Prepared for
Snowy Hydro Ltd.
Co No.: 17 090 374 431

AECOM

Fire Safety Study

05-Oct-2022
Hunter Power Station Development Project
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Fire Safety Study

Client: Snowy Hydro Ltd.

Co No.: 17 090 374 431

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Executive Summary

Background

Snowy Hydro Limited (Snowy Hydro) is developing a Gas Turbine Peaking Power Station at Kurri Kurri in the Hunter Valley, NSW – The Hunter Power Project. The project has been declared Critical State Significant Infrastructure (CSSI) under Section 5.13 of the NSW Environmental Planning and Assessment Act 1979 [ref.3].

The Infrastructure Approval, Application Number 12590060 [4], Consent Condition B12(a), for the project requires preparation and submission of a Fire Safety Study (FSS) of the design. This report describes the study and its conclusions.

The NSW Government, Department of Planning and Environment (DPE) has a key objective to pursue the orderly development of industry and the protection of community safety. DPE manages risk assessment and land use safety planning processes that account for both the technical and the broader locational safety aspects of potentially hazardous industry. These processes are implemented as part of the environmental impact assessment procedures under the Environmental Planning and Assessment Act 1979 [ref.3]. FSS of the design is one of the key procedures in this process and DPE's requirements for it are described in NSW *Hazardous Industry Advisory Paper 2 – Fire Safety* (HIPAP-2) [ref.5].

Developing a rigorous fire safety strategy is one element in the safety assurance process for the Hunter Power Project and forms the basis of the fire risk management for the project. Emergency planning is another important element of the safety assurance process, and the FSS will be used as a key input to the development of the emergency planning procedures for the project.

The study investigated the types of fires possible in the planned power station, the consequence of those fires and the adequacy of the planned control measures selected for the facility. Specific emphasis has been placed on understanding the potential for large fire scenarios with the intent of verifying that the planned control measures will be effective at interrupting the fire escalation and damage sequence.

The Fire Safety Study is limited to the Snowy Hydro power station facility project development; the Gas Receival Station project, being developed by APA Group, and the High Voltage Switchyard project, being developed by Ausgrid, are excluded from this FSS. Separate FSS' will be submitted by their respective project developers.

The key elements of the FSS are:

- Identification of fire hazards including identification of hazardous materials, processes and incidents.
- Analysis of consequences of incidents including the direct impacts of incidents and the potential for propagation of damage and secondary incidents.
- Fire prevention strategies and measures including facility design, layout and administrative controls.
- Analysis of the requirements for fire detection and protection, including detection of pre-conditions for fire, and specific detection and protection measures to be implemented.
- Calculation of fire-fighting water supply and demand.
- Containment of contaminated fire-fighting water.
- Firefighting systems to be implemented (including first response equipment).

Results

Fire safety for the project will follow widely recognised and used codes and standards for this type of facility and will be achieved through the use of high-level safety systems, regular preventative maintenance programs, detection and protective measures.

Early warning systems, including fire detection and automatic shut-down systems, will be provided. Flammable gas detection will also be provided. The facility will be monitored by Snowy Hydro General Operations remotely in Cooma, NSW, 24 hours per day. Facility-based personnel will attend the facility during the day from Monday to Friday as a normal operating practice to perform regular field surveillance of plant and to perform regular plant inspection and maintenance. The plant is designed for remote operation, but any manual field tasks required will be performed by the field staff, who will be trained as operator-maintainers. A call-out roster will be implemented for after-hours requirements.

The design and layout of the facility is based on the philosophy of separating key fire hazards from each other and from occupied buildings, without the need for engineered fire protection. Engineered fire protection is included in the design where sufficient separation is not feasible.

For combustible liquids, the design and layout of the facility is based on the philosophy of containing spills or leaks within bunds, remote sumps and closed oily water drain system and on locating the drain system and sumps such that the heat radiation resulting from a pool fire, including oil-filled transformer fires, will not damage neighbouring equipment and lead to incident escalation. Where separation from other equipment is impractical, firewalls have been utilised. Additionally, the fuel oil system has been designed to enable the cessation of all fuel oil movements in a major spill or leak event or a fire event.

