Preliminary Hazard Analysis

Wallaby Creek Wind Farm

ERM International Pty Ltd
Document No. RCE-23238_ERMWallaby_BESSPHA_Final_3Jun25_Rev(3)
Date 3/06/2025

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Quality Management

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Executive Summary

Background

Environmental Resources Management Australia Pty Ltd (ERM) have been engaged by ACCIONA Energy Australia Global Pty Ltd (ACCIONA Energia) to prepare an Environmental Impact Statement (EIS) for the Wallaby Creek Wind Farm to be located on Newell Highway 10 km South of Narromine, in the Narromine Shire, NSW. The wind farm will include a Battery Energy Storage System (BESS) with a storage capacity of up to 400 MWh. Due to the presence of the BESS, the Secretary's Environmental Assessment Requirements (SEARs) requires the preparation of a Preliminary Hazard Analysis (PHA) in accordance with the Hazardous Industry Planning Advisory Papers (HIPAP) No. 4 and No. 6 (Ref. [1] and [2]) as part of the EIS. The project will involve construction of up to 38 wind turbine generators and supporting infrastructure. It has an operational lifespan of around 30 years prior to decommissioning unless it is re-powered.

Riskcon Engineering Pty Ltd (Riskcon) has been engaged to assist with preparing the PHA for the EIS.

Conclusions

A hazard identification table was developed for the BESS at the Wallaby Creek Wind Farm to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with the potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. A review of the incidents carried forward for further analysis indicates that there were no observed offsite impacts.

Hence, based on the analysis presented in this report, the project would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

Recommendations

The following recommendations have been made as a result of the analysis:

- BESS must be tested in accordance with UL9540A.
- Testing in accordance with the guidelines of UL9540 shall be undertaken to demonstrate clearances required to prevent propagation of fires between separated units.
- BESS to be installed in accordance with manufacturer and UL9540A report recommended clearances between units, based on testing.
- BESS to be installed with fire protection systems specified by the manufacturer and UL9540A report.
- Before construction, detailed design to validate the system can be installed in the project area whilst meeting the UL9540A recommended clearances.
- UL testing information shall be made available to the certifying authority. It is noted that a confidentiality agreement may be required.
- The vent covers of the BESS shall be constructed of non-combustible material.
- The vents shall not be located above battery packs within the BESS container.

- Confirm that all transformers are bunded to contain oil releases. Transformers may be self-bunded on a skid, otherwise they will require a dedicated concrete bund.

Table of Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
AC	Alternating Current
ADG	Australian Dangerous Goods Code
AS	Australian Standard
BESS	Battery Energy Storage System
DC	Direct Current
DGs	Dangerous Goods
DPHI	Department of Planning, Housing, and Infrastructure
ELF	Extra Low Frequency
EMF	Electric and Magnetic Field
HF	Hydrogen Fluoride
HIPAP	Hazardous Industry Planning Advisory Paper
HVAC	Heating Ventilation and Air Conditioning
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDLH	Immediately Dangerous to Life and Health
LFP	LiFePO4 (Lithium Iron Phosphate)
MV	Medium Voltage
MVPS	Medium Voltage Power Station
NFPA	National Fire Protection Association
NMC	Nickel-Manganese-Cobalt
NSW	New South Wales
PHA	Preliminary Hazard Analysis
PO	Performance Outcome
PV	Photovoltaic
SEARs	Secretary’s Environmental Assessment Requirements
SEP	Surface Emissive Power
SOC	State of Charge
VBB	Victorian Big Battery

1.0 Introduction

1.1 Background

Environmental Resources Management Australia Pty Ltd (ERM) have been engaged by ACCIONA Energy Australia Global Pty Ltd (ACCIONA Energia) to prepare an Environmental Impact Statement (EIS) for the Wallaby Creek Wind Farm to be located on Newell Highway 10 km South of Narromine, in the Narromine Shire, NSW. The wind farm will include a Battery Energy Storage System (BESS) with a storage capacity of up to 400 MWh. Due to the presence of the BESS, the Secretary's Environmental Assessment Requirements (SEARs) requires the preparation of a Preliminary Hazard Analysis (PHA) in accordance with the Hazardous Industry Planning Advisory Papers (HIPAP) No. 4 and No. 6 (Ref. [1] and [2]) as part of the EIS. The project will involve construction of up to 38 wind turbine generators and supporting infrastructure. It has an operational lifespan of around 30 years prior to decommissioning unless it is re-powered.

Riskcon Engineering Pty Ltd (Riskcon) has been engaged to assist with preparing the PHA for the EIS.

1.2 Objectives

The key objectives of this PHA are to:

- Complete the PHA according to the HIPAP No. 6 – Hazard Analysis (Ref. [2]).
- Assess the PHA results using the criteria in HIPAP No. 4 – Risk Criteria for Land Use Planning (Ref. [1])
- Demonstrate compliance of the site with the relevant codes, standards and regulations (i.e. WHS Regulation, 2017 Ref. [3]).
- Consider recent standards and codes such as and not limited to FM Global DS 5-33, NFPA 855, AS 5193, IEC 62897, UL 9540, and UL9540A test reports when establishing separation distances.
- From here, using the estimated size of the BESS designated areas (ha, km2, m2) verify the areas can support the 200 MW capacity considering the required separation distances between the BESS modules, sub-units or enclosures, and on-site or off-site receptors.

1.3 Scope of Services

The scope of work is to complete a PHA study for the Wallaby BESS located at Wallaby Creek Wind Farm on the Newell Highway, Narromine Shire, NSW.

2.0 Methodology

2.1 Multi-Level Risk Assessment

The Multi-Level Risk Assessment approach (Ref. [4]) published by the NSW Department of Planning, Housing and Infrastructure, has been used as the basis for the study to determine the level of risk assessment required. The approach considered the development in context of its location, the quantity and type (i.e. hazardous nature) of Dangerous Goods (DGs) stored and used, and the project's technical and safety management control. The Multi-Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the project being studied.

There are three levels of risk assessment set out in Multi-Level Risk Assessment which may be appropriate for a PHA, as detailed in **Table 2-1**.

Table 2-1: Level of Assessment PHA

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

The Multi-Level Risk Assessment approach is schematically presented in **Figure 2-1**.

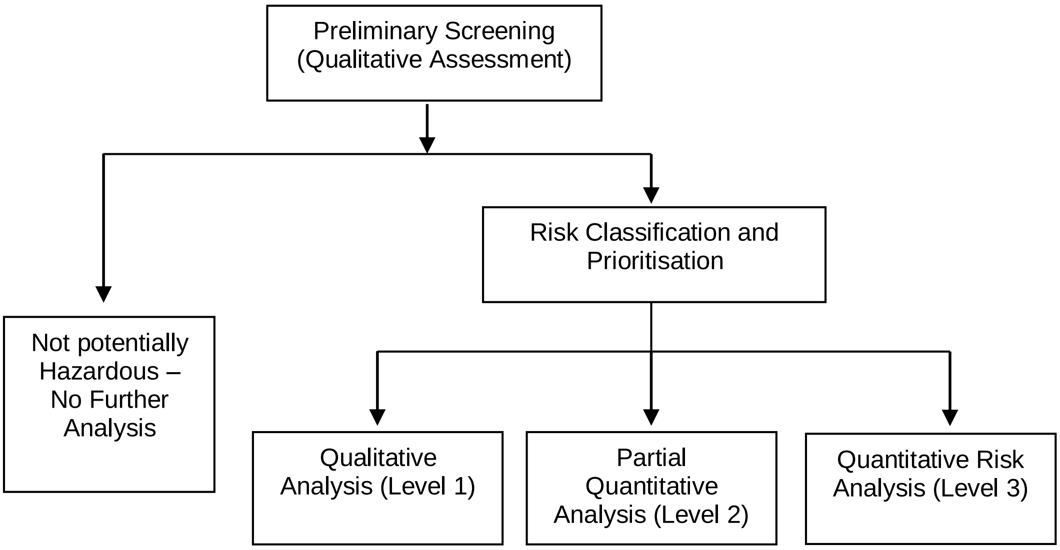


Figure 2-1: The Multi-Level Risk Assessment Approach

Based on the type of DGs to be used and handled at the proposed project, a **Level 1 Assessment** was selected for the Site. This approach provides a qualitative assessment of those DGs of lesser quantities and hazard, and a quantitative approach for the more hazardous materials to be used on-site.

2.2 Risk Assessment Study Approach

The methodology used for the PHA is as follows:

Hazard Analysis – A detailed hazard identification was conducted for the site facilities and operations. Where an incident was identified to have a potential off-site impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format recommended in HIPAP No. 6 (Ref. [2]).

Each postulated hazardous incident was assessed qualitatively, considering proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed. **Section 3.1** of this report provides details of values used to assist in selecting incidents required to be carried forward for further analysis.

Consequence Analysis – For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the consequence criteria listed in HIPAP No. 4 (Ref. [1]). The criteria selected for screening incidents is discussed in **Section 3.1**.

Where an incident was identified to result in an offsite impact, it was carried forward for frequency analysis. Where an incident was identified to not have an offsite impact, and a simple solution was evident (i.e. move the proposed equipment further away from the boundary), the solution was recommended, and no further analysis was performed.

Frequency Analysis – In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact was subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software). The results of the frequency analysis were then carried forward to the risk assessment and reduction stage for combination with the consequence analysis results.

Risk Assessment and Reduction – Where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident were combined to determine the risk and then compared to the risk criteria published in HIPAP No. 4 (Ref. [1]). Where the criteria were exceeded, a review of the major risk contributors was performed, and the risks reassessed incorporating the recommended risk reduction measures. Recommendations were then made regarding risk reduction measures.

Reporting – On completion of the study, a draft report was developed for review and comment. A final report was then developed, incorporating the comments received for submission to the regulatory authority.

3.0 Site Description

3.1 Site Location

The site is located on Newell Highway, 35km South-West of Dubbo in the middle of Narromine and Tomingley, NSW. The surrounding properties are agricultural, and the closest sensitive receptor is separated by close to 1 km from the BESS units as shown in **Figure 3-6**.

Figure 3-1 shows the regional location of the site. **Figure 3-2** shows the preliminary site layout of the full development. It was determined that the identified APA Gas line (medium pressure, 2.1 bar) which runs along the transmission line is 16.98 km away from the BESS location. Therefore, as the pipeline is not high pressure or in proximity to the project, it has not been considered in this report, please see **Appendix B** for the pipeline's location in relation to the BESS units.

Figure 3-1: Site Location

Figure 3-2: Preliminary Site Layout

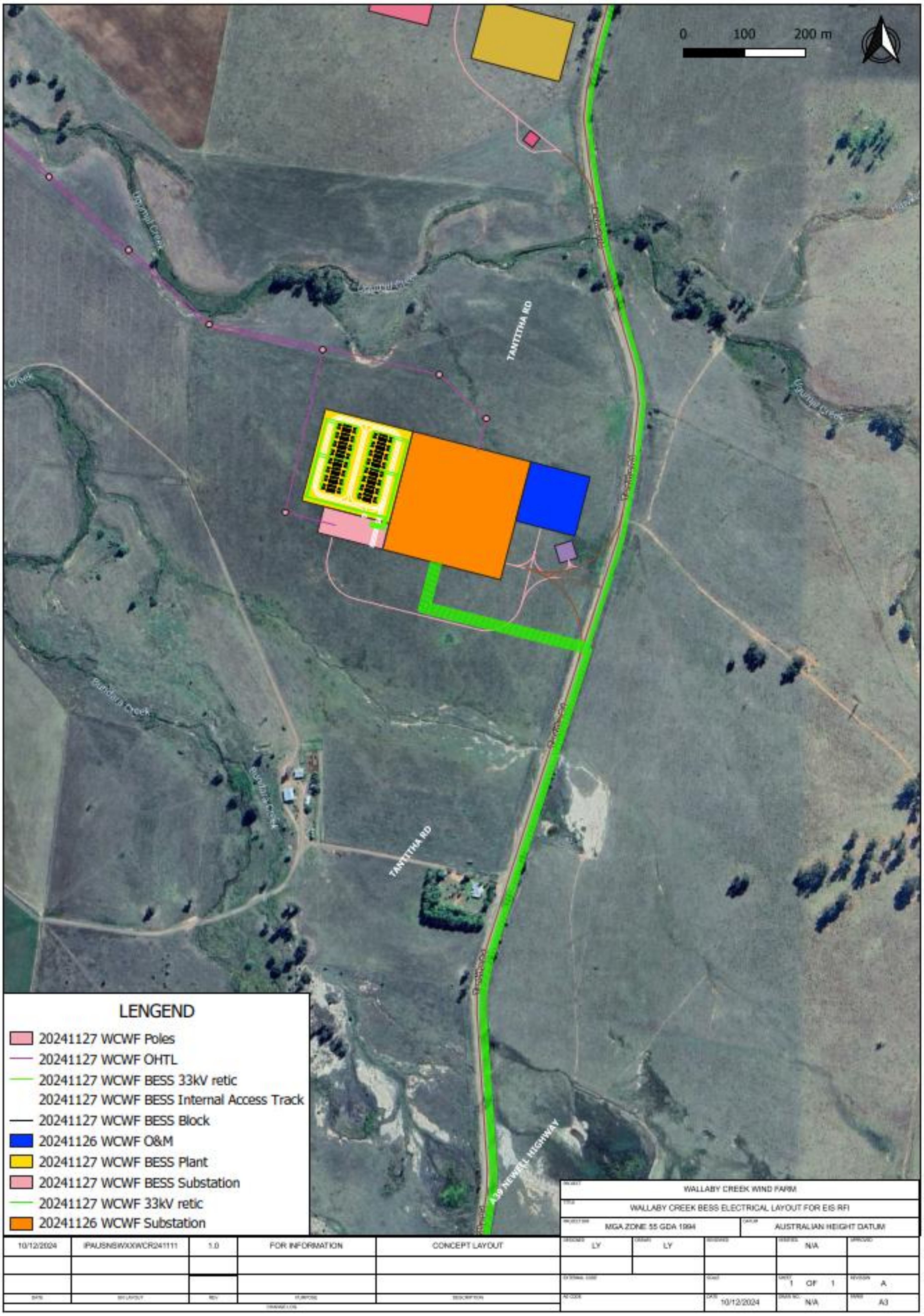
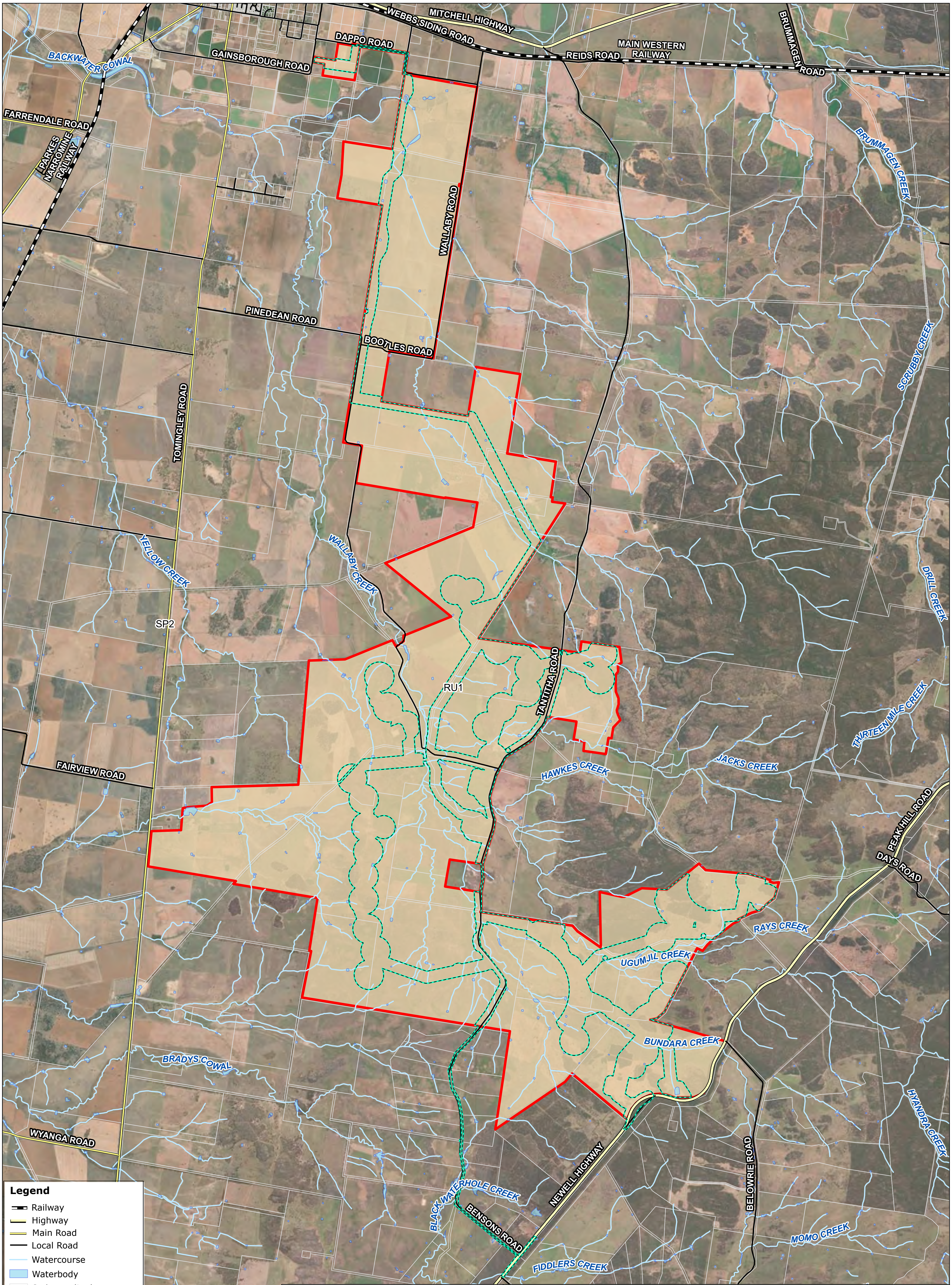


Figure 3-3: BESS Location

3.2 Adjacent Land Uses

The Dubbo Regional Local Environmental Plan 2022 indicates land use as Primary Production (RU1) to the North, South and West of the project; Environmental Management (C3) to the North East and South East of the project; and National Parks and Nature Reserves (C1) to the East of the project. The Land Zoning of the region is shown in **Figure 3-4** and a general site layout is shown in **Figure 3-5**.



