions and Justification Register in Appendix 3, provided the battery is designed such that a battery fire will not propagate to other battery enclosures, and that sufficient separation distances are established between the Project infrastructure and the surrounding land, including through the establishment and maintenance of the APZ (refer to the Bushfire Assessment in Ref 4), the risk of a major BESS fire involving more than one enclosure is low and can be managed ALARP. In such case, none of the consequences of potential hazardous incidents associated with the Project have a potential to cause significant individual or societal risk of harm to people outside of the Project Area boundary, and a Level 1 assessment can be justified.

- Another potential high consequence event that cannot be screened out at the concept stage of the Project relates to a failure to capture a loss of containment of pollutants, including oil (e.g. from the transformers) or, potentially, cooling water or refrigerant from the batteries, subject to detailed design. The detailed design stage will need to ensure that the risk of a spill and runoff into local surface waters and groundwater systems or ground pollution, or hazardous exposure to personnel and emergency services is eliminated where possible or reduced to low risk if elimination is not possible. The quantities of pollutants are low and a Level 1 assessment can be justified.

Provided the battery is designed such that a battery fire will not propagate to other battery enclosures and that sufficient separation distances are established between the Project infrastructure and the surrounding land, including through the establishment and maintenance of the APZ, and provided the risk of a spill, runoff and exposure is minimised, there is no serious potential for harm from the Project and a Level 1 qualitative risk assessment can be justified.

5 RISK ANALYSIS AND ASSESSMENT

5.1 HAZARD IDENTIFICATION

The hazard identification consists of the following steps:

1) List of hazardous properties of materials - Section 5.1.1
2) Identification of potentially hazardous incidents and their control - Section 5.1.2.

5.1.1 Material hazardous properties

The potentially hazardous properties of materials expected to be stored and handled during the construction, commissioning and operations phases of the Project are detailed in Table 6[2]. Details of preventative and mitigative controls are provided in Section 5.2 with further demonstration in the Assumptions and Justification Register in Appendix 3.

Material	Description and potential hazards
Design and construction phase	
Flammable and combustible material	Limited amounts of flammable or combustible material (e.g. diesel, petrol, superglue, solvents, thinners and paints) and of corrosive and toxic liquids (e.g. small containers of hydrochloric acid and other corrosives for surface preparation, pesticide for ground clearing etc.) are expected to be stored and handled during the construction phase of the Project. Specifications for the safe handling and storage of these chemicals include bunding and ventilation arrangements, control of ignition sources, and requirements for personal protective equipment. Adherence to Australian Standards (e.g. AS1940 *The storage and handling of flammable and combustible* liquids and AS3780 *The storage and handling of corrosive substances*) apply for the management of risks of these chemicals. Contractor management systems would be set up and SWMS, JSAs and Permits would be used. Provided that the internal (Neoen) and external (Australian Dangerous Goods Codes and Standards) requirements are followed, the risks associated with these chemicals is low and not discussed further in this PHA.
Corrosive liquids and aerosols	
Commissioning and operations phases	
Li-ion batteries	Fire at a Li-ion battery may be caused through uncontrolled reaction (e.g. thermal runaway), overcharge, short-circuit, damage or decomposition within the cell. Thermal runaway is triggered when the cell reaches a certain temperature (anticipated around 160oC). The heat source can be external or internal (i.e. due to cell failure).

[2] The inventories are provided in Table 3 for the commissioning and operations phases. As only small amounts of hazardous materials are to be used during the construction phase, as typical for any construction - these are not detailed in this PHA.

Material	Description and potential hazards
	A fire event would generate heat, possible deflagration overpressure if flammable vapours were ignited, and toxic gas and combustion products. Depending on the design and manufacture of the Li-ion battery, projectiles or cell explosions in case of failure to vent off-gases may occur (Refs 13,). Toxic vapours may be formed during a fire event (Ref 15 and Assumption No. 1 in Appendix 3). It is possible for a Li-ion battery to re-ignite, due to the exothermic reactions that continue to occur within the cell. If the burning battery cells are located close to combustible material within the enclosure, or close to other battery cells that can go into runaway reaction, or if the enclosure is located close to other infrastructure, there is a potential for escalation. Inherent safe battery design and other preventative and mitigations controls are discussed in Section 5.2 with further details in the Assumptions and Justification Register in Appendix 3.
Coolant	Some type of coolant may be used in the HVAC, probably a non-DG material of low hazard. Example of a typical battery coolant are mixtures of ethylene glycol and water. While pure ethylene glycol is a combustible liquid (Ref 14), when mixed with water in industrial application it becomes non-combustible. If water is driven off in a fire it can participate in the combustion reaction.
Refrigerant	The battery rack may include a refrigerant, probably composed of a single or mixture of non-flammable non-toxic compressed gases DG Class 2.2. The chiller unit may explode if heated. Contact with compressed gases may cause frost bite. Exposure is harmful (all routes).
Inert gas for fire suppressant	The battery enclosure may include a fire suppressant, probably e.g. non-flammable non-toxic compressed gas DG Class 2.2 such as carbon dioxide). The unit may explode if heated. Contact with compressed gases may cause frost bite. Exposure is harmful (all routes).
Oil and other petroleum products	Oil is expected to be used and handled, e.g. as insulating oils. The main hazard associated with oils relates to environmental pollution in case of a loss of containment, and with toxicity in case of human exposure. If a spill reaches surface water, petroleum products can kill aquatic wildlife. Oil is combustible and, while difficult to ignite in atmospheric conditions, it can participate in a fire and can pose a serious fire hazard if not contained.

Table 6: Materials hazards

5.1.2 Identification of potential hazardous incidents and their control

The following factors were considered in order to determine the key potential hazardous incident associated with construction and operation of the Project:

- Project infrastructure, location, workforce, local environment, adjacent land use
- Materials and energies, properties and associated hazards
- Type of equipment and known major incidents that have occurred in similar facilities
- Recent developments in research and standards for Project Infrastructure, including BESS (Australia and internationally)

- Construction, commissioning, operation and maintenance activities and potential threats
- External factors (bush fire, lightning, land slide, earth quake, strong winds, dust storm etc).