A major fuel gas or hydrogen rupture or leak scenario has the potential to result in a substantial jet fire or explosion, if ignited. The system has been designed to enable the cessation of all gas movements. In the case of jet fires, this will cause a rapid reduction in the jet fire size within a timeframe before fire-fighting and cooling of adjacent equipment can commence.

A CO_2 gas flooding fire suppression system will be provided for the gas turbine due to the high value and business criticality of this project element.

Electrical Equipment Rooms will be provided with multi-aspirating smoke detection technology for early identification of fire and SIEX-NC 1230™ suppression systems due to the business criticality of this project element.

The bulk hydrogen storage has been designed with a firewater deluge system to keep it cool to preserve its containment integrity in the event of an external fire.

The Gas Receival Station (GRS) project is being developed by APA Group and is excluded from this FSS, though this study has considered potential incident interactions between the Snowy Hydro power station and the GRS. APA is preparing a separate and complete FSS, which considers the potential for offsite impacts from the gas supply infrastructure.

A significant number of equipment items on the Power Island are located within enclosures. The design of the enclosures is based on the philosophy of non-combustible construction to isolate an equipment fire to the enclosure perimeter, and, in the case of significant fire event risk, the enclosure is provided with a fire suppression system.

The Snowy Hydro high voltage switchyard does not involve equipment with large quantities of insulation oil and therefore has a significant degree of inherent fire safety. The Ausgrid Switchyard project is being developed by Ausgrid and is excluded from this FSS. No significant fire impacts between the Snowy Hydro and Ausgrid high voltage switchyards are foreseen.

The main purpose of the firewater system on the facility is to cool adjacent equipment which may be damaged in a fire. Fire-fighting equipment will include fire hydrants and automatic deluge systems for the mineral oil-filled transformers and bulk hydrogen storage. Firewater sprinkler systems will be provided for the Control & Administration Building, Workshop & Storage Building, Auxiliary Plant Enclosure (i.e. lube and control oil plant), Seal Oil System and Fuel Oil Unit (associated with the GT). Firewater sprinkler systems will also be provided to the underside of the Electrical Equipment Rooms to complement the non-combustible construction material of the room walls, roof and floor rather than pursuing a fire-barrier cavity for cable entry. The fire-fighting system will be complete with connections for hook-up by FRNSW or the NSW RFS. Further, fire extinguishers will be provided throughout the facility.

The location of fire hydrants that may be called upon for cooling of neighbouring structures or equipment is adequate and has been based on fire scenarios with potential prolonged duration.

The firewater tanks, pumps and brigade booster connection are located to be clear of the effects of credible fire events (a full bund fuel oil fire has been studied and would impact this equipment; however, the scenario is considered bordering on non-credible).

The MFIP will be linked to the FRNSW through an approved third-party Automatic Fire Alarm Service Provider, given that the facility will only be attended during the day from Monday to Friday.

Firewater will be contained on the facility.

The impact of bushfire to the Snowy Hydro facility has been studied. Considering the planned APZ, all buildings, enclosures and structures on the facility are located outside the $19kW/m^2$ thermal radiation isopleth. Key vulnerabilities, i.e., occupied buildings and bulk hydrogen storage, are located outside the $12.5kW/m^2$. Ember attack at any location on the site is recognised. The design of all buildings, enclosures and structures is based on the philosophy of non-combustible construction and considered appropriate for the bushfire risk. The planned APZ is adequate.

The approach to fire safety specified for the project is considered appropriate for the identified fire scenarios and site manning.