Legend

- Railway
- Highway
- Main Road
- Local Road
- Watercourse
- Waterbody
- Cadastre (Lot)

Land Zoning

- RU1 - Primary Production
- SP2 - Infrastructure
- Project Area
- Development Footprint

Coordinate System: GDA 1994 MGA Zone 55
Date: 13/06/2025
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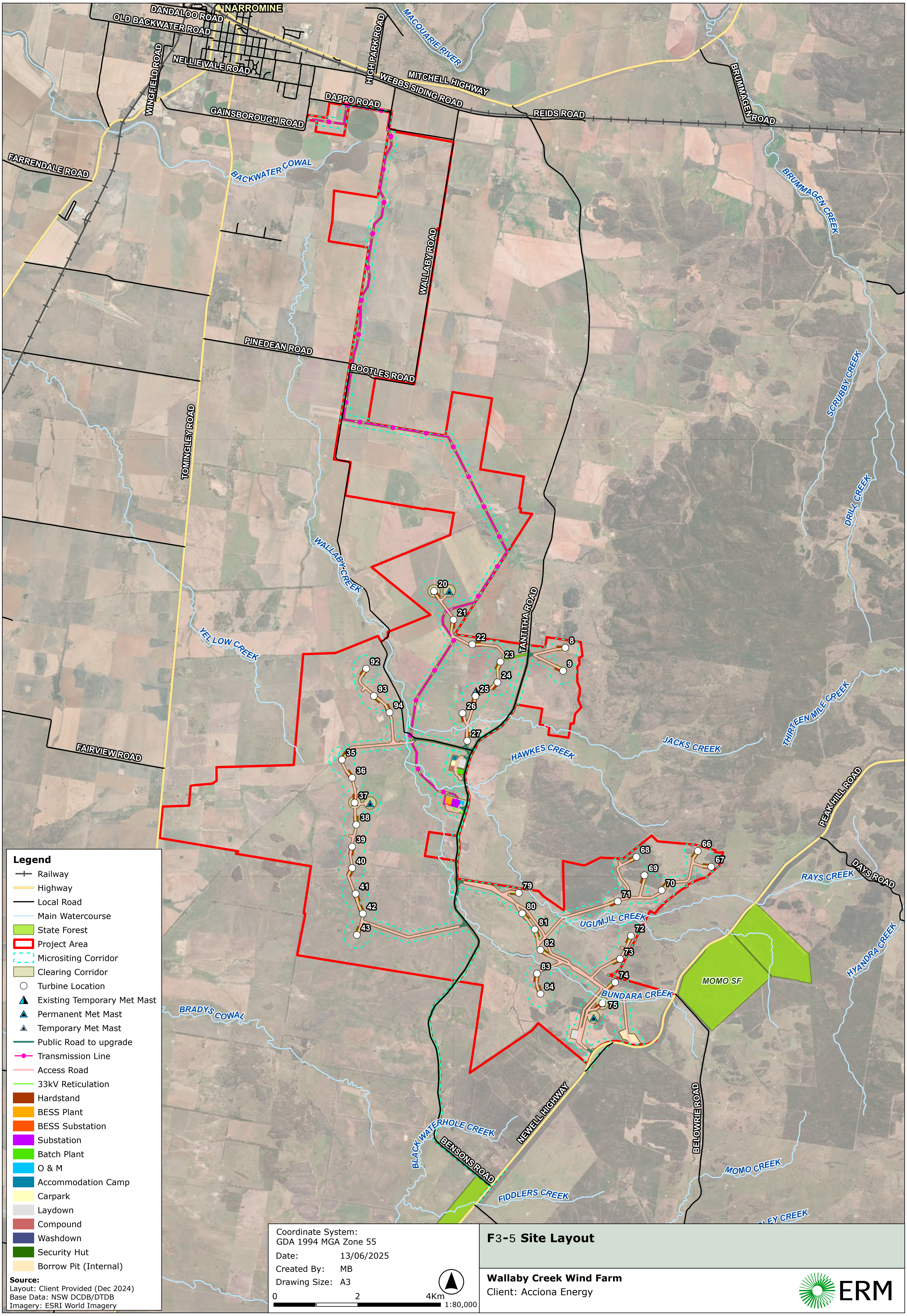
F3-4 Land Zoning

Wallaby Creek Wind Farm

Client: Acciona Energy

ERM



F3-5 Site Layout

Wallaby Creek Wind Farm
Client: Acciona Energy

ERM

3.3 Sensitive Receptors

Sensitive receptors refer to locations or areas that are vulnerable or responsive to changes in the surrounding environment which can include ecological, cultural, residential and agriculture bodies. The closest residential receptor is approximately 960m – 1 km away, as seen in **Figure 3-6**. There is occasional but not continuous road traffic along Tantitha Road which lies approximately 300m East of the BESS unit proposed location.

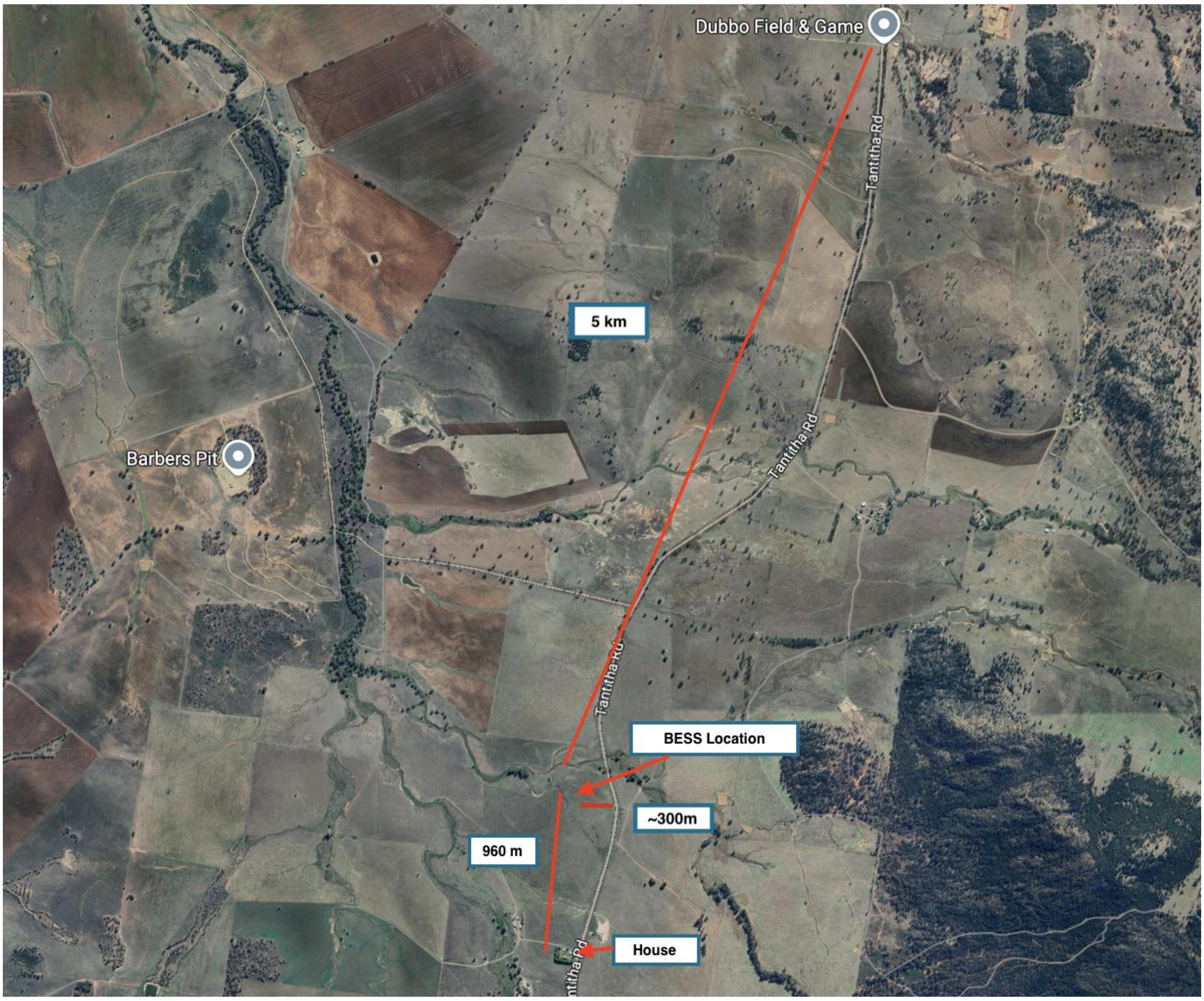


Figure 3-6: Location of sensitive receptors.

3.4 General Description

The project comprises of a BESS storage area with 200 MW/ 400 MWh storage and a 236 MW capacity wind farm. The exact battery units have not been selected yet; however each unit employs lithium iron phosphate (LFP) battery modules and is equipped with Heating Ventilation and Air Conditioning (HVAC) and a Battery Management System for operational control. The site is accessed via Tantitha Road via the Newell Highway at the southern end of the project. Alternatively, pending confirmation, a second access directly off the Newell Highway on the south-eastern corner of the project boundary. The exact battery units have not yet been chosen, however, the BYD Cube T28 has been used as an indicative. Each container measures 12192 × 2438 ×

2896 mm, with a total weight of approximately 28.6 tonnes and an IP54 rating. It is assumed that the BESS will have 1 x 220/33 kV 200 MVA HV transformer, 40 x 5 MVA BESS MV transformers.

The containers will conform to IEC 62619 and the site to AS/NZS 5139:2019 and the CFA Design Guidelines and Model Requirements for Renewable Energy Facilities v4 where relevant. This includes the installation of an active fire protection system within each container (**Appendix B**).

3.5 Detailed Description

The project is part of the Central-West Orana Renewable Energy Zone. Its purpose is to supply approximately 236 megawatts of electricity into the National Electricity Market (NEM), connecting up to 38 wind turbines to the Narromine grid. This contributes to the NSW government's NSW Electricity Infrastructure Roadmap.

The electricity can be stored in a 200 MW/ 400 MWh BESS, which can be used depending on electricity fluctuating demands, when energy demands peak. Lithium-ion battery storage is a fast-responding battery storage meeting this need. The project can deliver 200 MW power for 2 hours, allowing the storage of 400 MWh.

3.5.1 Medium Voltage Power Station (MVPS)

The MVPS house transformers and inverters which will be sited adjacent to the BESS units. There will normally be a MVPS installed for every two BESS units throughout the project area, which typically comprises:

1. 1x transformer
2. 1 x inverters

The inverters convert the Direct Current (DC) to Alternating Current (AC), while the transformers increase the voltage from Low Voltage to a Medium or High Voltage, as required for the electricity grid connection. MPVS are a compact, containerised product, with each unit measuring approximately 2.5 metres wide by 3 metres high, with a depth of 6 metres**. Figure 3-7** provides an example of a typical MVPS.

Figure 3-7: MVPS example

3.5.2 Battery Storage

The BESS will be located centrally within the project site, directly adjacent to the substation (see **Figure 3-3**). The BESS converts electrical energy into chemical energy and stores the energy internally. It may also provide additional network support such as Frequency Control Ancillary Services assisting with transmission network grid stability. A typical BESS is shown in **Figure 3-8.**

Figure 3-8: BESS exemplar arrangement

3.6 Quantities of Dangerous Goods

The classes and quantities of DGs are provided in **Table 3-1**. The type of transformer oil is not yet confirmed; hence it is conservatively assumed as a C1 combustible liquid for the purposes of this PHA. Transformer oil quantities are estimated based on 1,000 L per 5 MVA transformer and 50,000 L for each of the larger transformers (200 and 250 MVA). Additionally, the SEPP threshold of the individual classes has been provided for the purposes of the SEARs.

As the site exceeds the discharge capacity threshold of 30 MW the site is subject to the SEPP-RH and a PHA is required.

Table 3-1: Maximum Quantities of Dangerous Goods Stored

Area	Class	Description	Quantity	SEPP Threshold
BESS	9	Lithium Batteries	1,634 t	N/A
Transformer oil	C1	Combustible liquid	96 kL	N/A
Discharge Capacity	-	-	200 MW	30 MW

4.0 Hazard Identification

4.1 Introduction

A hazard identification table has been developed and is presented at **Appendix A**. This table has been developed following the recommended approach in Hazardous Industry Planning Advisory Paper No. 6, Hazard Analysis Guidelines (Ref. [2]). The Hazard Identification Table provides a summary of the potential hazards, consequences and safeguards at the site. The table has been used to identify the hazards for further assessment in this section of the study. Each hazard is identified in detail and no hazards have been eliminated from assessment by qualitative risk assessment prior to detailed hazard assessment in this section of the study.

In order to determine acceptable impact criteria for incidents that would not be considered for further analysis, due to limited impact offsite, the following approach has been applied:

- *Fire Impacts* - It is noted in HIPAP No. 4 (Ref. [1]) that a criterion is provided for the maximum permissible heat radiation at the site boundary (4.7 kW/m^2) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in a heat radiation less that at 4.7 kW/m^2, at the site boundary, are screened from further assessment.

  Those incidents exceeding 4.7 kW/m^2 at the site boundary are carried forward for further assessment (i.e. frequency and risk). This is a conservative approach, as HIPAP No. 4 (Ref. [1]) indicates that values of heat radiation of 4.7 kW/m^2 should not exceed 50 chances per million per year at sensitive land uses (e.g. residential).

- *Explosion* - It is noted in HIPAP No. 4 (Ref. [1]) that a criterion is provided for the maximum permissible explosion over pressure at the site boundary (7 kPa) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in an explosion overpressure less than 7 kPa, at the site boundary, are screened from further assessment. Those incidents exceeding 7 kPa, at the site boundary, are carried forward for further assessment (i.e. frequency and risk).

- *Toxicity* – Toxic by-products of combustion may be generated by a BESS fire; hence, toxicity has been assessed with criteria based upon the Emergency Response Planning Guidelines.

- *Property Damage and Accident Propagation* - It is noted in HIPAP No. 4 (Ref. [1]) that a criterion is provided for the maximum permissible heat radiation/explosion overpressure at the site boundary (23 kW/m^2 / 14 kPa) above which the risk of property damage and accident propagation to neighbouring sites must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk to incident propagation, for this study, incidents that result in a heat radiation less than 23 kW/m^2 and explosion over pressure less than 14 kPa, at the site boundary, are screened from further assessment. Those incidents exceeding 23 kW/m^2 at the site boundary are carried forward for further assessment with respect to incident propagation (i.e. frequency and risk).

- *Societal Risk* – HIPAP No. 4 (Ref. [1]) discusses the application of societal risk to populations surrounding the Project. It is noted that HIPAP No. 4 (Ref. [1]) indicates that where a development proposal involves a significant intensification of population, in the vicinity of such a project, the change in societal risk needs to be taken into account. In the case of the project, there is currently no significant intensification of population around the proposed site; hence, societal risk has not been considered in this assessment.

4.2 Properties of Dangerous Goods

The type of DGs and quantities stored and used at the site has been described in **Section 3**. **Table 4-1** provides a description of the DGs to be stored and handled at the site, including the Class and the hazardous material properties of the DG Class.

Table 4-1: Properties* of the Dangerous Goods and Materials Stored at the Site

Class	Hazardous Properties
9 – Miscellaneous DGs	Class 9 substances and articles (miscellaneous dangerous substances and articles) are substances and articles which, during transport present a danger not covered by other classes. Releases to the environment may cause damage to sensitive receptors within the environment. It is noted that the Class 9s stored within this project are lithium-ion batteries which may undergo thermal runaway (i.e. escalating reaction resulting in heat which ultimately leads to failure of the battery and a fire).
Combustible Liquids	Combustible liquids are typically long chain hydrocarbons with flash points exceeding 60.5^{o}C. Combustible liquids are difficult to ignite as the temperature of the liquid must be heated to above the flash point such that vapours are generated which can then ignite. This process requires either sustained heating or a high-energy ignition source.

* The Australian Code for the Transport of Dangerous Goods by Road and Rail (Ref. [5])

4.3 Hazard Identification

Based on the hazard identification table presented in **Appendix A**, the following hazardous scenarios have been developed:

- Li-ion battery fault, thermal runaway and fire.
- Victorian Big Battery fire review.
- Li-ion battery fire and toxic gas dispersion.
- Electrical equipment failure and fire.
- Transformer internal arcing, oil spill, ignition and bund fire.
- Transformer electrical surge protection failure and explosion
- Electromagnetic field impacts.
- Available Space for BESS Allocation Review.

Each identified scenario is discussed in further detail in the following sections.

4.4 Li-Ion Battery Fault, Thermal Runaway and Fire

Lithium ion (Li-ion) batteries are composed of a metallic anode and cathode which allows for electrons released from the anode to travel to the cathode where positively charged ions in the solute migrate to the cathode and are reduced. The flow of electrons provides the source of energy which is discharged from a battery and used for work. In a Li-ion battery, the lithium metal composites (a composite of lithium with other metals such as cobalt, manganese, nickel, or any combination of these metals) oxidises (loses an electron) becoming a positively charged ion in solution which migrates through the battery separator to the cathode. At the same time, the lost electron travels through the circuit to the cathode. The lithium ions in solution then recombine with the electron at the cathode forming lithium metal within the cathodic metal composite. This process is shown in **Figure 4-1**.