An overview of the types of hazards associated with the Project infrastructure is provided in Table 7.

Project element	Electrical hazards	Energy hazard	Fire hazard	Explosive hazard	Pollution hazard	Toxic fume hazard	Reference, see Section 2.8
BESS	✓	Note 1	Note 2	Note 3	Note 4	✓	AS 5139 / NFPA 855
Substation	✓	Note 1	✓	✓	Note 4	Note 5	AS 2067 / AS 1940
Transmission line and gantries	✓	Note 1	✓	✓	Note 4	Note 5	AS 2067 / AS 1940

Notes:

1. Arc flash incident potential
2. Fire may be caused by thermal runaway, short circuit, over voltage/overcharge
3. If the BESS releases hydrogen under fault conditions it is regarded as an explosive gas hazard (Ref 10)
4. Failure to contain a spill may cause pollution,
5. Toxic fumes may contain oxides of sulphur and fluor from combustion of sulphur hexafluoride in switchgear

In addition, mechanical hazards are associated with the Project infrastructure, e.g. weight, sharp edges & corners, moving parts, falling over, tripping, seismic, and lack of lifting or securing

Table 7: Types of hazards associated with the Project (HIPAP6 hazards only)

The key potential hazardous incidents associated with the Project are listed in Table 8.

- Incidents 1 and 5-7 are primarily associated with the BESS and form the focus of this PHA
- Incidents 2-4 are typical for any construction activity.
- Incident 8 is typical for development of electrical infrastructure associated with inverters, step-up transformers, substation, transmission line and gantries.

Hazardous incident title	
Construction phase	*Commissioning and Operations phases*
1. Impact, e.g. due to toppling of major lifting equipment; dropping of heavy equipment; failure to manage traffic, leading to injury and initiation of a major incident due to crushing, pinching of the battery	5. Fire in the battery cell (e.g. due to thermal runaway) and generation of toxic and pressurised gases and vapours
2. Hitting above / underground services or existing infrastructure (e.g. the underground transmission line or the existing road or coal conveyer infrastructure) leading to injury, fire, environmental	6. Loss of containment of pollutant material from the Project infrastructure (potentially involving cooling water, refrigerant, oils) with potential exposure and pollution hazards

Hazardous incident title	
Construction phase	*Commissioning and Operations phases*
damage and propagation to neighbouring plant and equipment	
3. Injury due to loss of control during construction work (work at heights; confined space; trench/pit collapse; struck by; electrocution; rotating equipment; high pressure equipment)	7. External event impacts Project infrastructure, with subsequent initiation of major incident scenarios 5 or 6 (above)
4. Injury or environmental damage or damage to property from general construction works, e.g. failure to manage vehicular access, laydown areas, excavations, loss of water & sediment and loss of containment of fuels, oils, grout, corrosives, pesticides and possibly other material used in general construction works	8. Electrical fault inside battery enclosure, inverters or transformers causing fire or injury

Table 8: Key potential hazardous incident scenarios

5.2 Risk Analysis and Assessment

The hazardous consequences and associated preventative and mitigating strategy of the above incident scenarios are listed in Table 9 below.

Consequence and likelihood estimation was based on Planager's experience in similar industry and on literature reviews, including the most current research and standards and lessons learned from major incidents that have occurred in similar facilities elsewhere.

The likelihood of the event was determined assuming application of preventative and mitigative controls.

The risk levels are ranked in accordance with the risk matrix in Appendix 2 which has been calibrated to DPIE risk criteria (HIPAP4, Ref 5).

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
Construction phase				
1. Impact at Project infrastructure enclosure during construction due to: - toppling of major lifting equipment - dropping of equipment during heavy lift - failure to manage traffic Leading to injury and potential initiation of hazardous incidents 5-7 through crushing, impact	Neoen and Contracting Company's Policies and Procedures, including pre-starts; lift studies; exclusion zones during lifts; PTW, SWMSs, JSA, Induction, training & competency The work will be planned such that conflicting tasks in the work area are avoided. Adequate space will be confirmed prior to initiating plant manoeuvring and load and unload operations Traffic Management Plan will be established Adherence to SafeWork NSW and other Codes of Practice Initiation of the Emergency Management Plan for construction activities	SERIOUS OR MAJOR	UNLIKELY OR REMOTE	MODERATE
2. Hitting above / underground services (e.g. transmission line or existing road and coal loader) leading to injury, fire, environmental damage and propagation to neighbouring plant and equipment	Neoen and Contracting Company's Policies and Procedures with requirement for appropriate safety measures to prevent incidents and injury Adherence to SafeWork NSW and other Codes of Practice Clearances for restricted spaces will be maintained The work will be planned such that conflicting tasks in the work area are avoided. Adequate space will be confirmed prior to initiating plant manoeuvring and load and unload operations SWMS / PTW / JSEAs Induction and training; Competency. Services search at set-up and consultation with service providers / infrastructure owners where relevant Pre-start and tool boxes Non-destructive pot holing, hand digging close to services, cable location and marking off of all services.	SERIOUS OR MAJOR	UNLIKELY OR REMOTE	MODERATE