1.0 Glossary of Terms and Abbreviations

Table 1 Glossary of Terms and Abbreviations

Abbreviation/Reference	Explanation/Meaning
AECOM	AECOM Australia Pty Ltd (Balance of Plant Design Consultant)
AFASP	Automatic Fire Alarm Service Provider
AHD	Australian Height Datum
APA	APA Group (natural gas infrastructure operator and supplier)
API	American Petroleum Institute
APZ	Asset Protection Zone (bushfire hazard assessment)
AS and AS/NZS	Australian Standard and Joint Australian and New Zealand Standard
Ausgrid	NSW electricity distribution network operator (recipient of produced power)
BAL	Bushfire Attack Level
BCA	Building Code of Australia
Balance of Plant	All equipment, buildings, yards, roads and fencing not on the Power Island
BLEVE	Boiling liquid expanding vapour explosion
BOWS	Building Occupant Warning System
BPL	Bushfire Prone Land
°C	Degrees Celsius
CCTV	Closed Circuit Television
CGA	U.S. Compressed Gas Association
CICL	Cast Iron Cement Lined (piping)
CIGRE	International Council on Large Electric Systems
CO_2	Carbon Dioxide
DCS	Distributed Control System
DG	Dangerous Goods
DN	Nominal Diameter (piping)
DO	Diesel Oil
ESD	Emergency Shut Down
ESDV	Emergency Shut Down Valve
FG	Fuel Gas (natural gas)
FIP	Fire Indicator Panel
FO	Fuel Oil (diesel)
FRNSW	Fire and Rescue New South Wales
FSS	Fire Safety Study
GRS	Gas Receiving Station (operated by APA)
GTG	Gas Turbine Generator plant
GSUT	Generator Step-Up Transformer
H2	Hydrogen
HDPE	High Density Polyethylene

Abbreviation/Reference	Explanation/Meaning
HGL	Hydraulic Grade Line
HIPAP	NSW Hazardous Industry Planning Advisory Paper
HPP	Hunter Power Project
HV	High Voltage
HY	Hydrogen
ISO	International Standards Organisation
kg	kilogram
kL	kilolitre
kPa	kilopascal
kPa(g)	kilopascal gauge
kW	kilowatt
LCO	Lube oil, seal oil, control oil
LOC	Loss of Containment
L/min	Litres per minute
L/s	Litres per second
LV	Low Voltage
m	metre
m^2	Square metres
$mm/m^2/s$	millimetres per square meter per second
MELCO	Mitsubishi Electric Corporation (Generator plant designer and supplier)
MEM	Multi-Energy Model of an explosion
MFIP	Main Fire Indicator Panel
MHI	Mitsubishi Heavy Industries (Gas turbine plant designer and supplier)
MJ	megajoule
ML	megalitre
MV	Medium voltage
NCCA or NCC	National Construction Code of Australia
NFPA	U.S. National Fire Protection Association
NG	Natural gas
N/R	Not Reached
NSW	New South Wales
OCGT	Open Cycle Gas Turbine
PES	Potential Explosion Site
PHAST™	Process Hazard Analysis Software Tool developed by DNV AS
Power Island	Gas turbine and generator equipment and associated auxiliary plant co-located in a common site area (remainder of facility is referred to as “Balance of Plant”
PTW	Permit to Work
RFS	(NSW) Rural Fire Service
SDV	Shut-down Valve

Abbreviation/Reference	Explanation/Meaning
SFC	Static Frequency Converter
SFIP	Sub Fire Indicator Panels
SHL	Snowy Hydro Ltd (owner and operator of power station)
Snowy Hydro	Snowy Hydro Ltd (owner and operator of power station)
TBC	To be confirmed
TNO	Netherlands Organisation for Applied Scientific Research (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek)
TO	Transformer oil
MASD	Multi-Aspirating Smoke Detection
VCE	Vapour Cloud Explosion

2.0 Introduction

2.1 Background

The Hunter Power Project will design and construct a new Open Cycle Gas Turbine power station in the Hunter Valley to enable Snowy Hydro to increase its dispatchable generating capacity in NSW. The facility will be able to supply electricity to the grid at short notice during periods of high electricity demand including during low supply periods from intermittent renewable sources or during supply outages at other base load power stations.

2.2 Scope and Aim of Study

The scope of this Fire Safety Study (FSS) is only the gas turbine power station being developed and subsequently operated by Snowy Hydro. The Gas Receival Station, referred to in Condition of Consent B12(a) for the project, which will eventually supply natural gas to the power station, is being developed by APA Group and is excluded from this FSS. APA Group is preparing a separate FSS for submission to the NSW Department of Planning and Environment (DPE).

This FSS only covers the operational phase of the facilities.

The aim of the FSS is to demonstrate that the fire safety strategy for the planned facility is appropriate for the specific fire hazards associated with it.

It is also a document to enable stakeholder consultation with Fire and Rescue NSW (FRNSW), the NSW Rural Fire Service (NSWRFS) and DPE.