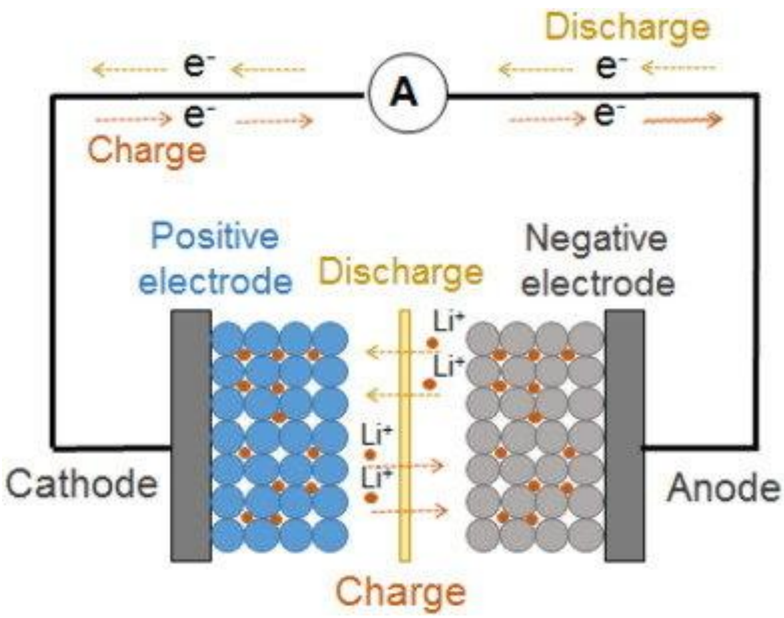


Figure 4-1:Cathode and Anode of a Battery (Source Research Gate)

Initial lithium batteries were designed around lithium metal (i.e. no composite structure) due to the high energy density yielded by the metal. However, when overcharging a battery, lithium ions can begin to plate on the anode in the form of lithium dendrites. Eventually, the dendrites pierce the separator within the battery resulting in a short of the battery which could result in heat, fire, or explosion of the battery. The technology evolved to move away from lithium metal to lithium ions (held within composite materials) which reduced the incidence of lithium dendrites forming resulting in an overall safer battery.

Despite the improvement in battery technology, there are several degradation mechanisms that are still present within the battery which can result in thermal runaway. These include:

- Chemical reduction of the electrolyte at the anode
- Thermal decomposition of the electrolyte
- Chemical reduction of the electrolyte at the cathode
- Thermal decomposition of the cathode and the anode
- Internal short circuit by charge effects

These effects arise primarily as a result of high discharge, overcharging, or water ingress into the battery which results in a host of biproducts being formed within the battery during charge and discharge cycles.

As a result, Li-ion batteries are equipped with several safety features to prevent the batteries from charging or discharging at voltages which result in battery degradation, leading to shorting of the battery and thermal runaway. Safety features generally include:

- Shut-down separator (for overheating)
- Tear-away tab (for internal pressure relief)

- Vent (pressure relief in case of severe outgassing)
- Thermal interrupt (overcurrent/overcharging/environmental exposure)

These features are designed to prevent overcharging or excessive discharge, pressurisation arising from heat generated at the anode or from battery contamination. Protection techniques for Li-ion batteries are standard; hence, the potential for thermal runaway to occur in normal operation is very low with the only exceptions being due to manufacturing faults or battery damage (i.e. battery cell is ruptured as this can short circuit the battery resulting in thermal runaway).

In terms of physical damage, the batteries are contained within in modules which are located within a fenced area; therefore, there is a low potential for damage to occur to the batteries which may initiate an incident.

A review of the batteries proposed to be used as part of this project indicates the battery chemistry is anticipated to be lithium iron phosphate (LiFePO4, or simply LFP) are one of the safest battery chemistries within the industry. When exposed to external heat the thermal rise of typical lithium-ion battery chemistries is 200-400 ^{o}C/min resulting thermal run away and fire which can then propagate to adjacent batteries escalating the incident to a full container fire. For LFP batteries, the thermal rise of the batteries at peak is 1.5^{o}C/min which results in a gradual temperature rise and does not result in fire and thus avoiding incident propagation to other batteries. The thermal rise of various battery chemistries is provided in **Figure 4-2** with a zoomed in temperature rise for LFP provided in the top right of **Figure 4-2**. The stability of the batteries is due to the cathode which does not release oxygen therefore preventing violent redox reactions resulting in rapid temperature rise as the oxygen oxides the electrolyte.

Additional testing for shock and damage to batteries (i.e. nail puncture test) has been shown that LFP batteries when punctured through membranes which typically results in a shorting of the battery does not result in ignition of the battery demonstrating that the battery chemistry is protected against shock damage.

If LFP chemistries do ignite by artificial means, the combustion by products release carbon dioxide which reduces the oxygen concentration within a confined space reducing the combustion rate. Finally, the containers are fitted with fire suppression systems which will activate to suppress and control a fire preventing escalation to other battery units (**Appendix B**).

NMC batteries (nickel-manganese-cobalt) are also considered viable due to their high energy density relative to LFP batteries, however operation of NMC does result in oxygen release, potentially increasing fire risks. For this reason, LFP batteries are advised as the industry standard for safety in lithium-ion battery technology.

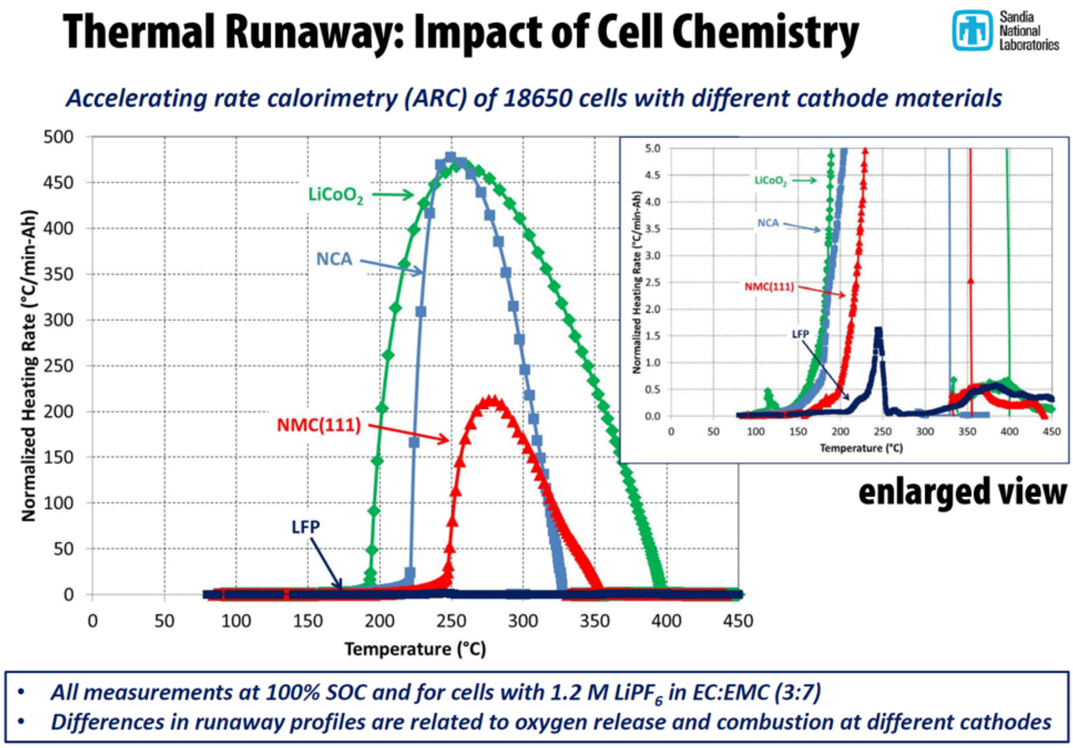


Figure 4-2: Temperature Rise of Lithium-Ion Battery Chemistries (Ref. [6]).

The preliminary battery product considered for the purposes of a preliminary hazard analysis for the project is a BESS with LFP technology. A UL9540A report (test standard report with a systematic evaluation of thermal runaway and propagation in energy storage system at cell, module, unit, and installation levels) may have been completed for this product and is unable to be shared due to privacy reasons. At install, the units will have been tested and have UL9540A test data for fire development and propagation.

Similarly, based on data shown from UL9540A reports for similar systems, the results demonstrate that when thermal runaway is triggered in one cell in a BESS container, the heat generated would neither be transferred to all cells within one battery module, nor from the test module to adjacent ones. This is attributed to the nature of LFP technology as well as the sheer mass of the battery module (heavier objects have higher thermal capacity).

Although the LFP technology does not cause fire, there can be circumstances where battery modules catch fire due to leaking coolant or electric faults. In those cases, fire will be constrained by the stainless-steel enclosure. Similar systems show that generally the container wall remains intact after sustaining heating in a furnace to over 900ºC.

Furthermore, each container should also have multiple built-in fire protection devices that work collaboratively, including smoke and thermal sensors, combustible gas detector, pressure relief system E-stop buttons and a gaseous or aerosol suppression system. Therefore, a container is expected to automatically detect an internal fire in the first instance.

In conclusion, the LFP technology does not cause fire during thermal runaway. Should fire be developed within one BESS container it would not transfer to nearby containers due to the fire safety design features; hence, this incident has not been carried forward for further analysis.

Notwithstanding, based on conversations with and review by NSW Department of Planning, Housing, and Infrastructure (DPHI) on other BESS projects, the following recommendations have been made:

- BESS must be tested in accordance with UL9540A.
- Testing to demonstrate clearances required to prevent propagation of fires between separated units.
- BESS to be installed in accordance with manufacturer and UL9540A report recommended clearances based on testing.
- BESS to be installed with fire protection systems specified by the manufacturer and UL9540A report.
- Before construction, detailed design to validate the system can be installed in the project area whilst meeting the UL9540A recommended clearances.
- UL testing information shall be made available to the certifying authority. It is noted that a confidentiality agreement may be required.

4.5 Victorian Big Battery Fire Review

Notwithstanding the findings of **Section 4.4**, it is necessary to review recent large scale BESS fires to determine whether similar incidents could occur with the present project.

The present project has thoroughly considered the separation distance considering fire safety, and operation and maintenance. The fire safety assessment is essentially around heat transfer which has been discussed in detail in **Section 4.4**.

The Victorian Big Battery (VBB) experienced a fire in July 2021 which also has a back-to-back layout. According to the independent investigation report on its fire incidence, the back-to-back layout was not the cause for propagation. The main reason for fire propagation was strong wind blowing flames from one Megapack into the unprotected vent atop of an adjacent Megapack which resulted in the ignition of the plastic fan which was able to impact the battery modules directly beneath the fan.

Lessons learnt from the VBB incident results in fire safety precautions on the design of the present project. The vent atop the containers shall be made of metal instead of plastic and covered by a metallic mesh shield. Furthermore, the placement of the fans shall be such that batteries or flammable materials shall not be located directly beneath ventilation openings. To ensure the above are captured the following recommendations have been made:

- The vent covers of the BESS shall be constructed of non-combustible material.
- The vents shall not be located above battery packs within the BESS container.

Based upon the designs incorporated with the container based upon the VBB fire, the available area assessment and the separation distance assessment, it is considered that the propagation between two units is considered unlikely; hence, this incident has not been carried forward for further analysis.

4.6 Available Space for BESS Allocation Review

As per DPHI past recommendation, an assessment should be made showing that the allocated space for a BESS will accommodate all units to be installed.

- The total BESS area (approx. 148 m x 156 m): 23,000 m^2

The separation distances for a BESS have been sourced from FM-Global DS 5-33 ESS Ref. [7] This is a highly conservative estimate as the FM-Global data sheet notes difficulties regarding experimental LFP technology data availability. Hence, the separation distances should be reviewed once the UL9540A report is disclosed. An example of the recommended configuration is shown in **Figure 4-3**.

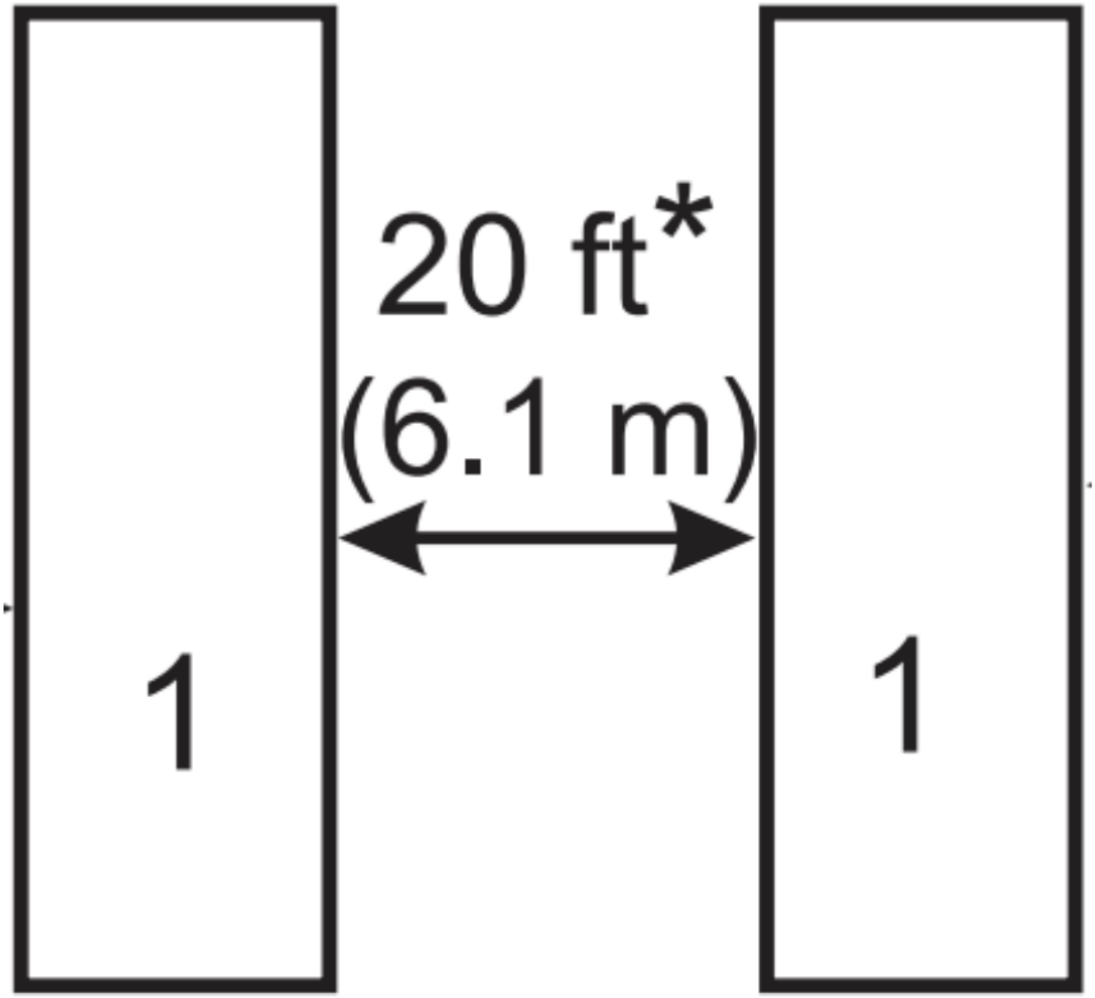


Figure 4-3: BESS Layout recommendation in FM-Global DS 5-33

According to **Figure 4-3,** the separation distance between modules is 6.1 m, it is assumed that the area footprint for a single BESS including the clearances (with an assumed dimension of 7.50 m x 3.13 m), is 59 m^2 . This value can then be divided by the available space in each of the potential locations to show the maximum number of BESS that can be installed (rounded down) without considering any cluster arrangements. These are summarised in **Table 4-2**.

Table 4-2: Potential BESS Allocation Area*

BESS Location	Available Area (m^2)	Maximum no. of BESS
1	23,000	389

*Rounded down for conservatism

This calculation shows that there is enough space for approximately 389 BESS units, and other auxiliary infrastructure (i.e sub-units, inverters, transformers etc).

Nevertheless, a recommendation has been made to further enhance the level of protection in terms of BESS clearances:

- Testing in accordance with the guidelines of UL9540 shall be made available to demonstrate clearances required to prevent propagation of fires between separated units.

4.7 Li-ion Battery Fire and Toxic Gas Dispersion

If a BESS failure occurs resulting in a fire, toxic biproducts of combustion may form. A literature review was conducted on lithium-ion battery fires to identify the toxic gases which may be generated in the event of a fire. The review identified the following gases or classes of gases can form:

- Carbon dioxide;
- Carbon monoxide; and
- Fluorine gases.

Each of these have been discussed in further detail in the following subsections.

4.7.1 Carbon Dioxide

Carbon dioxide is a colourless, odourless, dense gas which is naturally forming and is present in the atmosphere at concentrations around 415 ppm (0.0415%). At low concentrations carbon dioxide is physiologically impotent and at low concentrations does not appear to have any toxicological effects. However, as the concentration grows it increases the respiration rate with short term exposure limit occurring at 30,000 ppm (3%), above 50,000 ppm (5%) a strong respiration effect is observed along with dizziness, confusion, headaches, and shortness of breath. Concentrations in excess of 100,000 ppm (10%) may result in coma or death.

Carbon dioxide is a by-product of combustion where hydrocarbon or carbon-based materials are involved. A typical combustion reaction producing carbon from a hydrocarbon has been provided in **Equation 4-1**. This reaction proceeds when there is an excess of oxygen to the fuel being consumed and is known as complete combustion as it is the most efficient reaction pathway.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3Co_2(g) + 4H_2O(g)$$ **Equation 4-1**

The lithium-ion batteries are predominantly composed of metal structures. However, during a fire event ancillary equipment and materials within the batteries will be involved in the fire including wiring, plastics, anodes, etc. which will liberate carbon dioxide. However, a review of the toxicological impacts indicates high concentrations would be required to result in injury or fatality. Based upon a review of the sensitive areas, and the similar BESS fires (i.e. Victoria BESS fire), it is not considered that the formation of carbon dioxide in a fire would be sufficient to result in downwind impacts sufficient to cause injury or fatality. In other words, there would be insufficient production of carbon dioxide to generate a plume of sufficient concentration to displace the required oxygen for a significant downwind consequence to occur. Therefore, this incident has not been carried forward for further analysis.

4.7.2 Carbon Monoxide

Carbon monoxide is an odourless, colourless gas which is slightly denser than air and occurs naturally in the atmosphere at concentrations around 80 ppb. Carbon monoxide is a toxic gas as it irreversibly binds with haemoglobin which prevents these molecules from carrying out the function of oxygen / carbon dioxide exchange. The loss of 50% of the haemoglobin may result in seizures, coma or death which can occur at concentration exposures of approximately 600 ppm (0.06%).