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
3. Injury due to loss of control during construction work incl. during work at height, confined space, slip-trip-fall, trench / pit collapse, bites (snakes, spiders, mosquitos), struck by, electrocution, high pressure equipment, hoses, pumps & rotating equipment, cutting, grinding	Neoen and Contracting Company's Policies and Procedures with requirement for appropriate safety measures to prevent incidents and injury, including trench management, management of hot works, confined space work and work at heights, SWMS, PTW, JSEAs etc.; Training, Induction & Competency. Overhead spotter assigned for work near overhead transmission line Adherence to WorkSafe and other Codes of Practice Scaffolding / Elevated Works Platform as / if required Testing for potential contaminants in the ground and, if required, establishment of procedures Construction Management Plan (as required), including specific key control measures First Aid kits, safety showers / eye wash stations available as required	SERIOUS OR MAJOR	UNLIKELY OR REMOTE	MODERATE
4. Injury or environmental damage or damage to property (including initiation of bushfire) due to failure to manage vehicular access, laydown areas, excavations, water & sediment, containment of fuels, oils, grout, corrosive liquids, pesticides, hot works, security breach.	Construction Management Plan (as required), including contractors Control Plans to define specific key control measures Erosion and sediment control Prestart including weed control where required, (as per Construction Management Plan Control measures expected to include (not limited to): storage of hazardous substances in accordance with Australian Standards (e.g. AS1940 and AS3780), SDS and other safety specifications including use of bunds and drip trays; spill response equipment kept on site; Emergency Response Plan; regular checks and maintenance of machinery, plant and equipment, pre-start, tool boxes SWMS, JSEAs, PTW including hot work permit Spill kits During construction, the areas would be manned and temporary fences would be installed to manage access to site 24/7 and deter security breaches Emergency Response Plan established	MEDIUM TO SERIOUS	SELDOM TO UNLIKELY	MODERATE

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
Commissioning and operations phases				
5. Thermal runaway in the battery, e.g. due to: - imbalanced charge, - mechanical failure (cell defect, crush, damage), - overtemperature (BMS / HVAC failure, propagation from nearby fire including bushfire or electrical infrastructure failure). Leading to: - fire, explosion and generation of toxic gases; - potential for injury and property damage; - potential propagation to surrounding grassland.	The BESS Units would be designed such that a fire in one unit (e.g. from a thermal runaway in the battery cells, electrical fault or other cause) would not propagate to other units. This would be achieved through passive fire protection or active fire suppression system, to be defined in detailed design, and tested to UL 9540A requirements. BESS designed and operated to AS/NZS 5139:2019, *Electrical installations — Safety of battery systems for use with power conversion equipment* (Ref 10) requirements and to one or more of the major international BESS Codes, e.g. NFPA 855. Installation and maintenance by trained personnel using SWMS. Induction of all personnel prior to work. All relevant Australian Standards and Neoen's internal requirements met, including procedures, PTW, isolation (including LV/MV/HV), control of modifications, inspection regimes Warning signs (electrical hazards, arc flash, entry procedures into battery enclosure) BMS fully functional including preventing overcharging and current surges in the batteries; maintaining voltage levels; and ensuring automatic shut-down in the event of electrical shorts, overheating or other unplanned events. The BMS will also include and manage signals from fire and gas detection system. Alternatively, BMS and substation/switchgear control might be two different systems but can both report to a single HMI system. Unless under direct supervision of the OEM, the energy storage units will be permanently connected to SCADA/BMS from their first energisation to monitor fire/explosion risk. Preventative maintenance and condition monitoring of electrical equipment and batteries. Battery enclosures with outwardly opening door and battery racks accessed from the outside with no personnel entering the enclosures during operation unless under the OEM direct supervision. For containerised BESS solutions, illuminated warning signs on the outside of (containerised) enclosure, if relevant, that indicate a hazardous environment inside the enclosure, and /or thermal alarm and/or gas detection and/or gas suppression system activation for example. Key locked cabinets, electrical rooms and battery enclosures. Physical safety functions to ensure that the door is closed during battery operation. Use of appropriate PPE, including to protect against arc flash. Emergency response including activation of local emergency shutdown (ESD button) as required in Codes and Standards, and initiation of Emergency Response Plan. Emergency services personnel aware of possible toxic gas hazard through early engagement of first respondents in the design, construction and commissioning processes to provide high level of training/understanding of the risks.. Evacuation of sensitive receptors if fire propagates through the BESS (e.g. the local residents) Asset Protection Zone (APZ) established and maintained	MAJOR	REMOTE	MODERATE

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
6. Loss of containment of pollutant material from Project infrastructure (e.g. the cooling water from the HVAC system in the BESS or oil from the transformers or the transmission line's landing gantries) due to: - mechanical failure - damage - abnormal heating. Leading to release of pollutant material and potential for hazardous exposure and environmental pollution	Equipment and systems designed and tested to comply with the relevant Australian and international Standards and guidelines Battery design such that there is no releasable pollutant / hazardous material with the exception of low hazard cooling and/or refrigeration medium. Design of cooling and refrigeration systems such that a loss of containment is prevented, the cooling medium has low toxicity and irritation potential; and low volumes of pollutant material Design of transformers and other electrical installations to prevent a loss of containment Detection and automatic shut-down and automatic safety shut-down in case of failure of the HVAC system which would result in safe battery operational limits being exceeded A spill from the battery enclosures (e.g. coolant) or from the transformers (e.g. oil) would be captured; the transformer oil tanks would be sufficient to capture the full volume of oil, with a design compliant with Australian Standards. PPE in use. Need for safety shower / eye wash station to be determined in detailed design Emergency response to be determined in detailed design and may include spill clean-up using dry absorbent material and activation of Emergency Response Plan for major spills	MEDIUM	UNLIKELY	LOW

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
7. External event impacts Project infrastructure including from: - bush/grass fire - natural event (lightning strike, wind, flood) - impact by on-site vehicular traffic - vandalism, security breach with potential for subsequent initiation of incident scenario(s) number(s) 5 and 6 (above)	Adjacent grassland presents a low hazard due to the low fuel load. APZ established and maintained. Ground surface within Project infrastructure maintained as per APZ. Requirements for brush / bush firefighting to be defined in detailed design and in consultation with Fire Services. Construction activities undertaken using PTW, including for hot work Earthing and bonding of electrical equipment Lightning protection to be determined in detailed design Equipment housed in IP rated enclosures constructed in accordance to relevant Standards and above flood level. Moderate earthquake risk at the Project Area, and design to earthquake requirements as per AS 1170.4 *Structural design actions – Earthquake actions in Australia* Wind damage prevented through bracing, fixing and/or tie-downs for the conditions and design to AS1170.2 *Structural design actions - Wind actions* Speed restrictions enforced on site including through Contract WHS requirements. Mandatory Induction for all persons coming onto the Project Area. Traffic management plan established Fenced area prevents wildlife or cattle. accessing the Project Area Security protocol and Closed Circuit Television (CCTV) Need for fire suppressant (inside the battery enclosures and/or potentially using fire water from outside of the enclosure) to be determined during detailed design (it is noted that the efficiency of such measures is questioned by a number of stakeholders and not offered by several of the tier one battery suppliers) Fire water to be available to combat bush / grass fire in accordance with the requirements in the bushfire risk assessment (Ref 4) Activation of the Emergency Response Plan	MAJOR	REMOTE	MODERATE