The FSS is required as part of the planning approval in NSW, as per the Condition of Consent B12(a) (Application No. 12590060) by DPE. Additionally, the impact of the Asset Protection Zone, established at the early design phase for the project and reported in the Preliminary Hazard Analysis (PHA, ref.11), is discussed, in accordance with the Condition of Consent B12(a) for the project. Conditions of Consent B12 relating to fire safety are presented in Appendix A.

Snowy Hydro’s high level fire safety philosophy is twofold:

- Safety of personnel
- Protection of asset

Fundamentally the philosophy is based on prevention of fires, i.e., by keeping the elements of the “fire triangle” (fuel, oxygen and ignition sources) segregated to the extent possible.

Should a hazardous condition develop with the potential to escalate into a fire event the philosophy with respect to safety of personnel working in HPP is to ensure there is combination of early detection, suppression and personnel protection for escape appropriate to the types of credible fire events at HPP. The philosophy with respect to the asset is to protect critical asset (intolerable loss) items from damage and economic minimisation of damage to other asset items.

The Study also highlights the designer’s expectations of operational procedures required to be implemented to complement the planned extent and configuration of hardware (from a fire safety perspective) to achieve the overall HPP fire safety goals.

2.3 Methodology

NSW DPE has developed an integrated assessment process for safety assurance of development proposals, which are potentially hazardous. The process is shown diagrammatically in Figure 1 with the FSS highlighted.