Carbon monoxide is by-product of combustion if there is insufficient oxygen to enable complete combustion. The reaction pathway for the formation of carbon monoxide is provided in **Equation 4-2**.

$$2C_3H_8(g) + 7O_2(g) \rightarrow 6CO(g) + 8H_2O(g)$$ **Equation 4-2**

As noted, in **Section 4.7.1** there is the potential for a fire to occur with the BESS units which could form carbon monoxide if there is insufficient oxygen to sustain complete combustion. However, it is noted that the combustible load within the BESS which could result in the formation of carbon monoxide is relatively low compared to the available oxygen in the surrounding atmosphere. Therefore, it is considered that the formation of carbon monoxide at levels which would result in a substantial downwind impact are not considered credible and subsequent analysis of, this incident is not required.

4.7.3 Fluoride Gases

The electrolyte used in Li-ion batteries typically is lithium hexafluorophosphate ($LiPF_6$) or other li-salts containing fluorine. In the event of a thermal runaway, the electrolyte will expand and be vented from the battery. In the event of a fire, the vented gas and other components such as the polyvinylidene fluoride binders may form gases such as hydrogen fluoride (HF), phosphorous pentafluoride (PF_5) and phosphoryl fluoride (POF_3) (Ref. [8]).

The decomposition of $LiPF_6$ can be promoted by the presence of water / humidity according to reactions **Equation 4-3** to **Equation 4-5**.

$$LiPF_6 \rightarrow LiF + PF_5$$ **Equation 4-3**

$$PF_5 + H_2O \rightarrow POF_3 + 2HF$$ **Equation 4-4**

$$LiPF_6 + H_2O \rightarrow LiF + POF_3 + 2HF$$ **Equation 4-5**

Of the fluorine gases formed, PF_5 is a short-lived gas while POF_3 is a reactive intermediate. Thermal destruction of a several battery chemistry, configurations and State of Charge (SOC) indicated the vast majority of these did not produce observable POF_3 with the only observance occurring in a specific battery chemistry at 0% SOC (Ref. [8]). Therefore, the main fluorine gas of concern in a Li-ion battery fire is HF.

HF gas is hydroscopic readily dissolving into water vapour / humidity or moisture in airways forming hydrofluoric acid. Hydrofluoric acid is a weak acid although is highly corrosive and may result in chemical burns. In addition, it is calcium scavenging. Hence, it will readily bind with calcium in cells and tissues disrupting the nerve signalling. The immediately dangerous to life or Health (IDLH) for HF is 30 ppm and the 10-minute lethal concentration is 170 ppm.

For a toxic gas dispersion, a battery container fire is necessary as the initiating event. As discussed in **Section 4.4** the potential for a fire to occur is considered negligible due to the highly stable and safe battery chemistries used. Therefore, a toxic gas dispersion impacting sensitive receptors is not deemed a credible scenario and this incident has not been carried forward for further analysis.

4.8 Electrical Equipment Failure and Fire

Electrical equipment is located within the switch room which may fail resulting in overheating, arcing, etc. which could initiate a fire. In the event of a fire, it may begin to propagate to adjacent combustible materials (i.e.wiring). It is noted that electrical equipment fires typically start by smouldering before flame ignition occurs resulting in a slow fire development.

The type of equipment used within the Project is ubiquitous throughout the world and across industry segments and is therefore not a unique fire scenario. Based upon fire development within switch rooms the fire would be relatively slow in growth and would be unlikely to result in substantial impacts in terms of offsite impact or incident propagation. Therefore, this incident has not been carried forward for further analysis.

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

Transformers contain oil which is used to insulate the transformers during operation. If arcing occurs within the transformer (e.g. due to a low oil level), the high energy passing through the coolant vaporises the oil into light hydrocarbons (methane, ethane, acetylene, etc.) resulting in rapid pressurisation within the reservoir.

Notwithstanding the protection systems, if the pressure rise exceeds the structural integrity of the reservoir, and the installed pressure relief devices, the reservoir can rupture allowing the release of oil into the bund. The rupture also allows oxygen to enter the reservoir. The temperature of the gases is anticipated to be above the auto ignition point, but this does not occur until oxygen is present. When oxygen enters the reservoir, the gases auto ignite which generates sufficient heat to ignite the oil in the bund.

Notwithstanding this, transformers are ubiquitous units with a low potential for failure and every transformer is to be self-bunded on a skid or have a concrete bund, limiting the spread of an oil pool fire. Additionally, the separation distance to the site boundary and other adjacent units would be unlikely to result in incident propagation and offsite impacts. Nevertheless, it has been decided to quantitatively determine the risk of such a fire, hence this incident has not been carried forward for further analysis.

4.10 Transformer Electrical Surge Protection Failure and Explosion

Transformers generate large amounts of heat due to the high electrical currents that pass through them; hence, as described in **Section 4.8**, oil is used as an insulating material within the transformers to protect the mechanical components. However, if the transformer gets an extreme surge of energy, such as that which could occur due to a lightning strike, and the electrical surge protection measures fail, the oil may start to decompose and vaporise, resulting in flammable gas bubbles including hydrogen and methane (Ref. [9]) at temperatures above the autoignition of the gases.

The formation of gases will increase the pressure within the transformer which can result in the transformer structure rupturing which allows the ingress of oxygen. As the oxygen enters, the concentration of flammable gases falls within the explosive limits which are above their autoignition temperatures which ignite resulting in increased formation of hot gaseous products resulting in an explosion. The explosion may generate significant overpressure, sparks and fire and would result in a whole transformer fire, as discussed in **Section 4.9**.

In order to protect against overheating and explosions, transformers generally have surge protection devices which shunt electrical surges safely to ground. However, this surge detection and protection devices are not universally installed nor do they protect against all events such as in the case of a major lightning strike or significant oil deterioration, leakage of water into the transformer, and physical damage such as a fallen tree (Ref. [10]). Therefore, while transformers are ubiquitous units with a low potential for failure, there is the potential for an explosion to occur which may result in offsite impacts. Hence, this incident has been carried forward for further analysis.

4.11 Electromagnetic Field Impacts

4.11.1 Introduction

Electric and Magnetic Fields (EMFs) are associated with a wide range of sources and occur both naturally as well as man-made. Naturally occurring EMFs, occurring during lightning storms, are generated from Earth's magnetic field. Man-made EMFs are present wherever there is electricity; hence, EMFs are present in almost all built environments where electricity is used.

Extremely low frequency (ELF) electric and magnetic fields (EMF) occupy the lower part of the electromagnetic spectrum in the frequency range 0-3,000 Hz which is the current will change direction 0-3,000 times a second. ELF EMF result from electrically charged particles. Artificial sources are the dominant sources of ELF EMF and are usually associated with the generation, distribution and use of electricity at the frequency of 50 Hz in Australia. The electric field is produced by the voltage whereas the magnetic field is produced by the current.

BESS create EMFs from operational electrical equipment, such as transmission lines, transformers and the electrical components found within BESS units, inverters, etc. This equipment has the potential to produced ELF EMF's in the range of 30 to 300 Hz.

4.11.2 Existing Standards

There are currently no existing standards in Australia for governing the exposure limits to ELF EMFs; however, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) has provided some guidelines around exposure limits for prolonged exposure which limits the exposure to 2,000 milligauss (mG) for members of the public in a 24 hour period (Ref. [11]).

Table 4-3 provides typical magnetic field measurements and ranges associated with EMF sources. It is noted that electric fields around devices are generally close to 0 due to the shielding provided around the equipment. In addition, EMF levels drop away quickly with distance; hence, while a value may be measurable at the source, within a short distance the EMF is undetectable.

Table 4-3: EMF Sources and Magnetic Field Strength

Source	Typical Measurement (mG)	Measurement Range (mG)
Television	1	0.2 – 2
Refrigerator	2	2 – 5
Kettle	3	2 – 10

Source	Typical Measurement (mG)	Measurement Range (mG)
Personal computer	5	2 – 20
Electric blanket	20	5 – 30
Hair dryer	25	10 – 70
Distribution powerline (under the line)	10	2 – 20
Transmission power line (under the line)	20	10 – 200
Edge of easement	10	2 – 50

4.11.3 Exposure Discussion

A review of the site indicates the nearby residences adjacent to the area where the BESS will be developed are separated by over 1 km providing substantial distance for attenuation of EMFs.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) advises that the strength of radiation decreases exponentially with distance from the source, and it will become indistinguishable from background radiation within 50 m of a high voltage power line and within 5 to 10 m of a substation. (Ref. [12]).

A field study was undertaken to characterise the EMF between the frequencies of 0 – 3 GHz at two large scale solar facilities operated by the Southern California Edison Company in Porterville and San Bernardino, (Ref. [13]).

The field study findings were adopted to estimate the EMF measurements for the project. The findings are as follows:

- The highest DC magnetic fields were measured adjacent to the inverter (277 μT) and transformer (258 μT). These fields were lower than the ICNIRP's occupational exposure limit.
- The highest AC magnetic fields were measured adjacent to the inverter (110 μT) and transformer (177 μT). These fields were lower than the ICNIRP's occupational exposure limit.
- The strength of the magnetic field attenuated rapidly with distance (i.e. within 2-3 metres away, the fields drop to background levels).
- Electric fields were negligible to non-detectable. This is mostly likely attributed to the enclosures provided for the electricity-generating equipment.

As the strengths of EMF attenuate rapidly with distance, the ICNIRP reference level for exposure to the general public will not be exceeded and the impact to the general public in surrounding land uses is negligible.

As the potential for exposure to EMF exceeding the international guidelines is negligible, this incident has not been carried forward for further analysis.

5.0 Conclusion and Recommendations

5.1 Conclusions

A hazard identification table was developed for the BESS at the Wallaby Creek Wind Farm to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with the potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. A review of the incidents carried forward for further analysis indicates that there were no observed offsite impacts.

Hence, based on the analysis presented in this report, the project would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

5.2 Recommendations

The following recommendations have been made as a result of the analysis:

- BESS must be tested in accordance with UL9540A.
- Testing in accordance with the guidelines of UL9540 shall be undertaken to demonstrate clearances required to prevent propagation of fires between separated units.
- BESS to be installed in accordance with manufacturer and UL9540A report recommended clearances between units, based on testing.
- BESS to be installed with fire protection systems specified by the manufacturer and UL9540A report.
- Before construction, detailed design to validate the system can be installed in the project area whilst meeting the UL9540A recommended clearances.
- UL testing information shall be made available to the certifying authority. It is noted that a confidentiality agreement may be required.
- The vent covers of the BESS shall be constructed of non-combustible material.
- The vents shall not be located above battery packs within the BESS container.
- Confirm that all transformers are bunded to contain oil releases. Transformers may be self-bunded on a skid, otherwise they will require a dedicated concrete bund.

6.0 References

[1] Department of Planning, Industry and Environment, "Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning," Department of Planning, Industry and Environment, Sydney, 2011.

[2] Department of Planning, Industry and Environment, "Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis," Department of Planning, Industry and Environment, Sydney, 2011.

[3] SafeWork NSW, "Work Health and Safety Regulation," SafeWork NSW, Lisarow, 2017.

[4] Department of Planning, Industry and Environment, Multi-Level Risk Assessment, Sydney: Department of Planning, Industry and Environment, 2011.

[5] National Transport Commission (NTC), "Australian Code for the Transport of Dangerous Goods by Road & Rail, 7th Edition," 2011.

[6] Power Tech Systems, "Safety of Lithium-Ion batteries," Power Tech Systems, 2022. [Online]. Available: https://www.powertechsystems.eu/home/tech-corner/safety-of-lithium-ion-batteries/. [Accessed 13 April 2022].

[7] F. M. I. Company, "FM Global Property Loss Prevention Data Sheets 5-33," Factory Mutual Insurance Company, Rhodes Island, 2021.

[8] F. Larson, P. Andersson, P. Blomqvist and B.-E. Mellander, "Toxic fluoride gas emissions from lithium ion battery fires," Nature: Scientific Reports, 2017.

[9] J. Demos, "What Causes Transformer Explosions and Burns?," Durabarrier USA Fire Barrier Experts, 26 July 2021. [Online]. [Accessed 2 February 2022].

[10] P. Hoole, S. Rufus, N. Hashim, M. Saad, S. Abdullah, A. Othman, K. Piralaharan, A. CV and S. Hoole, "Power Transformer Fire and Explosion: Causes and Control," *International Journal of Control Theory and Applications,* vol. 10, no. 16, pp. 211-219, 2017.

[11] International Commission on Non-Ionizing Radiation Protection, "ICNIRP Guideline for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1-100 Hz)," International Commission on Non-Ionizing Radiation Protection, 2010.

[12] EMM Consulting, "Planning Permit Application - Mornington Battery Energy Storage System," Maoneng Australia Pty Ltd, Sydney, 2021.

[13] R. A. Tell, H. C. Hooper, G. G. Sias, G. Mezei, P. Hung and R. Kavet, "Electromagentic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities," *Journal of occupational and environmental hygiene,* vol. 12, no. 11, pp. 796-803, 2015.

[14] Standards Australia, “AS/NZS 3000:2018 - Wiring Rules,” Standards Australia, Sydney, 2018.

Appendix A

Hazard Identification Table

Appendix A

A1. Hazard Identification Table

Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
Battery Storage	• Failure of Li-ion battery protection systems	• Thermal runaway resulting in fire or explosion • Incident propagation through battery cells • Toxic smoke dispersion	• Batteries are tested by manufacturer prior to sale / installation • Overcharging and electrical circuit protection • Battery monitoring systems • Batteries composed of subcomponents (i.e. modules, cells) reducing risk of substantial component failure • Batteries are not located in areas where damage could easily occur (i.e. within the fenced property) • Electrical systems designed per AS/NZS 3000:2018 (Ref. [14]) • HVAC system • Blast panels and pressure relief vents • Gaseous fire suppression • UL9540A testing
Switch rooms, communications, etc.	• Arcing, overheating, sparking, etc. of electrical systems	• Ignition of processors and other combustible material within servers and subsequent fire	• Fires tend to smoulder rather than burn • Isolated location • Switch room separation from other sources of fire
Transformers	• Arcing within transformer, vaporisation of oil and rupture of oil reservoir	• Transformer oil spill into bund and bund fire	• Self-bunded transformer skids • Separated from combustible materials and sensitive receptors
	• Power surge to transformers (e.g. from lightning)	• Major failure of surge protection in transformer, vaporisation of oil, ignition and explosion	• Transformers have surge protection system to shut down upon detection of extreme energy input • Lightning protection to prevent lightning strikes impacting transformers

Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
			• Control of ignition sources – no smoking / open flames around the transformers
EMF	• Electric and magnetic equipment	• Generation of ELF EMF and injury / nuisance to surrounding area	• Separation distances allow for attenuation of EMFs • Cumulative impacts from equipment below acceptable thresholds. • Low occupancy density within vicinity of the development