Hazardous incident	Required Controls	Risk assessment		
		Consequence	Likelihood	Risk
8. Electrical fault at electrical equipment (inverters, step-up transformers, substation, transmission line and gantries) causing - fire - arc flash - pressure wave - toxic combustion products, - burns and injury - exposure to intense light/ noise - exposure to voltage - pollution Leading to injury or potential for propagation to adjacent infrastructure and areas (e.g. surrounding grassland)	Equipment and systems designed and tested to comply with the relevant Australian and international Standards and guidelines Installation and maintenance by trained personnel using SWMS. Induction prior to work PTW (including hot work) and control of modifications Preventative maintenance and condition monitoring including thermography, following manufacturer's recommendations Automatic activation of local emergency shutdown through equipment management system (e.g. BMS at battery enclosures) The equipment housed in dedicated enclosures. Only restricted personnel allowed. Key locked cabinets and electrical rooms. Warning signs (electrical hazards, arc flash) Use of appropriate PPE Separation distance between infrastructure in accordance with Codes and Standards minimises the risk of escalation Infrastructure is located in open area which minimises the risk of accumulation / ingress and exposure of toxic combustion products. Toxic combustion products or gas released from fault conditions would be evacuated such that people would be able to escape from the area and not be exposed at adjacent egress routes Bunding and containment of oils or other pollutants as per Code requirements, including AS1940, AS3780 Emergency response including activation of local emergency shutdown (ESD button) as required in Codes and Standards, and initiation of Emergency Response Plan. Fire extinguishers available to combat small electrical fires Asset Protection Zone (APZ) established and maintained. Vegetation management near the battery enclosures	MAJOR	REMOTE	MODERATE

Table 9: Key potential hazardous incidents and associated controls, construction and operations phases

The risk profile for the Project is consistently between *Low* and *Moderate* risk, as per the definition in the matrix in Appendix 2. Out of the eight (8) risk identified for the Project, the following risk levels apply:

- Construction phase
    - All four (4) scenarios are of *Moderate* risk. The scenarios identified for the construction phase are typical for such activities. The fact that it involves a BESS has very little impact on the risk profile of the construction phase with the possible exception of incident scenario No. 1 which may initiate a battery incident (scenarios 5 and 6) e.g. due to dropping of a battery module or impacting/crushing batteries.
- Commissioning and operations phases:
    - Three (3) scenarios are of *Moderate* risk (scenarios 5, 7, and 8)
    - One (1) scenario is of *Low* risk (scenario 6).

    Scenarios. numbers 5, 6 and 7 are specific to a BESS and involve a potential for a fire or an environmental release involving the battery or associated functions (e.g. the HVAC). Scenario 8 involves electrical hazards and is typical to any major electrical infrastructure.

The consequences level assigned to the *Moderate* risk scenarios is associated with major injury or major environmental damage, in line with the focus of this PHA. Further details on the consequence rating for battery fire scenarios (No. 1 and 5-7) are provided in Appendix 3, and summarised below:

- The maximum concentration from a credible Li-ion battery fire (DNV, Ref 11) is not expected to be hazardous at the nearest resident provided that the batteries are designed such that a fire one battery does not propagate to other batteries (see Assumption 1 in Appendix 3). The same applies also to within the BESS - however, smoke is unpredictable and therefore self-contained breathing apparatus may be required if the wind is driving the smoke plume in the direction of emergency services.
- If, despite all safety in design principles, the fire was able to spread to further parts of the BESS, including to general construction materials which would generate toxic and acrid smoke, the knowledge gained by NSWFR and RFS from general building fires, including the rate of formation and dispersion of toxic combustion products from plastics, can be used (DNV, Ref 11). In such case, evacuation of the people nearby would be prudent, e.g. if the wind is driving the smoke plume in the direction of the residential dwelling.

The analysis presented above found that the likelihoods of all events can be managed to *Seldom, Remote* or *Unlikely* levels as per the definition in the matrix in Appendix 2. This should be verified in detailed design.

6 CONCLUSION AND RECOMMENDATIONS

6.1 OVERVIEW RESULTS AND ALARP CONDITION

The following factors must coincide to give rise to an exposure to a dangerous dose – the combination of the likelihood of the hazardous event and the probability of the last two dot points give rise to the risk of the event:

- Failure must occur causing a release or hazardous material or energy.

  There are several possible causes of failure, with the primary ones being failure to manage operation conditions, thermal runaway within a battery, failure to maintain the integrity of plant and equipment and damage to the equipment by external impact

- Depending on the release conditions, including the energy generated, the results may be localised within the battery rack, enclosure, switchgear or transformer, or it may extend past the local area causing more severe consequences

- Finally, for there to be an exposure, people, property or the environment must be present within the harmful range, i.e. the consequence distance of the harmful dose. How close the sensitive receptors are would determine whether any injuries, fatalities, pollution or damage results from the event.

The findings in this PHA are that the Project is not considered *potentially hazardous'* in accordance with the Department of Planning, Industry and Environment's definition, based on the storage and transport of hazardous material. Potential hazards from the Project are predominantly associated with the risk of a battery fire and of environmental pollution from a spill of oil or other pollutant from the Project, with other risks associated with electricity and standard construction related hazards.