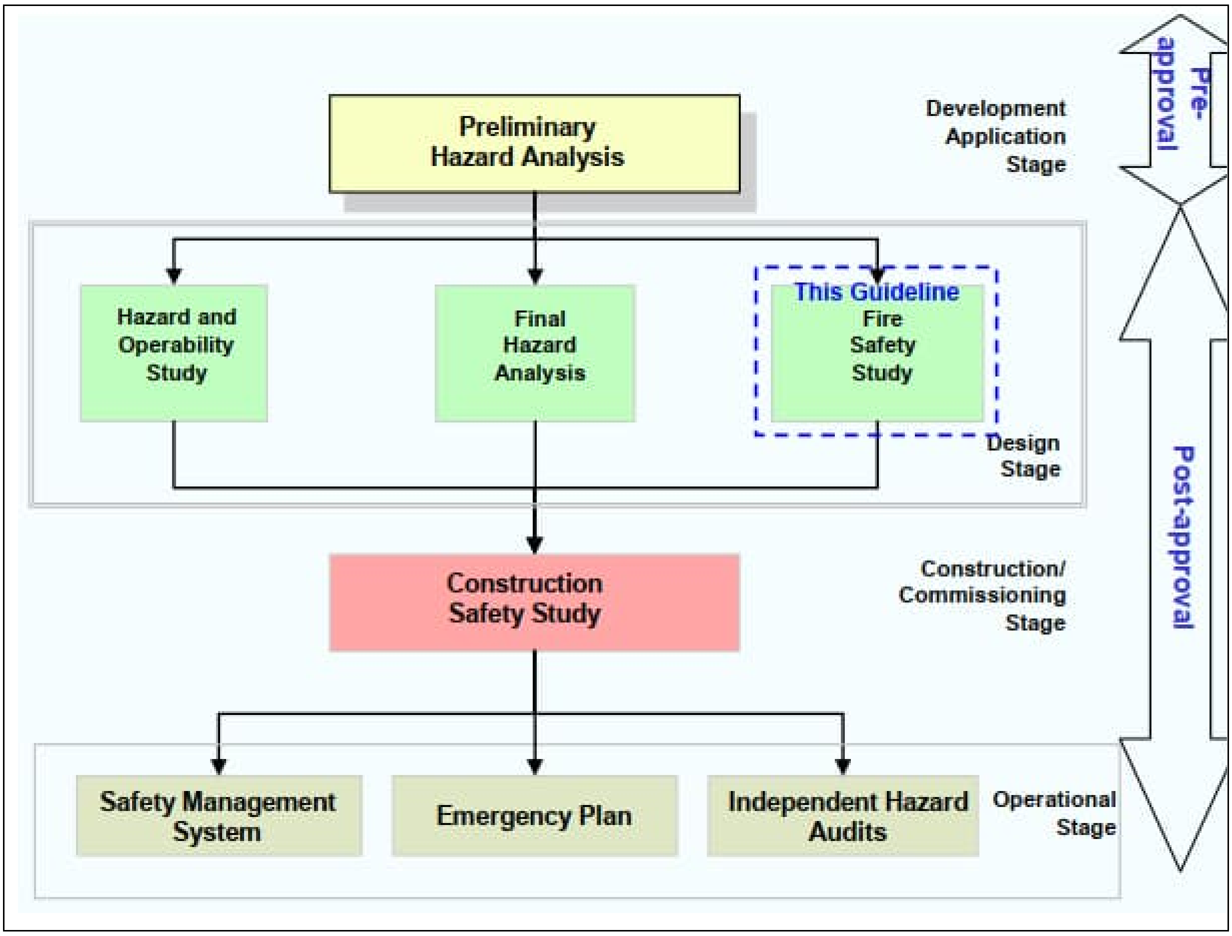

Figure 1 NSW DPE Hazards-Related Assessment Process [ref.5]

The FSS has two elements:

The study is the activity of examining the planned design to identify potential fire scenarios and assessing the impact of each scenario. Group activities were the primary vehicle for scenario identification to facilitate input of knowledge about the fire risks of the plant equipment by its designers. Snowy Hydro operations personnel from its gas turbine portfolio also participated in the group activities to input their operating experience and industry incident knowledge. The group activities included:

- HAZOP workshops conducted during the period January to May 2022 [refs.6, 7]
- Safety in Design workshops conducted during March and April with an additional session in June 2022 [refs.8, 9, 10]
- Preliminary hazardous chemicals inventory storage assessment in January 2022
- Fire Safety Strategy review meetings in April 2022
- Design coordination meetings with MHI and MELCO.

The hazard identification in Section 4.0 draws directly from the results of the workshops and meetings highlighted in the previous bullet list.

The prevention, detection, protection and emergency response associated with each scenario is evaluated by risk analysts and fire protection engineers and documented.

The report summarises the fire safety strategy on site and justifies design decisions. It facilitates discussions with the relevant stakeholders and development of further hazard and risk-related studies and risk management plans.

2.4 Key Elements of Fire Safety Study

The key elements of the FSS are:

- Identification of fire hazards including identification of hazardous materials, processes and incidents.
- Analysis of consequences of incidents including the direct impacts of incidents and the potential for propagation of damage and secondary incidents.
- Fire prevention strategies and measures including facility design, layout and administrative controls.
- Analysis of the requirements for fire detection and protection, including detection of pre-conditions for fire, and specific detection and protection measures to be implemented.
- Calculation of fire-fighting water supply and demand.
- Containment of contaminated fire-fighting water.
- Firefighting systems to be implemented (including first response equipment).

3.0 Description of the Facility

3.1 Site Location

The Project Site is located at Hart Road, Loxford, about one kilometre (km) east of the M15 Hunter Expressway and about three km's north of the town of Kurri Kurri as shown below in Figure 2.