Appendix B

Supporting Information

Appendix B Supporting Information

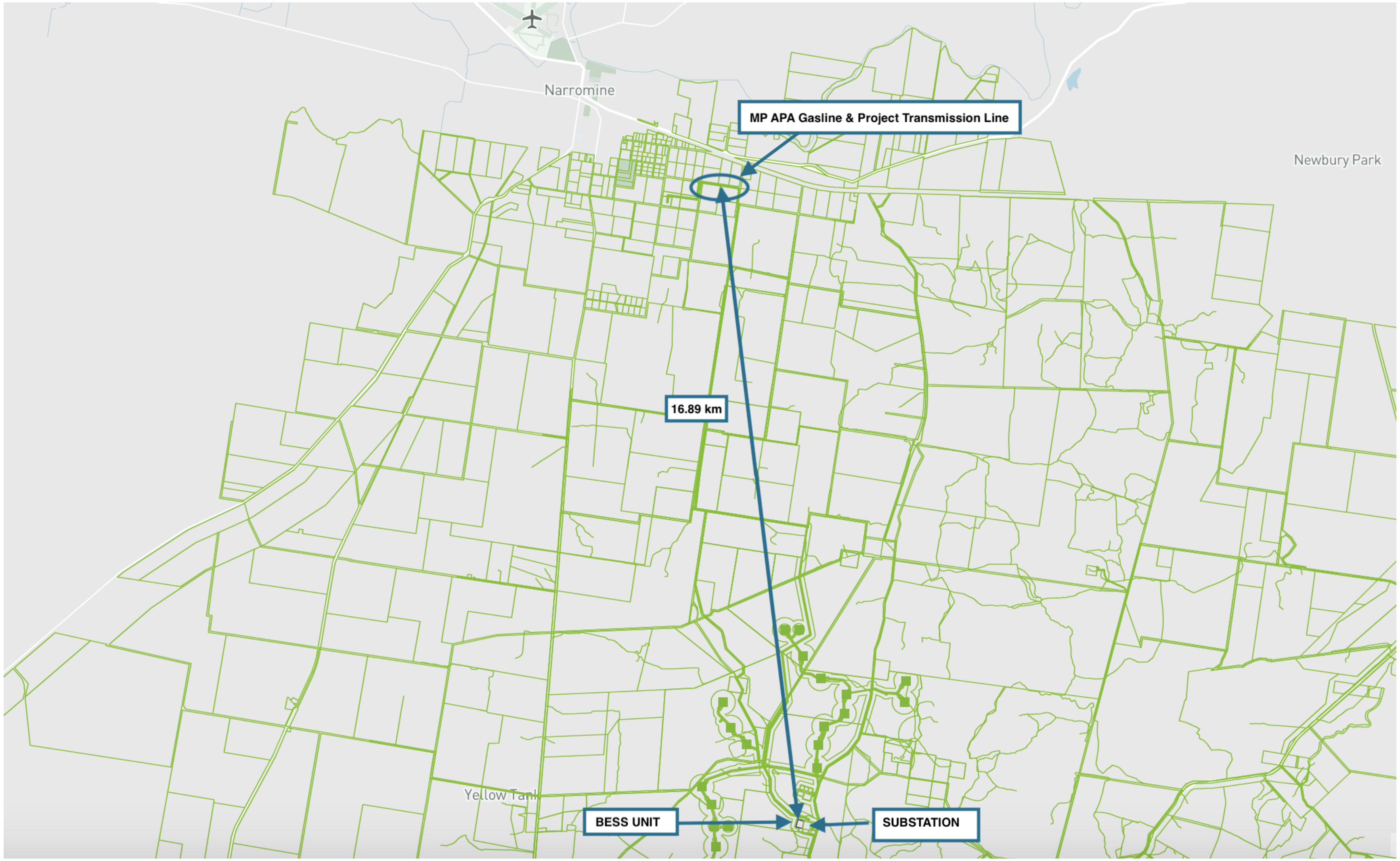
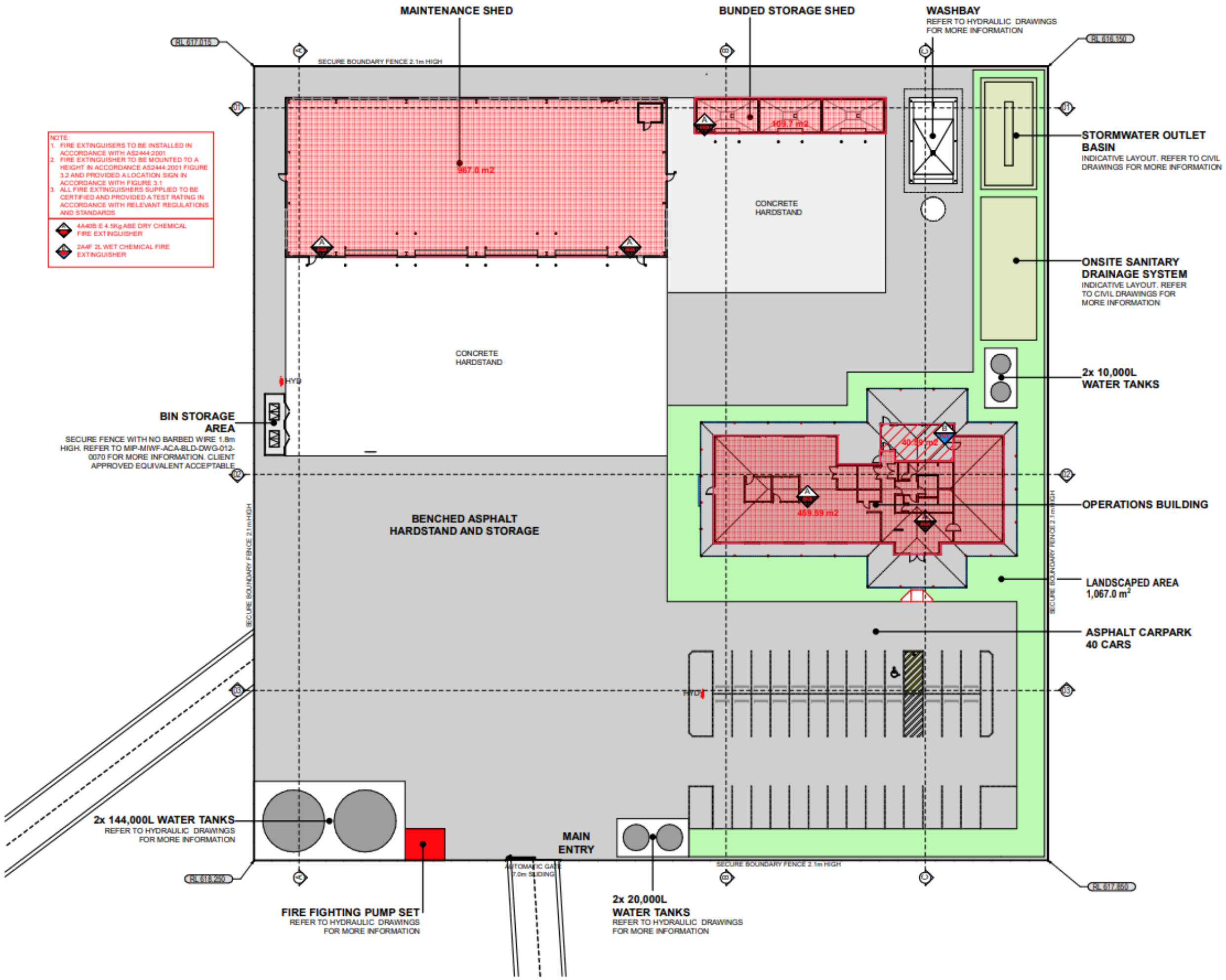


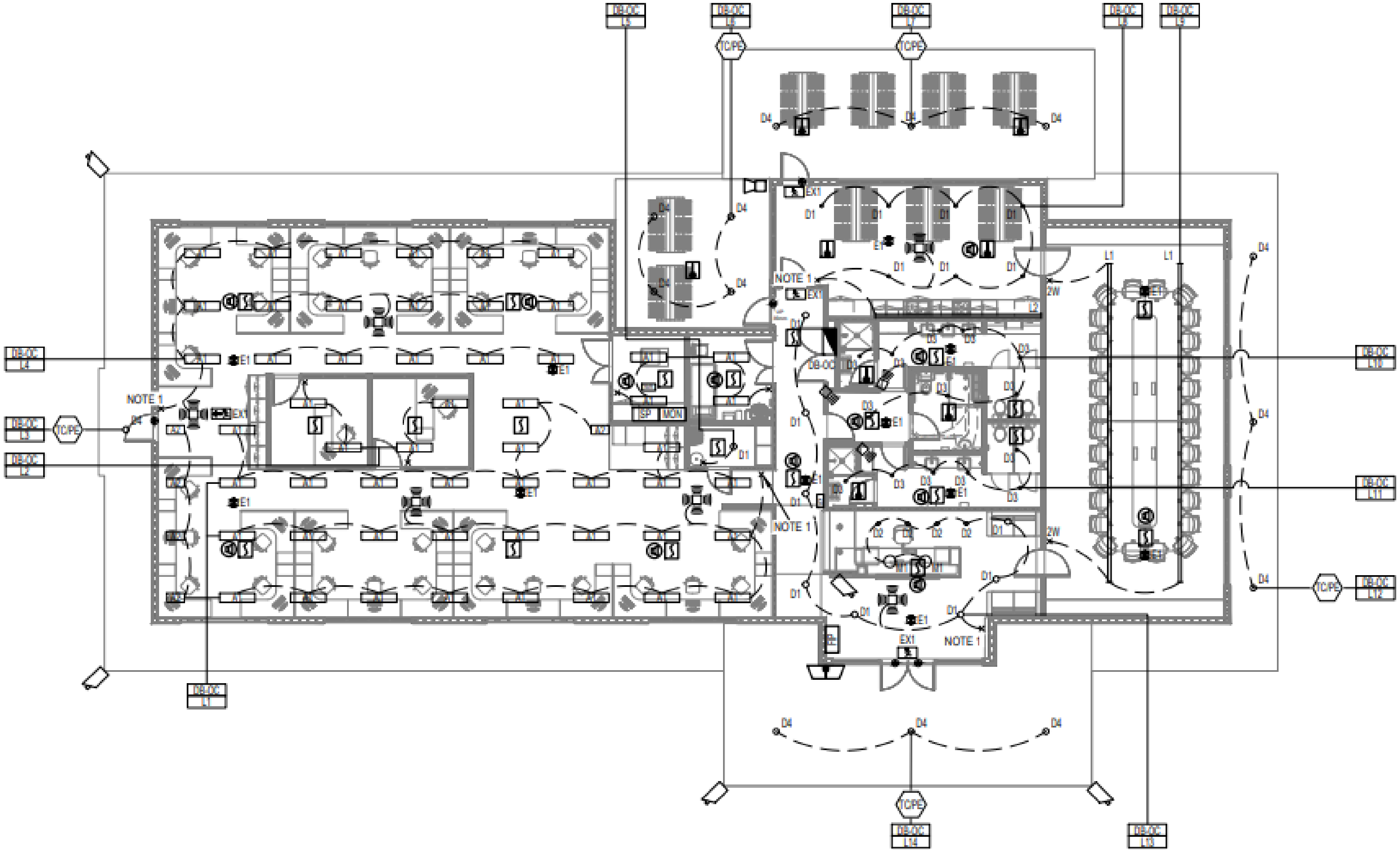
Figure B 1: Site Layout in relation to APA Gas line