The main hazards identified for the BESS are associated with a fire event affecting the batteries:

- The only potential impact from the Project to society outside of the Project Area is associated with a failure to manage propagation from a fire or explosion in one battery enclosure or transformer. BESS and transformer fires technically have the potential to propagate to areas outside of the battery enclosure and even to initiate a bushfire in the surrounding grass land if the risk of propagation is not managed. Toxic combustion products may evolve and could technically affect the nearby resident and emergency services personnel.

Provided that the batteries and the battery enclosures are designed and tested to withstand a credible fire scenario, and that sufficient separation is established within the BESS and between the BESS and the transformers and the surrounding grassland (including through an APZ, Ref 4), the risk of propagation can be managed ALARP.

Provided emergency response is implemented, including ensuring the risk to firefighting personnel is minimised (e.g. through the use of SCBA equipment, to be determined in detailed design), the risk to fire fighters can be managed ALARP.

If the fire was to spread to further parts of the BESS, including to general construction materials which generate toxic and acrid smoke, the knowledge gained by NSWFR and RFS from general building fires, including the rate of formation and dispersion of toxic combustion products from plastics, can be used (Ref 16). In such case, evacuation of the resident would be prudent, if the wind is driving the smoke plume in the direction of the residential dwelling. Neoen internal rule, based on other installations, is to provide a typical exclusion zone of 25 metre radius during a fire and evacuate a 250 metre radius during fire to account for the toxic smoke – this should be integrated into emergency response plan and communicated with emergency services. This requirement should be integrated into the emergency response plan for the Project, and communicated with emergency services. As such, the risk to society outside of the Project Area can be managed ALARP.

Although the PHA found that the need for external firefighting is unlikely, these conclusions should be discussed in consultation with NSW Rural Fire Service, Fire Rescue NSW and the DPIE.

Environmental pollution may occur, subject to detailed design, in the event of a failure to contain pollutants at the BESS or the substation:

- If a spill is not contained, there is a potential to affect adjacent land use.
- Measures to prevent a loss of containment from occurring, and for secondary containment, would be addressed in the detailed design phase for the BESS.
- Provided that the likelihood of a serious loss of containment event associated with this BESS are eliminated or designed to *Unlikely* or *Rare* levels (refer to the risk matrix in Appendix 2), the risk of environmental pollution can be managed to ALARP principles.

The analysis conducted as part of this PHA has found that the Project can be managed in accordance with the established risk criteria and in accordance with ALARP principles. Most hazards can be prevented by employing a combination of common measures, including following all applicable AS/NZ Standards, separation distances and setbacks, physical protection and control systems measures.

Mitigation measures are available, to reduce the severity of the hazards should they occur, including specific secondary containment, e.g. as built into the battery enclosure, and the BESS operational training. Provided the commitment for safety and environmental protection, and the recommendations in this PHA are adhered to, the risk profile for the BESS is consistently within the *Low* or *Moderate* risk ranking and ALARP can be established.

An overview of the risks associated with the BESS is provided in Table 10. This table also includes a brief summary of the ALARP condition – more details are provided under each hazardous event in Section 5.2.

BESS element and hazard	Finding	Risk and ALARP evaluation
Risk of major injury or environmental damage during construction	Construction risks are well known and understood. Existing Codes and Standards are established within the industry to manage construction risk. The risk arises from typical construction activities and the impact of the BESS on the risk is minimal.	MODERATE RISK: Can be managed to ALARP principles provided general construction Codes and Standards are adhered to.
Fire and pollution at the BESS as initiated by an internal or external event during commissioning or operation	Codes and Standards provide clear guidance as to how to prevent and protect against a fault in a battery escalating into a fire at a battery enclosure. Key controls include continuous BMS with automatic shut-down; battery fire proven not to propagate, in accordance with international methodologies (e.g. UL9540A); and establishment of minimum separation distances within the BESS and between the BESS and external boundaries. As a precautionary approach, a fire water tank would be installed at the boundary, for firefighting in the surrounding grassland. The need for external firefighting is unlikely, but will need to be reviewed in the detailed design phase, in consultation with RFS, NSWFR and DPIE. On-site hazardous effects are possible in case of a battery fire, and the risk associated with generation of toxic gas and toxic combustion products should be minimised in design; safe evacuation from the facility should be established; and the toxicity of such vapours should be considered in emergency response (e.g. by using SCBA gear if nearby and through evacuation of the local resident). Environmental pollution may be possible, subject to detailed design, from a failure to pollutants, and the need for secondary containment of a spill should be considered in detailed design.	MODERATE RISK: Can be managed to ALARP principles provided the battery and the enclosure is designed such that a credible fire will not propagate; the requirements in Codes and Standards are adhered to; and the minimum separation distances within the BESS and an appropriate APZ are established and maintained
Fire and pollution at the electrical infrastructure during commissioning or operation of the BESS	Provided the requirements under the Australian Standards (e.g. AS 2067 & AS 1940) and Neoen's management practices for Low, Medium and High Voltage systems are adhered to, the risk associated with fire and with environmental pollution at the electrical infrastructure associated the BESS, the substation and the transmission line and landing gantries can be managed.	MODERATE RISK: Conforms to ALARP provided the requirements in Codes and Standards & Neoen's management practices are adhered to

Table 10: Overview of risks assessment results and ALARP conditions

6.2 Recommendations

The following recommendations are made as part of this PHA:

1. The separation distance between infrastructure within the BESS is to be determined in accordance with the applicable Codes and Standards and with manufacturer's recommendations so that the preferred strategy of allowing a fire in one battery enclosure, inverter or transformer to burn without the risk of propagating to other infrastructure can be maintained without the need for external firefighting

2. The separation distances between infrastructure within the BESS are to be determined in accordance with Codes and Standards and with manufacturer's recommendations to allow safe escape from the BESS in case of a fire

3. All relevant requirements in the Australian Standard AS5139 (2019) are to be adhered to at the BESS. The BESS should also adhere to the requirements in international Standards applicable to major BESS, for example, to the US National Fire Protection Association Code NFPA855 (2020)

4. Procurement of a battery system that is certified to the requirements of an internationally recognised test method such as that by the Underwriters Limited UL9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, proving that a credible fire within a battery rack or enclosure will not propagate to other battery enclosures

5. Detailed firefighting response and need for fire water containment should be assessed and reported, e.g. in the format of a Fire Safety Study, post development approval, for review by the DPIE, NSW Fire Rescue and the Rural Fire Service

6. Measures to prevent a leak from occurring at the BESS and the transformers, and for containing a spill of pollutant should it occur, should be addressed in the detailed design phase for the Project

7. The specific risk associated with the location of the resident close to the BESS must be integrated into the fire safety of this Site, including evacuation plan in case of a major incident associated with the BESS. Neoen's internal rule, based on other installations, is to provide a typical exclusion zone of 25 m radius during a fire and evacuate a 250 m radius during fire to account for the toxic smoke – such clear advice should be integrated into the emergency response plan and communicated with the emergency services.

8. The register of commitment (Appendix 1 of the PHA) is integrated into the Project. This includes integration of 26 individual commitments, including for the design, installation and maintenance of the BESS; automatic shutdown system on exceedance of safe limits; installation of measures to cope with build-up of gases inside the enclosure; potentially fire protection inside the battery enclosures (subject to manufacturer's recommendations); design of the BESS and transformers such that the risk of pollution from a release is reduced to ALARP; installation of protective barriers if required by Codes and Standards; and application of a rigorous and formal management of change process for the Project and operational phases of the BESS, substation and the transmission line, including detailed hazard identification and risk assessment processes.

7 REFERENCES

1 Environmental Impact Statement*, Great Western Battery,* Aecom Australia Pty Ltd, December 2021

2 NSW Department of Planning and Infrastructure*, Hazardous Industry Planning Advisory Paper No 6, Hazard analysis,* 2011

3 Department of Planning and Infrastructure, *Multi-level Risk Assessment*, 2011

4 Short L, *Bushfire Assessment Great Western Battery*, Blackash Pty Ltd, December 2021

5 NSW Department of Planning and Infrastructure*, Hazardous Industry Planning Advisory Paper No 4, Risk criteria for land use planning,* 2011

6 Geoscience earthquake map, https://geoscience-au.maps.arcgis.com/home/webmap/viewer.html?webmap=490e068f37494dbc997a2f7e55d4cc4d downloaded 19 October 2021

7 Bureau of meteorology lightning flash density map, Australian Climate Averages - Thunder and lightning (bom.gov.au) downloaded 19 October 2021

8 NSW Government, State Environmental Planning Policy No 33 - *Hazardous and Offensive Development,* 1992

9 Hazardous and Offensive Development Application Guidelines *Applying SEPP33*, State of New South Wales through the Department of Planning, 2011

10 AS/NZS 5139:2019, *Electrical installations — Safety of battery systems for use with power conversion equipment*

11 AS / IEC 62619 Safety requirements for secondary lithium cells and batteries, for use in industrial applications

12 NFPA 855-2020 *Standard for the Installation of Stationary Energy Storage Systems*, (US) National Fire Protection Association, 2002

13 *Australian Dangerous Goods Code, 2020*, Edition 7.7, National Transport Commission, 2020

14 www.ilo.org/dyn/icsc/showcard.display?p_card_id=0270&p_version=2&p_lang=en

Appendix 1

Register of Commitments

Preliminary Hazard Analysis for the Great Western Battery, NSW

Appendix 1 – Register of commitments

This PHA has been developed on the bases that the following commitments by Neoen will be integrated into the BESS Project:

Type of safeguard	Register of commitments: Preventative and protective safeguards
Prevention and detection	1. All equipment and systems would be designed and tested to comply with the relevant Australian Standards and Codes and with at least one major International Code (e.g. NFPA 855) 2. Equipment would be procured from reliable and internationally recognised supplier with proven track-record 3. Equipment would be installed by Contractors following Neoen's internal requirements for Contractor management, PTW, control of modifications and other established systems 4. All installation and maintenance would be performed by trained persons using JSAs and/or SWMS 5. The BESS would follow rigorous Management of Change process throughout its life. This will include management of protective systems including trips and alarms within the BMS and/or other control system 6. Induction of all personnel would occur prior to works commencing on Site 7. Electrical isolation protocol would be in place during construction and installation as well as during commissioning and operation of the electrical equipment forming part of this Project 8. PTW, including hot work permits would be in place during construction and installation as well as during commissioning and operation of the equipment forming part of this Project 9. Preventative maintenance practices would be put in place, including maintenance schedules and calibration of equipment, instruments and sensors, APZ, vegetation control within the Site, and Non-Destructive Testing (**NDT**) as recommended by manufacturer(s) 10. Impact barriers would be installed to prevent damage of infrastructure and equipment from vehicles and heavy machinery including during construction 11. Warning signs would be installed as per Code and Standards requirements, including DG signage and High / Medium voltage warnings (including arc flash) 12. Earthing of electrical equipment would be established