The following drawings are referred to as MIWF as a example for WCWF

- O&M Facility: Site Plan - Fire Extinguisher

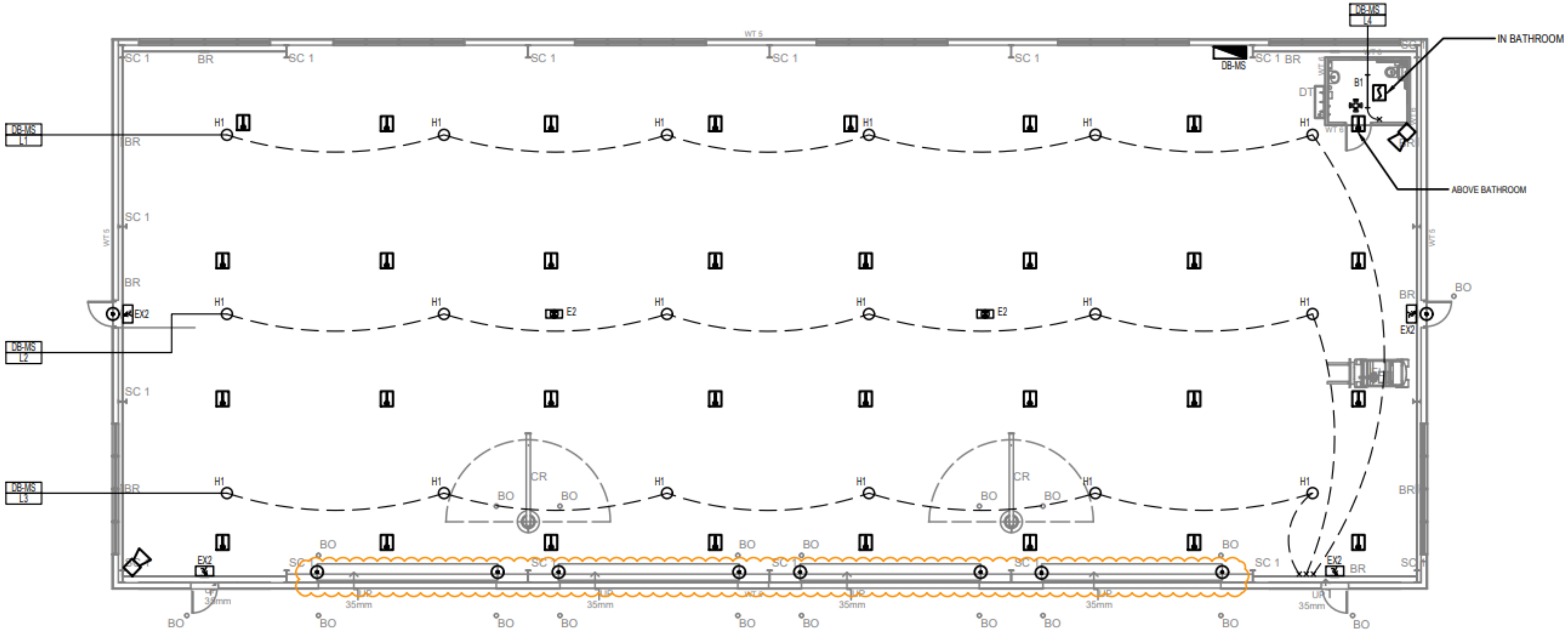


- Operation building Fire layout

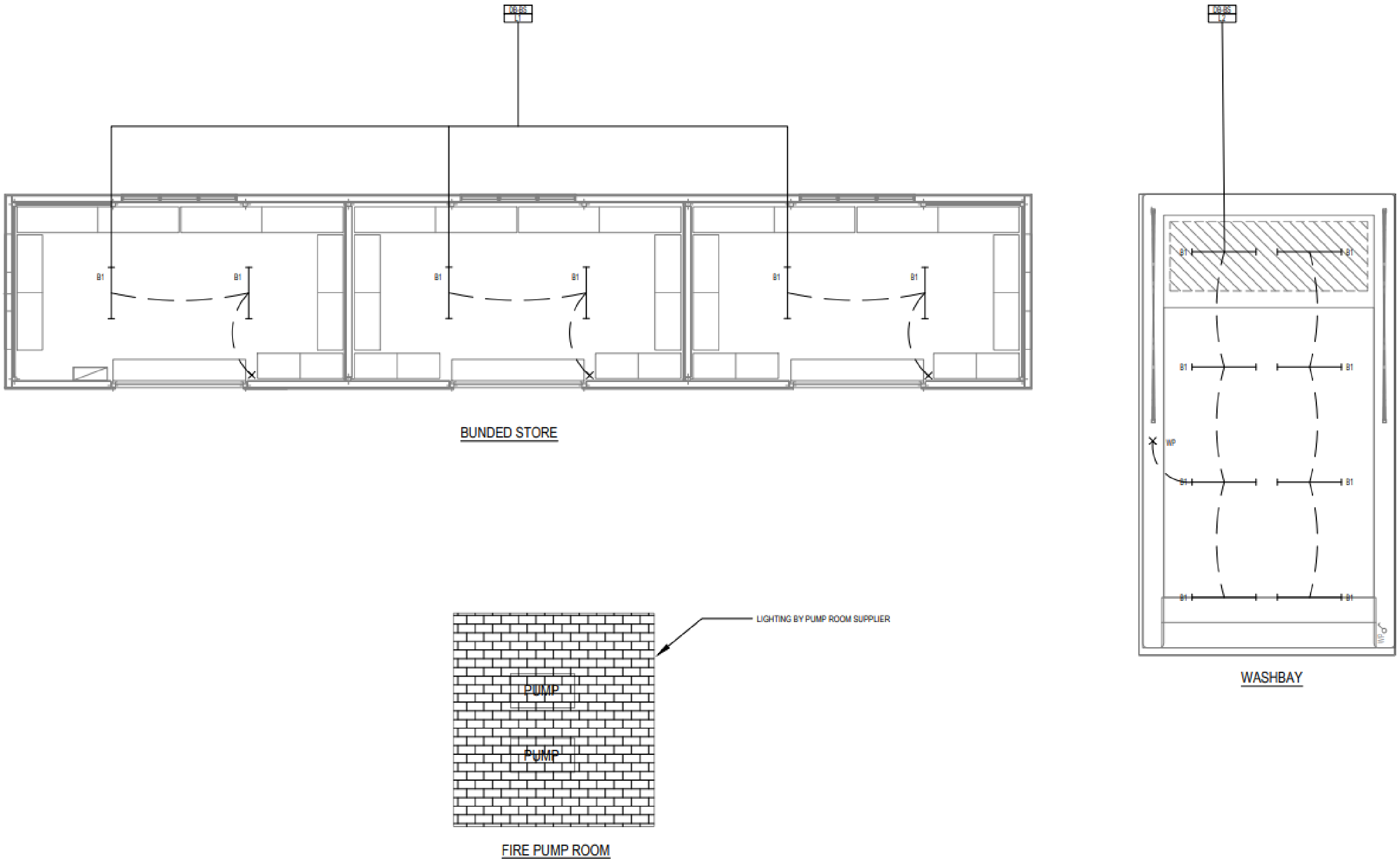


DB/OC
TC/PE
NOTE 1
EX1
E1
A1
D1
D2
D3
D4
L1
L2
2W
M1
ISP
MON

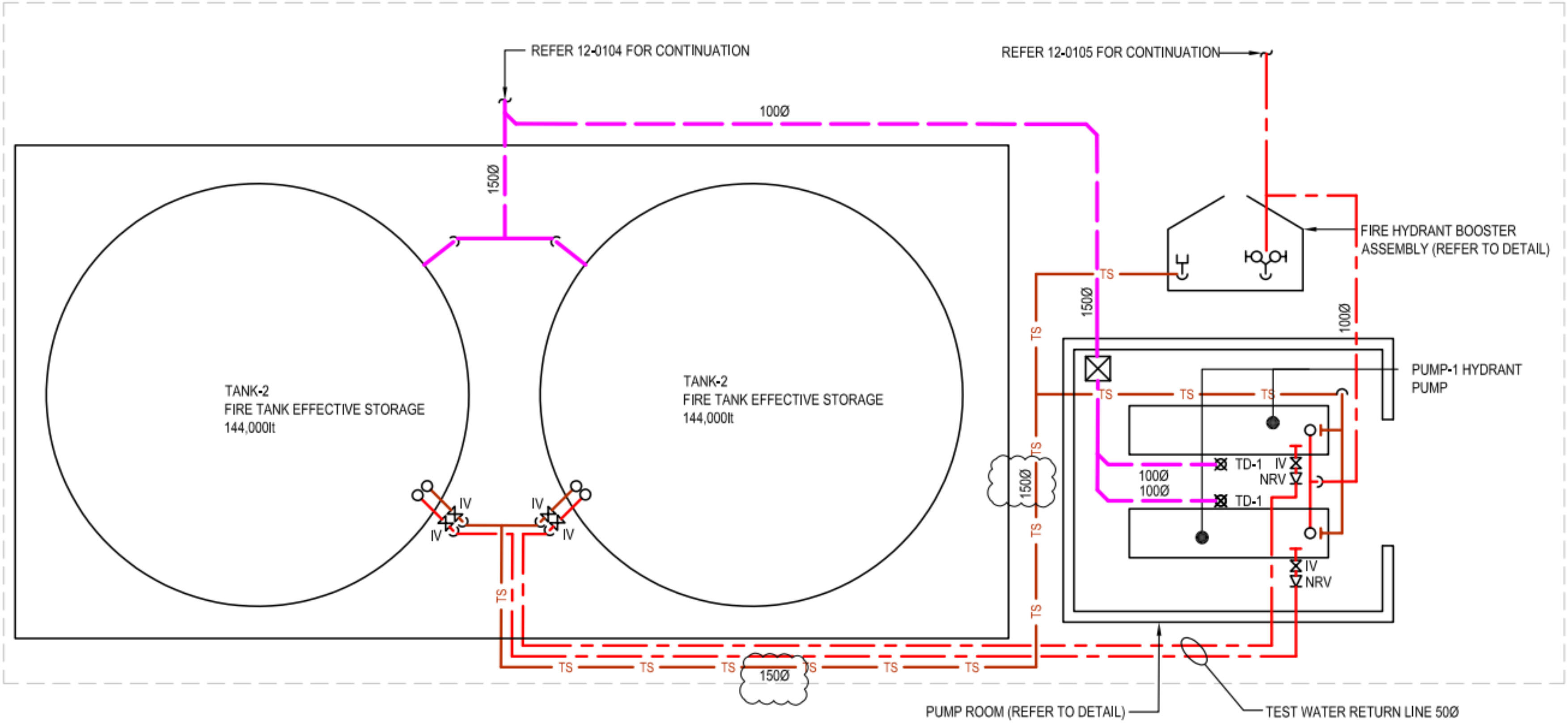
- Maintenance Shed Fire Layout



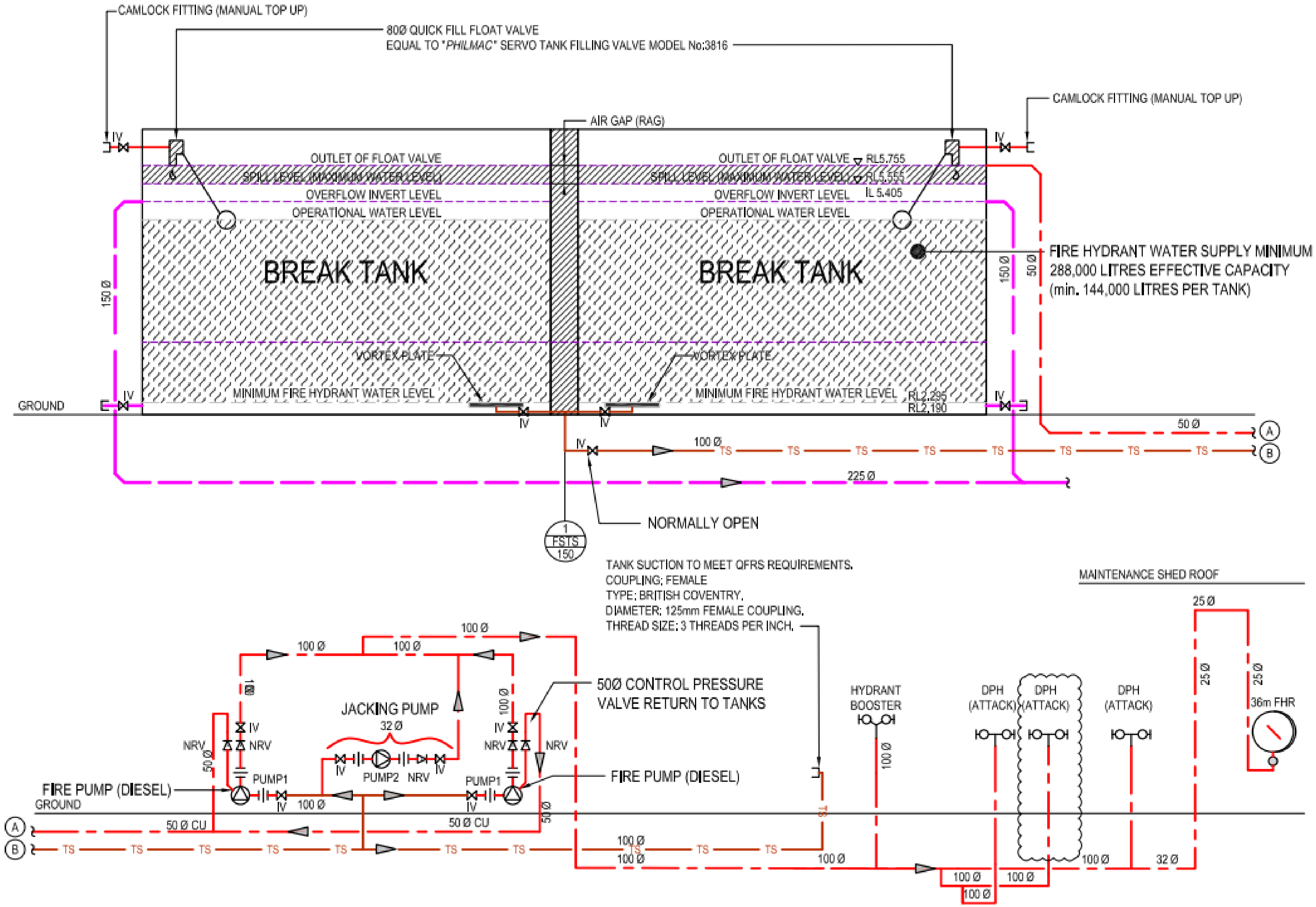
- Bunded Storage Shed & Wash bay Fire Layout



- Water Tanks



REFER 12-0104 FOR CONTINUATION
REFER 12-0105 FOR CONTINUATION
100Ø
150Ø
TANK-2
FIRE TANK EFFECTIVE STORAGE
144,000lt
TANK-2
FIRE TANK EFFECTIVE STORAGE
144,000lt
FIRE HYDRANT BOOSTER
ASSEMBLY (REFER TO DETAIL)
PUMP-1 HYDRANT
PUMP
TD-1
IV
NRV
PUMP ROOM (REFER TO DETAIL)
TEST WATER RETURN LINE 50Ø
TS



CAMLOCK FITTING (MANUAL TOP UP)
80Ø QUICK FILL FLOAT VALVE
EQUAL TO "PHILMAC" SERVO TANK FILLING VALVE MODEL No:3816
CAMLOCK FITTING (MANUAL TOP UP)
AIR GAP (RAG)
OUTLET OF FLOAT VALVE
SPILL LEVEL (MAXIMUM WATER LEVEL)
OVERFLOW INVERT LEVEL
OPERATIONAL WATER LEVEL
RL5.755
RL5.555
IL 5.405
BREAK TANK
BREAK TANK
FIRE HYDRANT WATER SUPPLY MINIMUM
288,000 LITRES EFFECTIVE CAPACITY
(min. 144,000 LITRES PER TANK)
VORTEX PLATE
MINIMUM FIRE HYDRANT WATER LEVEL
RL2.295
RL2.190
GROUND
NORMALLY OPEN
TANK SUCTION TO MEET QFRS REQUIREMENTS.
COUPLING; FEMALE
TYPE; BRITISH COVENTRY.
DIAMETER; 125mm FEMALE COUPLING.
THREAD SIZE; 3 THREADS PER INCH.
MAINTENANCE SHED ROOF
JACKING PUMP
32 Ø
50Ø CONTROL PRESSURE
VALVE RETURN TO TANKS
FIRE PUMP (DIESEL)
FIRE PUMP (DIESEL)
PUMP1
PUMP2
HYDRANT
BOOSTER
DPH
(ATTACK)
36m FHR

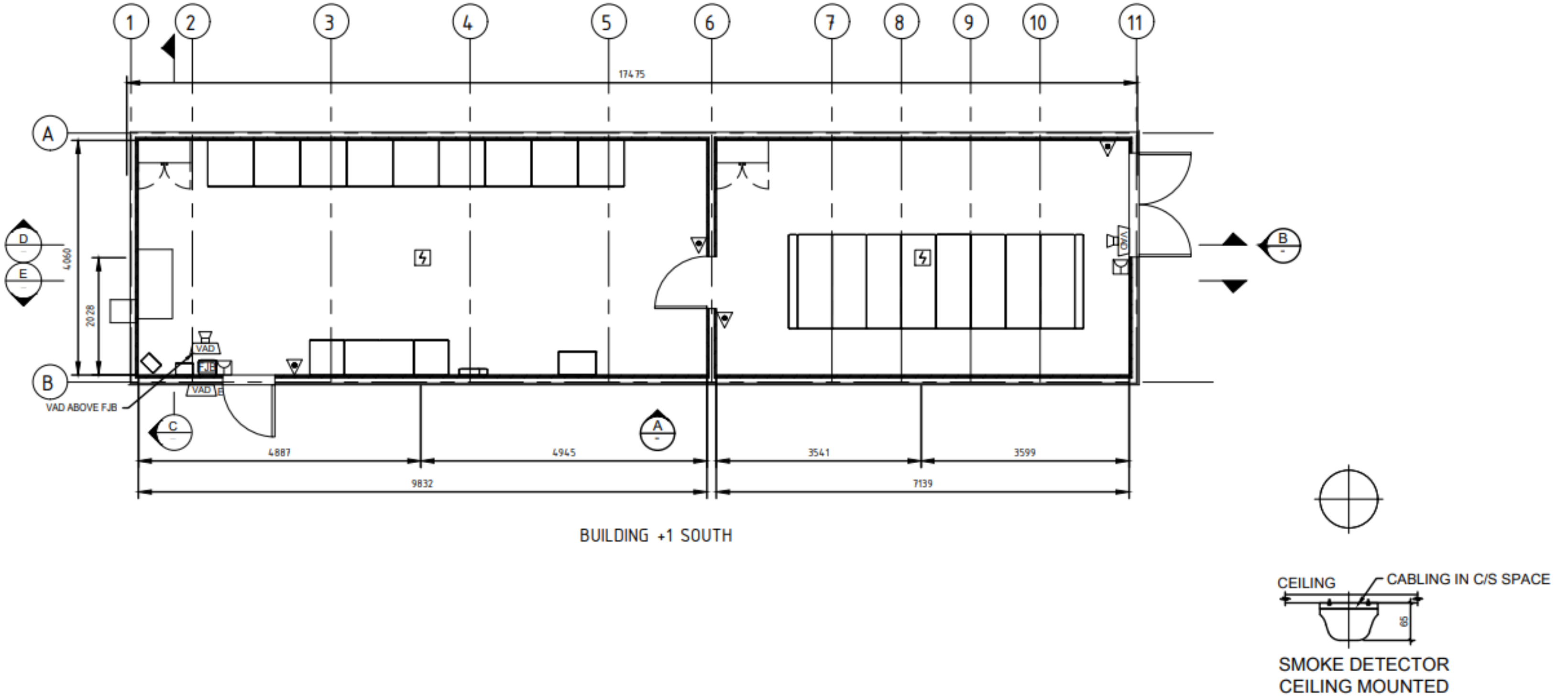
- 33kV Control & Switchgear Building

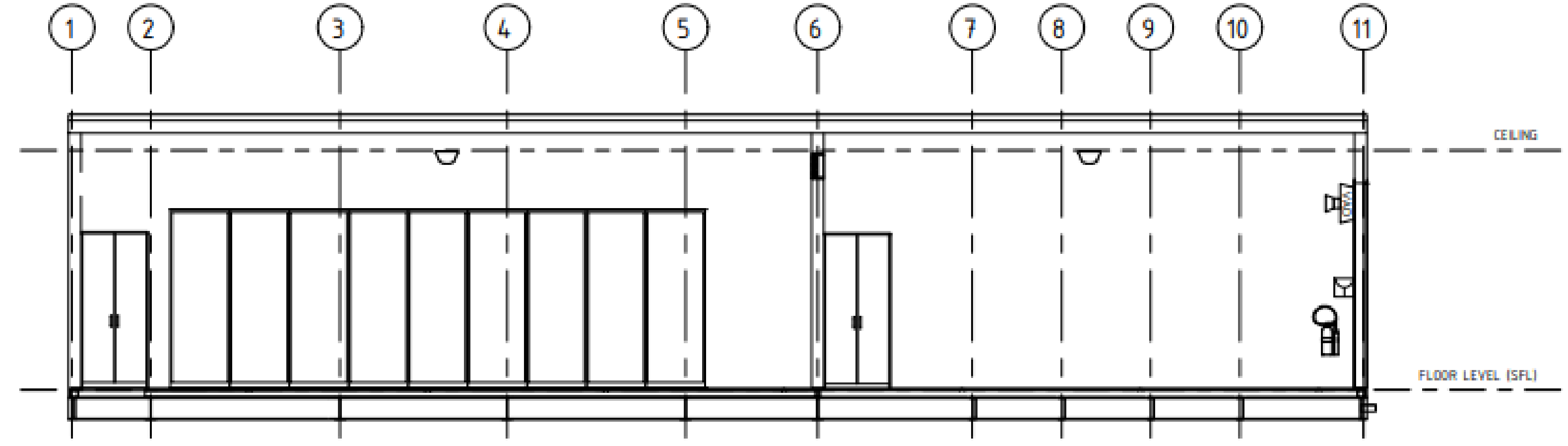
NOTE
FOR EQUIPMENT ID AND ACCESS CLEARANCES
REFER TO MIP-MIWF-ACA-ELE-DWG-042-1002

ALL LV CABLING TO BE RUN SURFACE MOUNT IN PVC CONDUIT

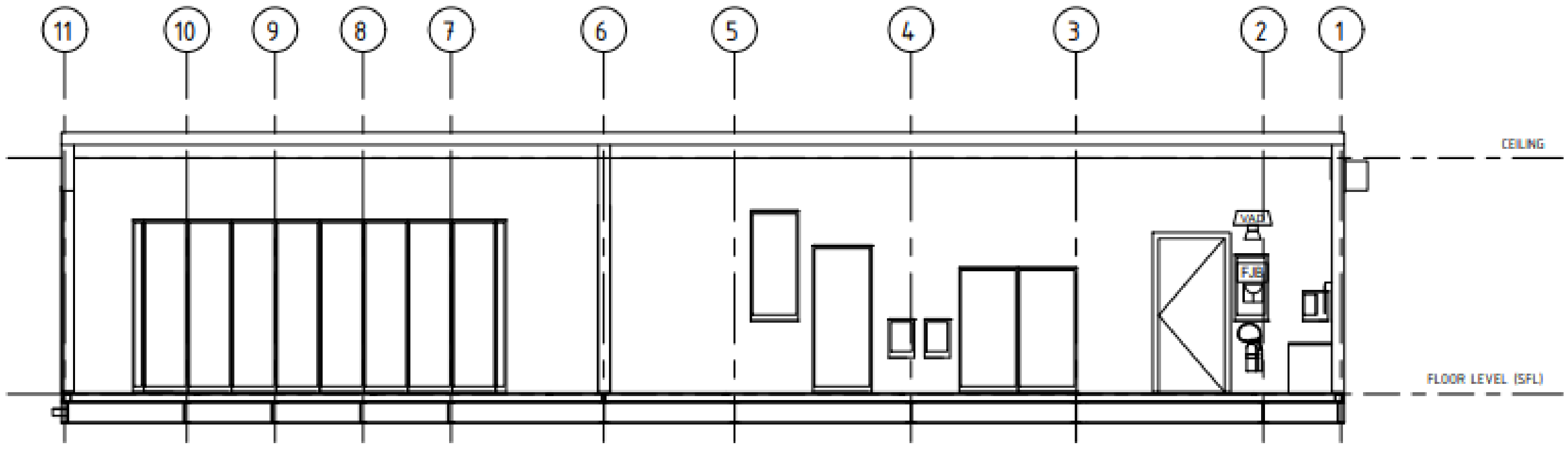
FIRE SYSTEM LEGEND

SYMBOL	DESCRIPTION	MAKE AND MODEL		QTY
FJB	FIRE JUNCTION BOX	KLIPPON	STBB 2.1 SS	1
VAD E	VISUAL ALARM DEVICE - EXTERNAL	ENSCAPE	CWSS-RR-W5	1
VAD	VISUAL ALARM DEVICE - INTERNAL	FIRESENSE	STR-SOU-W-RW	2
	PHOTO OPTICAL SMOKE DETECTOR	FIRESENSE	SS-P	2
	5kg CO2 EXTINGUISHER	FLAMESTOP	CO2	4
	MANUAL CALL POINT	FIRESENSE	MCP-K-R-M	2