Type of safeguard	Register of commitments: Preventative and protective safeguards
	13. Need for lightning protection would be determined in accordance with Neoen requirements and Australian Codes at the detailed design stage 14. The BESS would be housed within a secure fenced area. On-site security protocols developed 15. Battery Management System (BMS) would be installed, including voltage control, charge/discharge current control and temperature monitoring to battery manufacturer's specifications. Automatic safety shut-down functions would be initiated in case of safe limits exceeded 16. Secondary detection may be installed in the enclosure, to manufacturer's recommendations (e.g. smoke/heat) so that, if there is a fire, smoke or excessive temperature the battery module would automatically isolate and shut down), with information transferred to the control room – the details will be defined in the detailed design of the Project 17. Alarms would be available to provide hazard warning on operations upset conditions, and fault conditions would be transmitted to permanently staffed control room located remotely 18. The batteries would be housed within dedicated enclosures. Personnel entry during a hazardous event such as a run-away would be prevented (e.g. illuminated warning signs for containerised solution) 19. BESS and transformer enclosure venting would be achieved as per manufacturer's recommendations, to ensure concentrations inside the enclosures do not exceed requirements in Codes and Standards 20. Escape from the BESS and substation would be assured in accordance with Code requirement 21. Explosion venting and venting of toxic or flammable gases, would be achieved as per Codes and Standards and in accordance with manufacturer's instructions. This includes both BESS enclosures and transformers 22. Fire water to combat bush / grass fire would be achieved in accordance with the requirements in the bushfire risk assessment (Ref 4) 23. Any need for fire suppressant at the BESS would be determined during detailed design and in consultation with NSWFR and RFS 24. The risk of seismic activity, dust storm and severe winds would to be integrated into the design for this BESS, through the application of the relevant Australian Standards 25. Separation distances would be established between infrastructure at the BESS, to minimise risk of propagation of a fire event in accordance with Codes and Standards and manufacturer's recommendations 26. APZ would be established in accordance with the Bushfire Assessment (Ref 4)

Appendix 2

Risk Matrix

Preliminary Hazard Analysis for the Great Western Battery, NSW

Appendix 2 – Risk assessment risk matrix

Likelihood			Consequence				
		Frequency (per year)	**Notable event**	**Medium**	**Serious**	**Major**	**Catastrophic**
			No physical injury / work stress or environmental consequences	Medical treatment / First aid injury or environmental clean up	Serious injury - LTI or serious environmental damage	Permanent disability or major environmental damage	Fatal injury, existential threat, or environmental destruction
Likely	Event can reasonably be expected to occur a few times of the expected lifetime	0.5 - 1 or more	Moderate	High	Very High	Very High	Very High
Occasional	Conditions may allow the consequences to occur at the facility during its lifetime	0.5 - 0.1	Moderate	High	High	Very High	Very High
Seldom	Exceptional circumstances may allow consequences to occur during the facility's lifetime	0.1 - 0.01	Low	Moderate	High	High	Very High
Unlikely	Reasonable to expect it will not occur in this facility. Has occurred several times in similar industry	1×10^{-4} - 0.01	Low	Low	Moderate	High	High
Remote	Has occurred once or twice within industry	1×10^{-4} - 1×10^{-6}	Low	Low	Low	Moderate	High
Rare	Rare or unheard of	$< 1 \times 10^{-6}$	Low	Low	Low	Moderate	Moderate

CRITERIA - GROUPED BY PRIORITY AND ACTION	
Risk rating	Action
LOW	Risk considered acceptable
MODERATE	The proposed task or process can proceed provided that: - the risk level has been reduced as low as reasonably practicable using the hierarchy of controls - The risk assessment has been reviewed and approved - All administrative controls are in place
HIGH	The proposed activity can only proceed provided that: - the risk level has been reduced as low as reasonably practicable using the hierarchy of controls - The risk controls must include those identified in legislation, AS/NZ Standards, Code of Practice - The risk assessment has been reviewed and approved - All administrative controls are in place The effectiveness of the implemented control measures must be reviewed and documented
VERY HIGH	The proposed task or process activity must not proceed. Steps must be taken to lower the risk level to as low as reasonably practicable using the hierarchy of controls

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Appendix 3

Assumptions and justification

Preliminary Hazard Analysis for the Great Western Battery, NSW

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Appendix 3 – Assumptions and justification

Assumption and Justification No. 1: Generation of hazardous energies and gases in a battery fire

Assumption:

- A fire event within a battery would generate heat, deflagration overpressure, and toxic gas and combustion products
- Depending on the design and manufacture of battery, this may lead to projectiles or cell explosions in case of failure to vent off-gases
- Toxic gas and combustion products formed during a fire event may contain decomposition products which can vaporise and be vented from cells, and the vented electrolyte may be flammable, and may ignite
- BESS cell vent gas composition would depend upon a number of factors, including cell composition, cell state of charge, and the cause of cell venting
- Depending on battery manufacture, vent gases may include volatile organic compounds (VOCs), hydrogen gas, carbon dioxide, carbon monoxide, soot, and particulates containing oxides of nickel, aluminium, lithium, copper, and cobalt, and phosphorus pentafluoride (PF5), phosphoryl fluoride (POF3), and hydrogen fluoride (HF) vapours
- Vented gases may irritate the eyes, skin, and throat. Cell vent gases are typically hot and upon exit from a cell, can exceed 600°C
- The maximum concentration from a credible Li-ion battery fire is not expected to be hazardous at the nearest resident and is expected to be below ERPG1 level. The same applies also within the BESS. However, smoke is unpredictable and therefore self-contained breathing apparatus may be required if the wind is driving the smoke plume in the direction of emergency services.
- If the fire was to spread to further parts of the BESS, including to general construction materials which generate toxic and acrid smoke, the knowledge gained by NSWFR and RFS from general building fires, including the rate of formation and dispersion of toxic combustion products from plastics can be used (Ref **Error! Bookmark not defined.**). In such case, evacuation of the resident w ould be prudent, if the wind is driving the smoke plume in the direction of the residential dwelling.

Justification and impact/s of assumption/s:

- Latest available data by the NFPA and the Fire Protection Research Foundation (an affiliate of NFPA)
- Review of research report into Li-ion battery safety in the programs conducted by DNV; the large-scale battery tests conducted by FM Global; and the research by the Victoria University in conjunction with the Maritime Division, Defence Science & Technology Group
- A *worst case scenario* was defined in the research report by DNV (Ref **Error! Bookmark not defined.**) a nd involved 1.5 battery modules[3], with the presumption that the system should demonstrate adequate separations, cascading protections, and suppression systems to limit failure to a single cell or at least a single module (from Ref **Error! Bookmark not defined.**). The DNV analysis of the c oncentration of toxic combustion products that may be generated from the Li-ion battery fire (i.e. HCl, HF, HCN, CO) showed that the maximum concentration would be low even close to the battery. In the case of the Project the concentration would not be sufficient to reach any hazardous levels at the nearest resident

[3] DNV tested battery modules ranging from 7.5kWh to 55kWh.