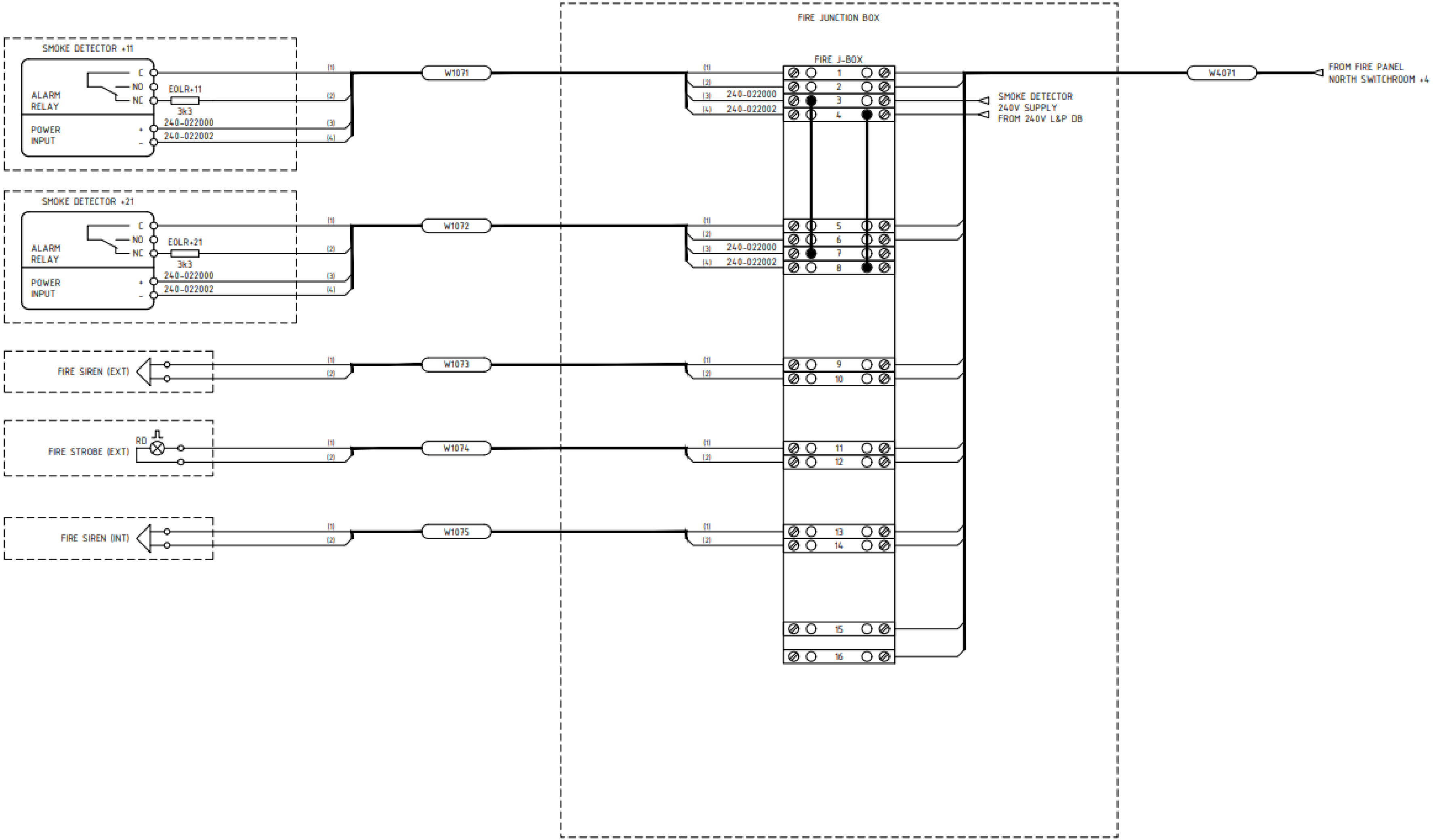


SECTION D

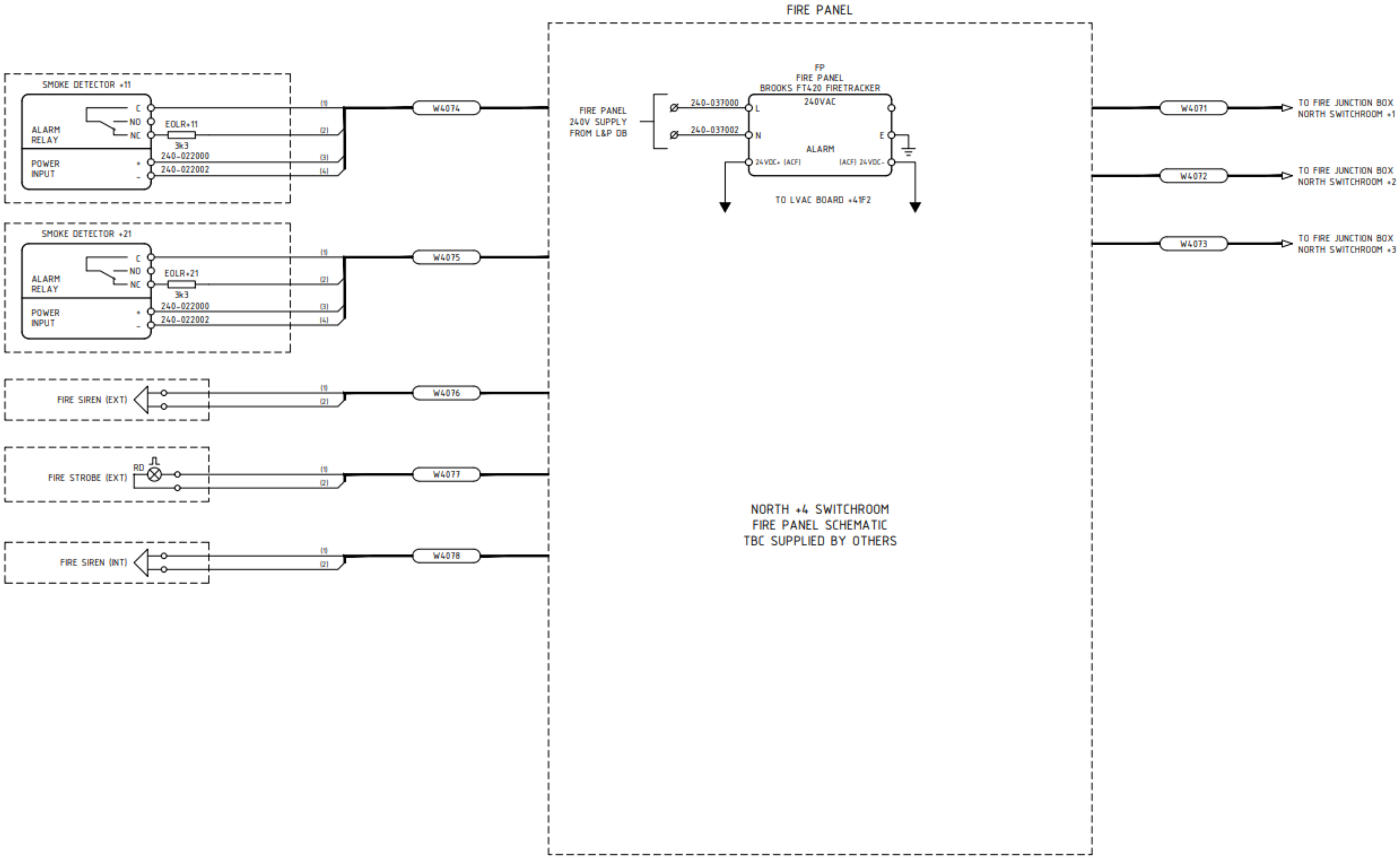


SECTION E

- Fire junction box

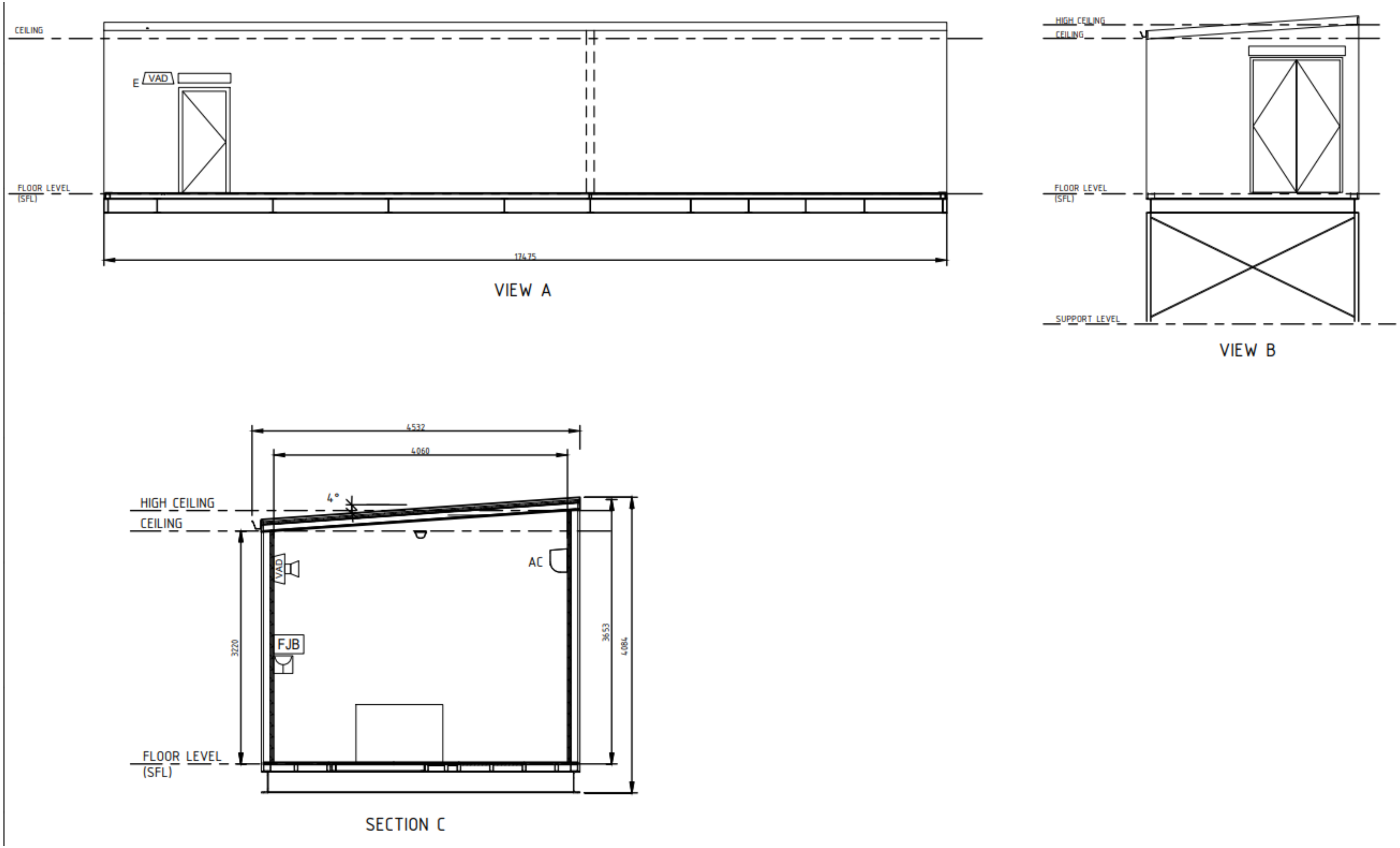


- Fire Panel

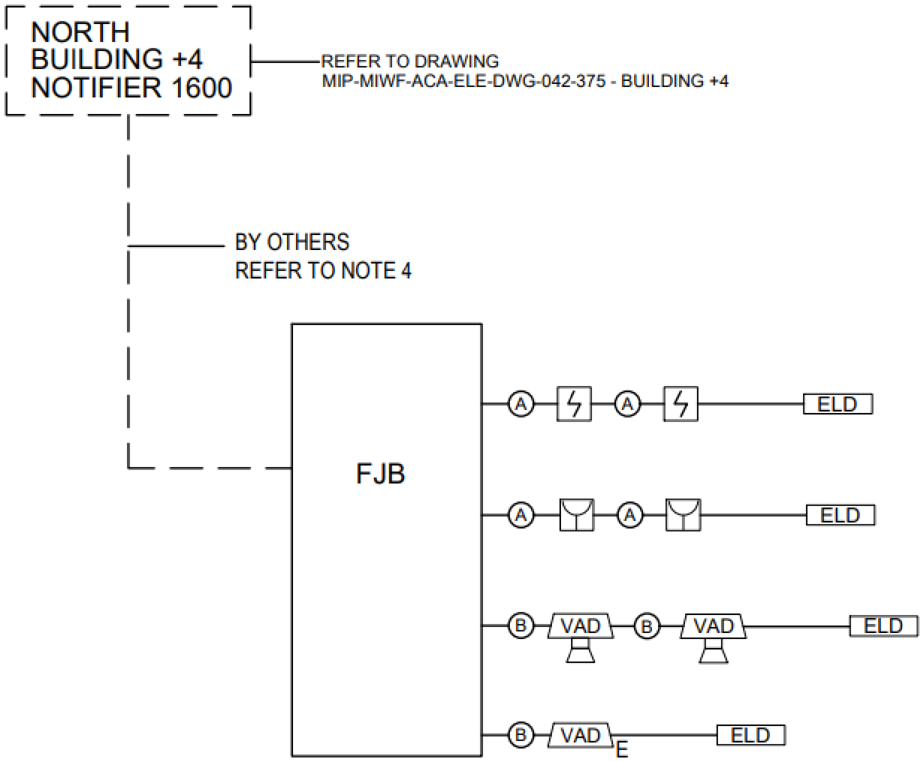


FIRE PANEL
SMOKE DETECTOR +11
ALARM RELAY
POWER INPUT
C
NO
NC
EOLR+11
3k3
240-022000
240-022002
W4074
SMOKE DETECTOR +21
EOLR+21
W4075
FIRE SIREN (EXT)
W4076
FIRE STROBE (EXT)
RD
W4077
FIRE SIREN (INT)
W4078
FP
FIRE PANEL
BROOKS FT420 FIRETRACKER
240VAC
FIRE PANEL
240V SUPPLY
FROM L&P DB
240-037000
240-037002
ALARM
24VDC+ (ACF)
(ACF) 24VDC-
TO LVAC BOARD +41F2
W4071
TO FIRE JUNCTION BOX
NORTH SWITCHROOM +1
W4072
TO FIRE JUNCTION BOX
NORTH SWITCHROOM +2
W4073
TO FIRE JUNCTION BOX
NORTH SWITCHROOM +3
NORTH +4 SWITCHROOM
FIRE PANEL SCHEMATIC
TBC SUPPLIED BY OTHERS

• Fire Services Detection Building Elevation



- Fire Services Wiring Schematic



NOTES:

1. CABLING WILL BE STANDARD RED COLOURED TPS CABLE CONCEALED WITH THE WALL AND CEILING CAVITIES.
2. BOOTLACE LUGS TO BE USED FOR ALL ELECTRICAL CONNECTIONS INSIDE THE FIRE DETECTION CIE PANEL AND FOR ALL EXTERNAL DEVICES.
3. WIRE NUMBERS / FERRALS TO BE USED FOR ALL ELECTRICAL CONNECTIONS INSIDE THE FIRE DETECTION CIE PANEL AND FOR ALL EXTERNAL DEVICES.
4. POWER DROP CALCULATIONS REQUIRED TO CONFIRM WORKABILITY BETWEEN FDCIE (FIRE DETECTION CIE) IN BUILDING NORTH +4 AND BUILDINGS +1, +2 & +3

LEGEND

FJB FIRE JUNCTION BOX

PHOTO OPTICAL SMOKE DETECTOR

VAD ALARM ALARM STROBE / SOUNDER (INTERNAL)

E VAD FIRE STROBE (EXTERNAL)

MANUAL CALL POINT (MCP)

ELD END OF LINE DEVICE

CABLES:

A = RED SHEATHED TPS HALOGEN FREE -
1.5mm 2 CORE TWISTED (ACTIVEFIRE CERTIFIED)

B = RED SHEATHED TPS HALOGEN FREE -
1.5mm 2 CORE FLAT (ACTIVE CERTIFIED)

- Location of smoke detectors in the nacelle

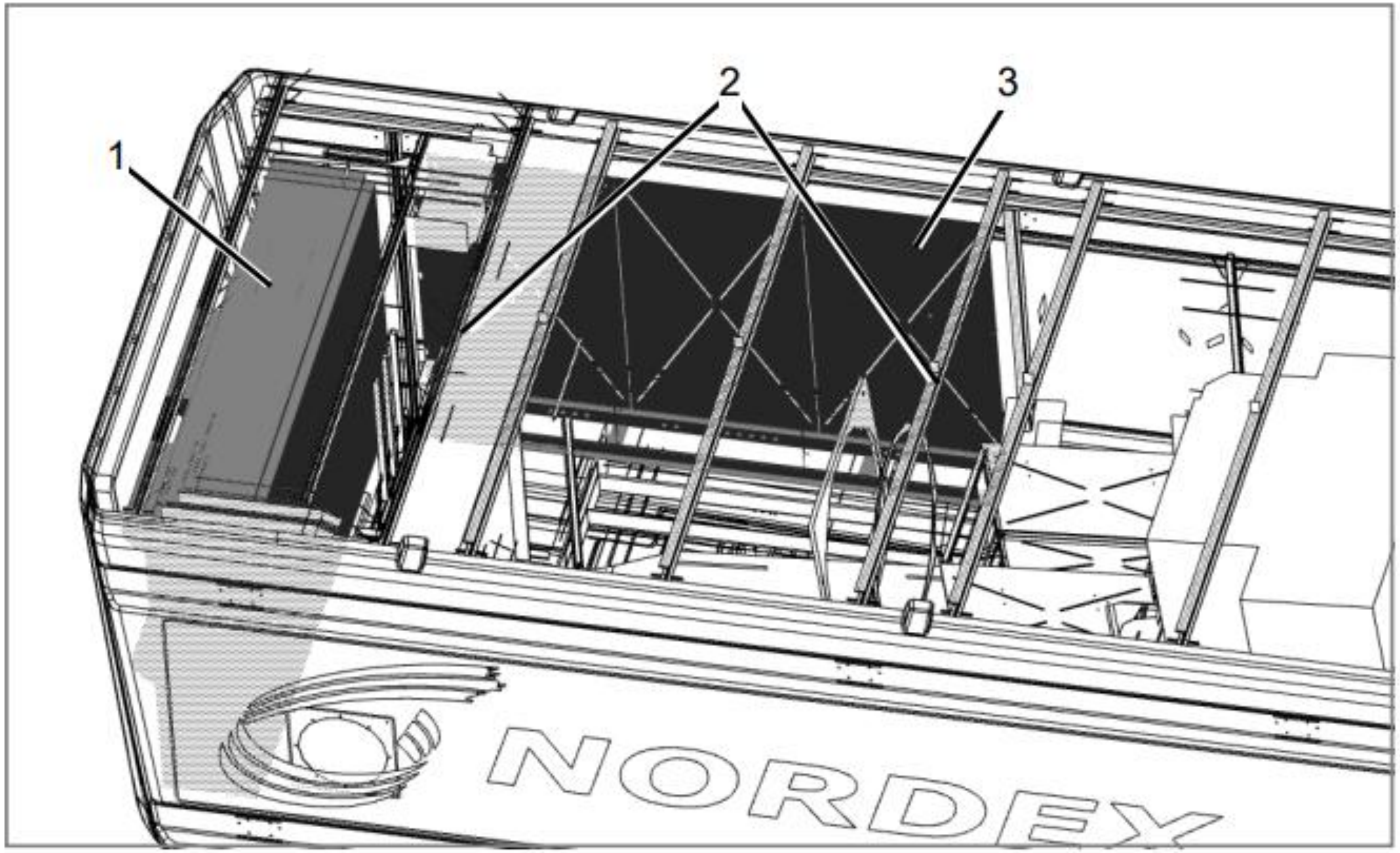


Fig. 1: Location of smoke detectors in the nacelle

1	**Main converter**	**3**	**Topbox**
2	**Roof girder**		

- Location of smoke detector in tower

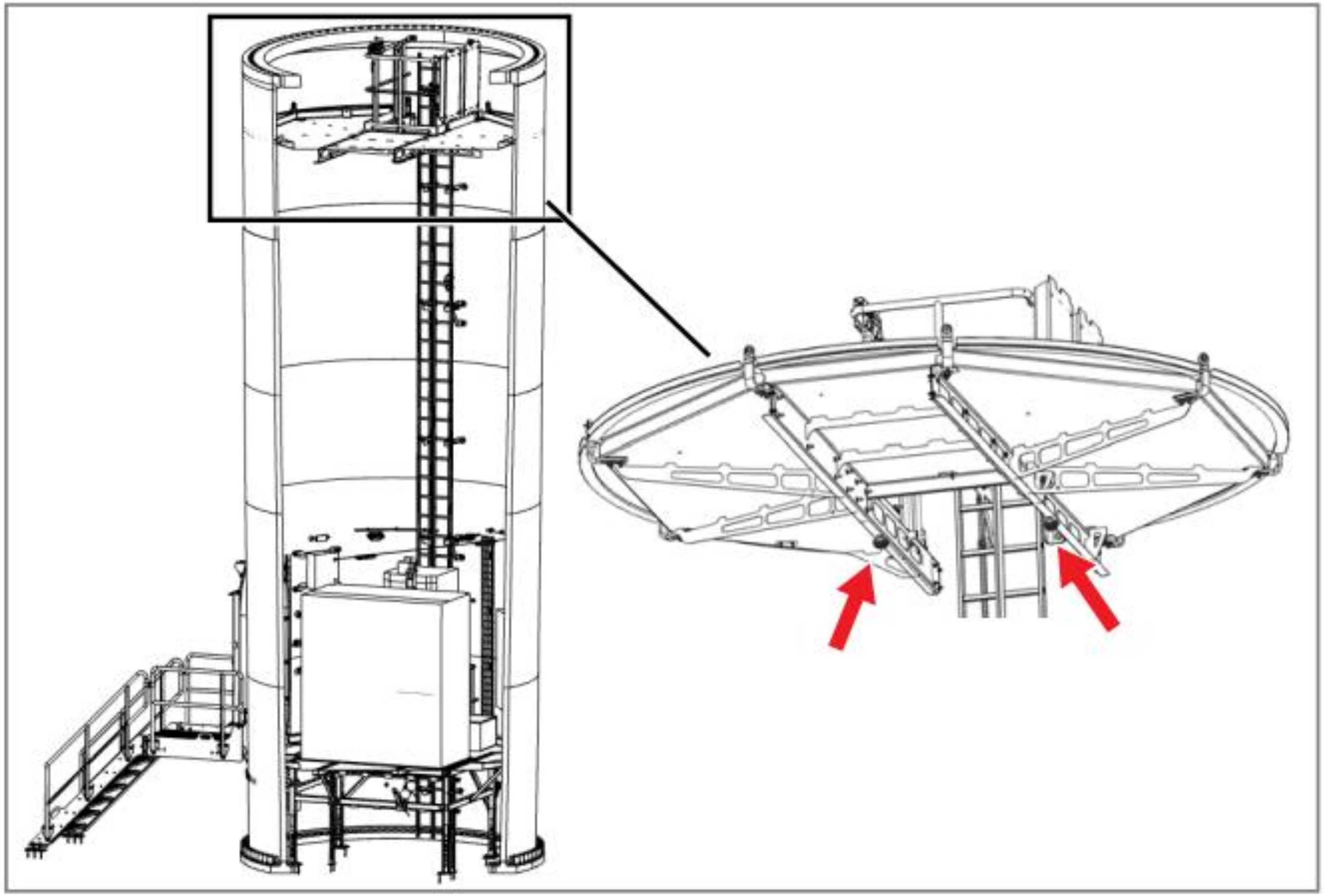


Fig. 2: Location of smoke detectors in tower

- Fire extinguishing system for Delta4000 series

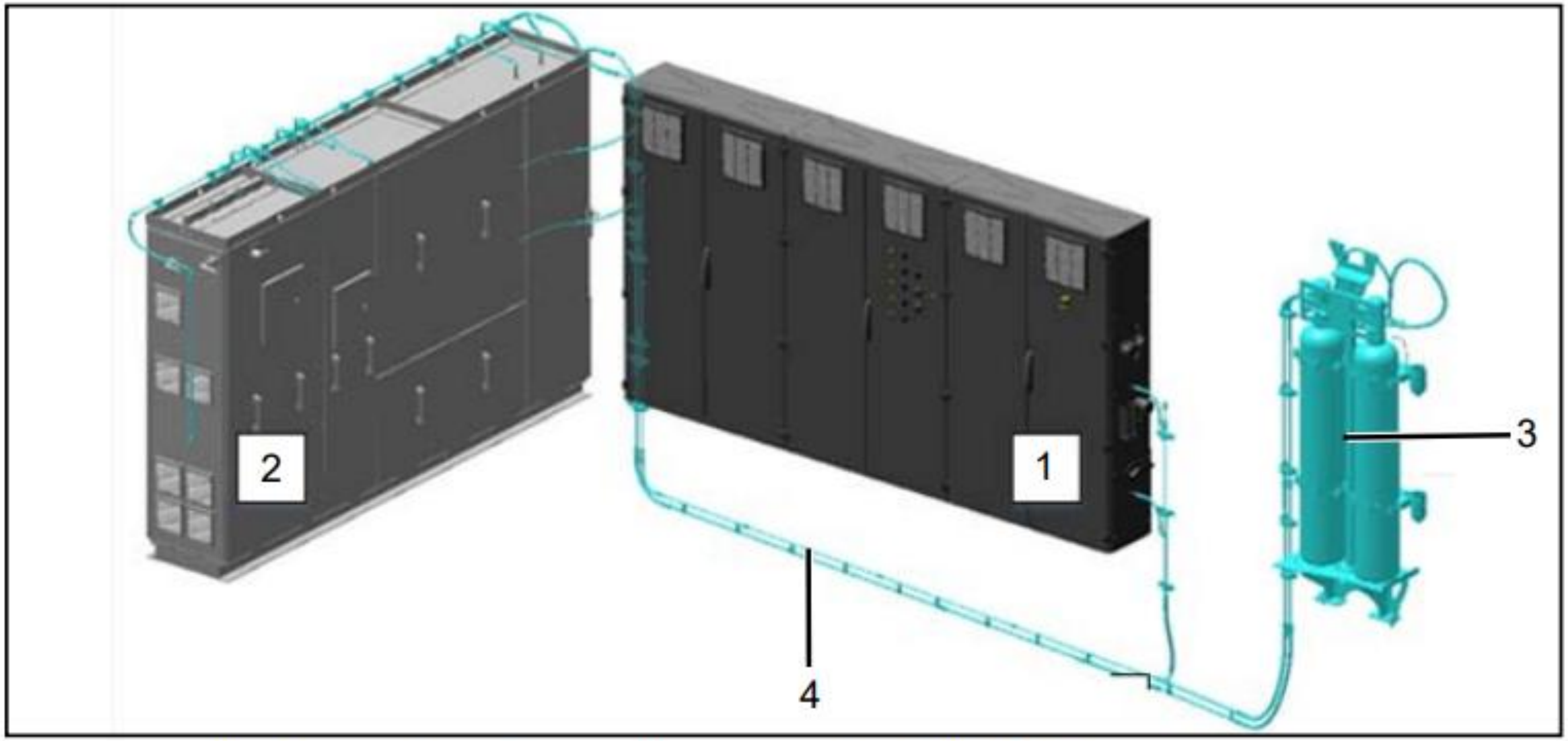


Fig. 3: Fire extinguishing system for Delta4000 series

1	Topbox	2	Main converter
3	Extinguishing agent cylinders	4	Piping system

- Smoke detector locations in the nacelle

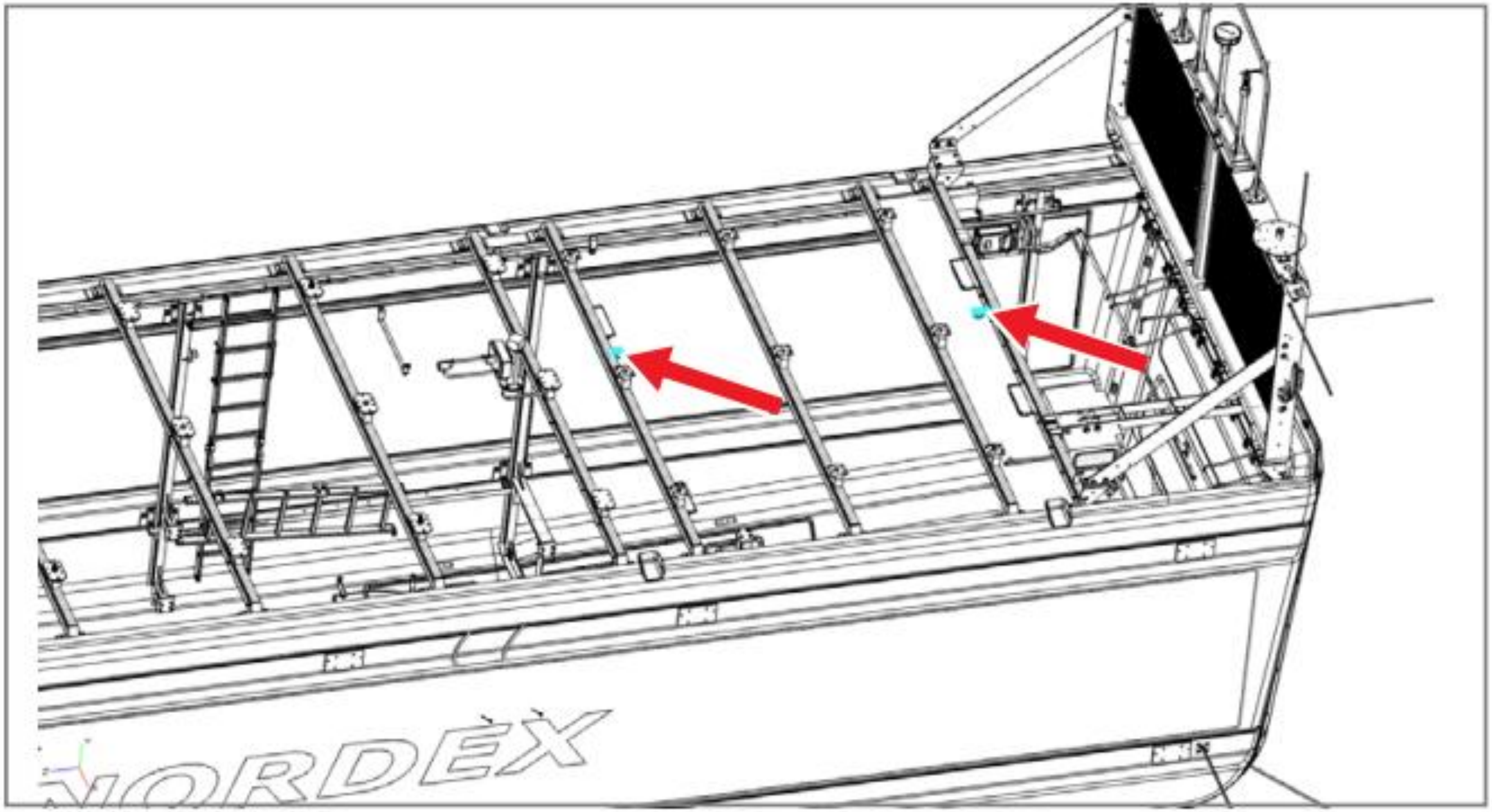


Fig. 7: Nacelle: Smoke detector locations

- Positions of smoke detectors under the first platform

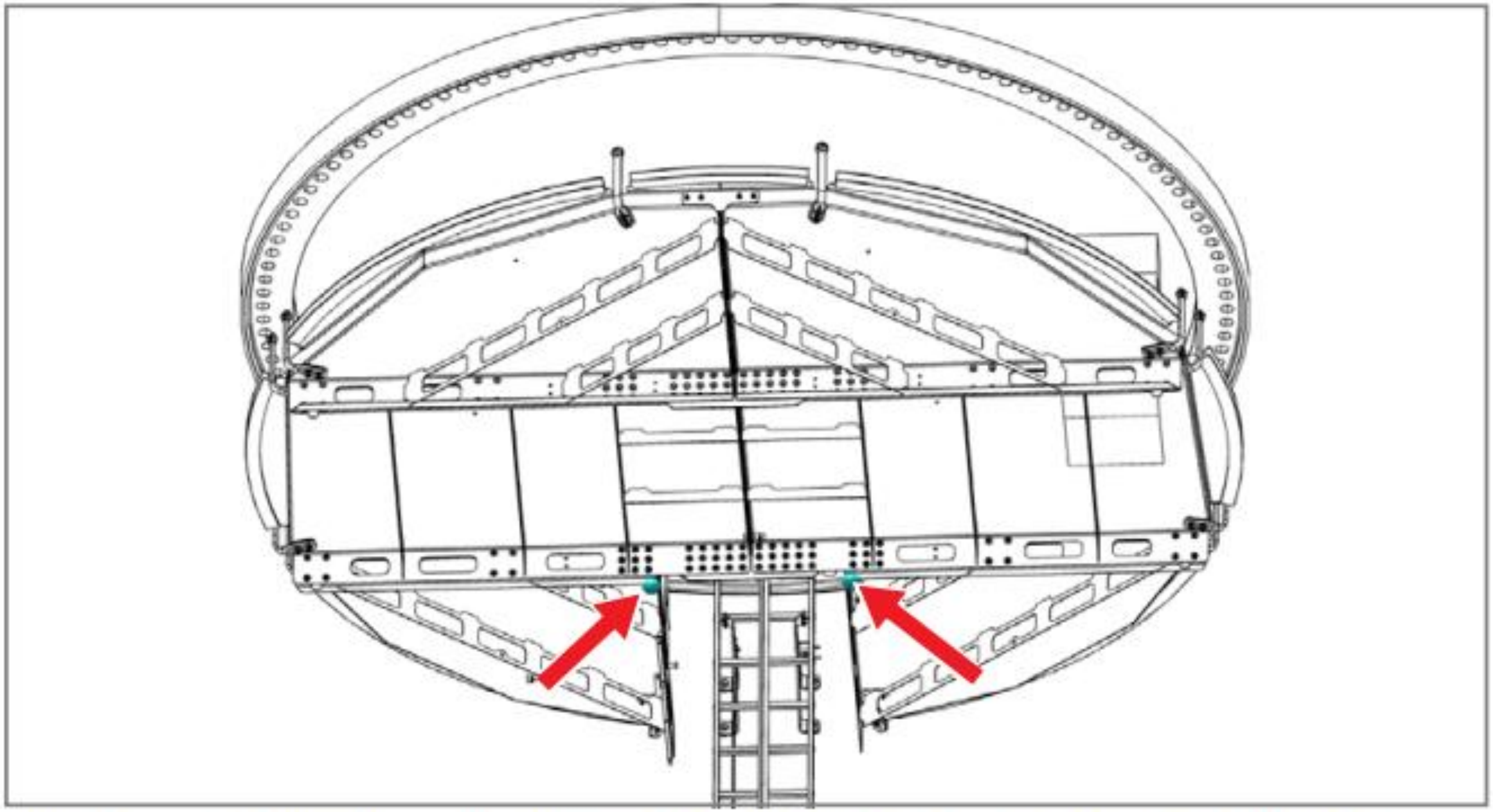


Fig. 13: Tower base: Positions of smoke detector under the first platform

- Evacuation routes inside the tower

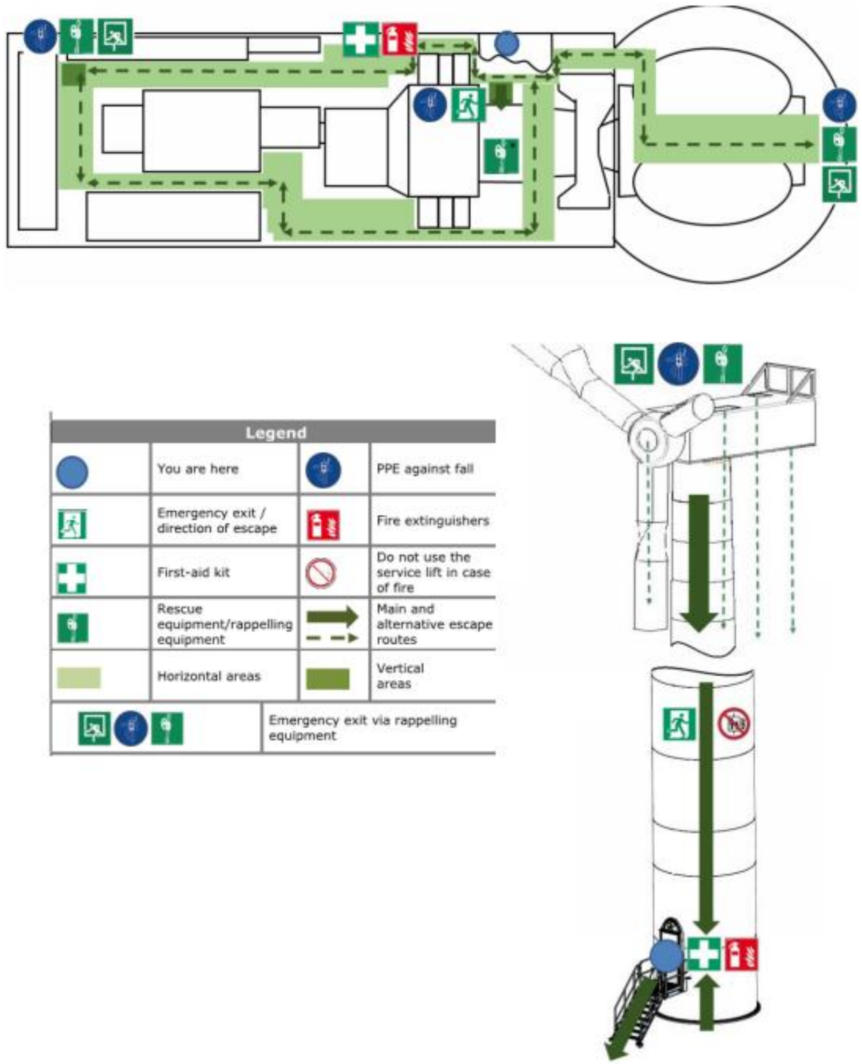


Figure 5:Excerpts from (Nordex Energy GmbH, 2020) – Indication of evacuation routes

Appendix

MIP-MIWF-ACA-BLD-DWG-012-0014

MIP-MIWF-ACA-ELE-DWG-012-0105

MIP-MIWF-ACA-ELE-DWG-012-0107

MIP-MIWF-ACA-ELE-DWG-012-0109

MIP-MIWF-ACA-ELE-DWG-082-0221

MIP-MIWF-ACA-ELE-DWG-082-0223

MIP-MIWF-ACA-ELE-DWG-082-0224

MIP-MIWF-ACA-ELE-DWG-082-0225

MIP-MIWF-ACA-HYD-DWG-012-0106

MIP-MIWF-ACA-ELE-DWG-082-0226

MIP-MIWF-ACA-HYD-DWG-012-0403

MIP-MIWF-NDX-CON-MAN-000-0092

MIP-MIWF-NDX-STR-RPT-000-0002