- The DNV research report found that (Ref **Error! Bookmark not defined.**) toxic and acrid smoke from BESS fires is similar to normal building fires, including mattresses, and that the knowledge gained by emergency services from general building fires, including the rate of formation and dispersion of toxic combustion products from plastics can be used.

Incidents Affected:

- Battery fire, scenarios 1, 5 and 7

Reference/s:

- Blum A, Long T, *Hazard Assessment of Lithium Ion BESS Energy Storage Systems*, Fire Protection Research Foundation, February 2016
- NFPA 855-2020 *Standard for the Installation of Stationary Energy Storage Systems*, (US) National Fire Protection Association, 2002
- Hill D, Warner N, Kovacs W*, Considerations for ESS Fire Safety, Consolidated Edison and NYSERDA New York, NY*, DCN: OAPUS301WIKO(PP151894), Det Norske Veritas (USA) Inc. (DNV GL), Rev. 4, 9 February 2017

Assumption and Justification No. 2: Potential for propagation

Assumption:

- If the battery cells on fire are located close to other batteries or combustible material within the enclosure or if the enclosure is located close to other infrastructure, there is a potential for escalation to other battery racks, the enclosure, to adjacent infrastructure and, potentially, to the entire BESS
- The result would be increasing generation of heat and toxic gases and combustion products
- In the case of more than one battery enclosure being involved in a fire the rate of failure, and hence rate of evolving heat and toxic combustion products, would be randomised and staggered, limiting the heat release and toxic release rate of the fire
- If the BESS is located close to the surrounding environment, including to neighbouring bushland, the fire may propagate to this, potentially initiating fire in the surrounding area
- The heat and toxic gases and combustion products generated by the fire involving only one battery/battery enclosure are unlikely to cause any significant hazardous effects off-Site.
- If the fire continues to spread to other enclosures then further hazardous effects may occur, potentially affecting land use outside of the Project Area boundary.
- Risk of propagation of a fire between battery enclosures is eliminated or at least minimised provided that the battery enclosure has been designed and tested in accordance UL9540S and the BESS layout adheres to Australian and relevant international Codes and standards (e.g. NFPA855)
- APZ determined and maintained as per Australian Code minimises risk of propagation to and from the surrounding bush

Justification and impact/s of assumption/s:

- NFPA 1-2021 *Fire Code*
- NFPA 855-2020 *Standard for the Installation of Stationary Energy Storage Systems*
- Test methods (UL and IEC, refer References below) developed as large-scale fire tests for battery energy storage systems. These methods provide data to validate BESS design and installations
- UL9540 is referenced in NFPA 855, ICC IFC and NFPA 1 as the large scale fire test to use if required per these codes
- UL 9540A includes: *Cell level test*: whether the battery cell can exhibit thermal runaway, thermal runaway characteristics and the gas composition and properties. *Module level test*: propensity for propagation of thermal runaway, heat and gas release rates (severity/duration) and flaming/deflagration hazards. *Unit level test*: fire spread, heat and gas release rates (severity/duration), deflagration hazards and re-ignition hazards. *Installation level test*: effectiveness of fire protection system(s), heat and gas release rates (severity/duration), deflagration hazards and re-ignition hazards.
- Detailed comparison between UL test and IEC test shows similar outcomes between test methods.

Incidents Affected:

- Battery fire, scenarios 1, 5 and 7

Reference/s:

- 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*
- IEC 63056 *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems (recently published)*

- UL 9540 *Standard for Energy Storage Systems and Equipment, for the basis for documenting and validating the safety of an ESS as an entire system or product*
- UL 9540A *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, for a test method for evaluating thermal runaway propagation in battery ESS*
- Florence L, *UL and IEC Standards: A Comparison in the Approach to Safety of Energy Storage Systems*
- Hill D, Warner N, Kovacs W, *Considerations for ESS Fire Safety*, Consolidated Edison and NYSERDA New York, NY, DCN: OAPUS301WIKO(PP151894), Det Norske Veritas (USA) Inc. (DNV GL), Rev. 4, 9 February 2017
- Ditch B, Zeng D, *Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems*, FM Global, Project ID RW000029, June 2019
- Mohammadmahdi G, Novozhilov V, Burch I, Suendermann B et al, *A Review of Lithium-Ion Battery Fire Suppression*, Institute of Sustainable Industries and Liveable Cities, Victoria University, Melbourne and the Maritime Division, Defence Science & Technology Group, : 1 October 2020

Assumption and Justification No. 3: Fire suppression and fire fighting

Subject: Likelihood and risk

Assumption:

- APZ established and maintained
- Ground vegetation maintained to APZ levels
- Fire water would be available for combatting grass fires
- The need for further active firefighting measures within the BESS will be determined during detailed design and in consultation with DPIE, NSWFR and RFS

Justification and impact/s of assumption/s:

- Australian and International Codes and Standard do not prescribe firefighting measures for BESSs
- Battery manufacturer's recommendations for fire suppression would be provided in detailed design
- A Fire Safety Study, developed in consultation with the NSWFR, RFS and the DPIE, would determine any need for further fire suppression or fire fighting

Incidents Affected:

- Battery fire, scenarios 1 and 5-7

Reference/s:

- HIPAP2 *Fire safety study*, DPIE 2011
- NFPA 855-2020 *Standard for the Installation of Stationary Energy Storage Systems*
- ASC/ESC 5000: *The Australian Battery Guide by the Energy Storage Council*
- AS 2419.1 Fire hydrant installations - System design, installation and commissioning
- RFS' *Planning for Bushfire Protection*
- AS3959 *Construction of buildings in bushfire prone areas*