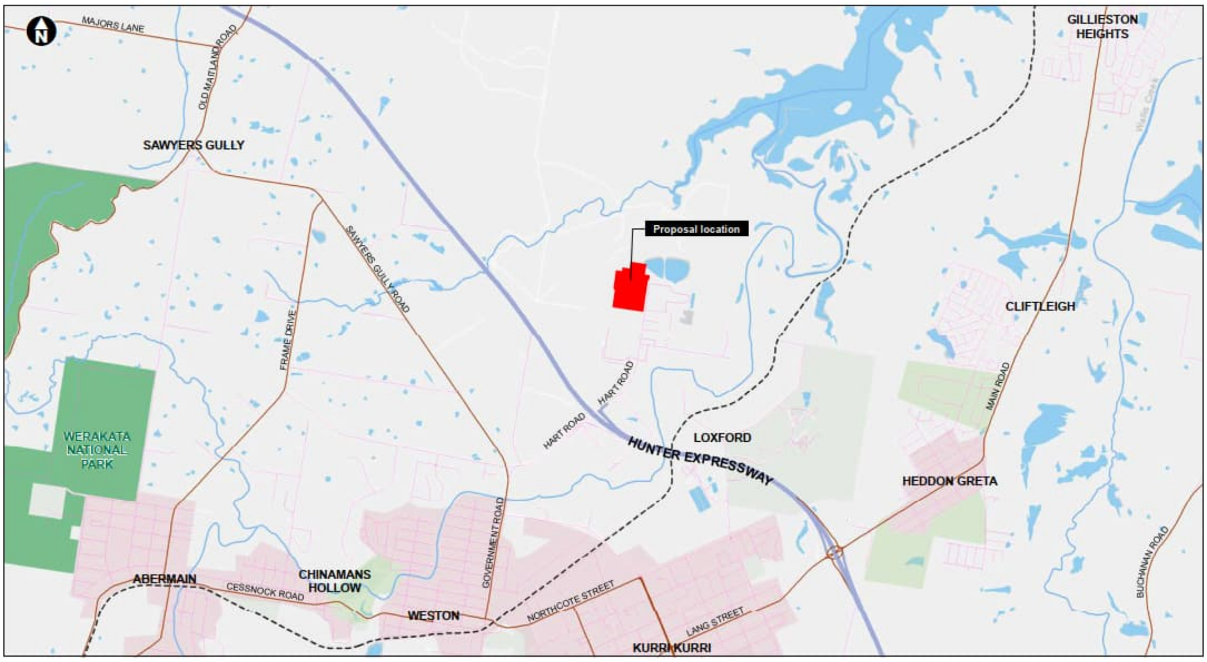

Figure 2 Project Location

3.2 Project Infrastructure Description

The power station will be a dual fuel (gas and diesel), "peak load" generation facility supplying electricity at a capacity of up to approximately 660 MW, which will be generated via two heavy-duty open cycle gas turbines (OCGTs).

The project involves the construction and operation of a power station together with other associated infrastructure. The major supporting infrastructure required for the project is a 132kV electrical switchyard located adjacent to the power station and within the project site. The project will connect into the existing 132kV electricity transmission infrastructure of Ausgrid located near the project site. A new gas lateral pipeline and Gas Receival Station is being developed by APA Group (APA) to supply gas at 4.5MPa to the power station. Figure 3 schematically shows the key process elements of the overall plant in a block flow diagram and Figure 4 depicts the site layout.

Snowy Hydro has engaged two main organisations to perform the design with the following division of design responsibility:

- Power Island Plant– Mitsubishi Heavy Industries (MHI)
- Balance of Plant and Power Island Plant integration – AECOM Australia Ltd

MHI will also supply the Power Island Plant.

The Power Islands include two heavy duty F-class OCGTs (one set per Power Island) with generator circuit breakers, generator step-up transformers and necessary auxiliary plant infrastructure, including:

- Static frequency converter and associated equipment
- Excitation transformer and associated equipment
- Fuel gas control

- Fuel oil control
- Oil systems (control, lubrication and gas sealing)
- Closed cooling water system
- Turbine enclosure air cooling
- Gas fire suppression systems
- Firewater deluge and sprinkler systems
- Turbine blade washing facility

The Balance of Plant infrastructure includes:

- 2 x diesel fuel storage tanks, forwarding pumps and associated piping systems
- Diesel tanker truck unloading facilities
- Water storage tanks (potable and demineralised) and associated pumping facilities and piping systems
- Demineralised water production plant
- Natural gas reticulation piping system
- Hydrogen storage (tube trailer and cylinder crates) and associated piping systems
- Nitrogen and Carbon Dioxide storage (cylinder crates) and associated piping systems
- Compressed air (service and instrument) production facility and associated piping systems
- Oily water drainage system and separation system
- Wastewater treatment system (primarily pH adjustment)
- Stormwater drainage system
- Fire-fighting system including water storage, pumps, hydrants, monitors, sprinkler and deluge systems
- Emergency diesel generator with associated internal fuel storage
- Electrical Switch Rooms and associated power distribution cabling
- Control & Administration Building incorporating a Local Control Room and amenities
- Integrated Workshop & Storage Building
- Chemical Store
- Yards for outdoor laydown
- Roads, car parks and security fencing

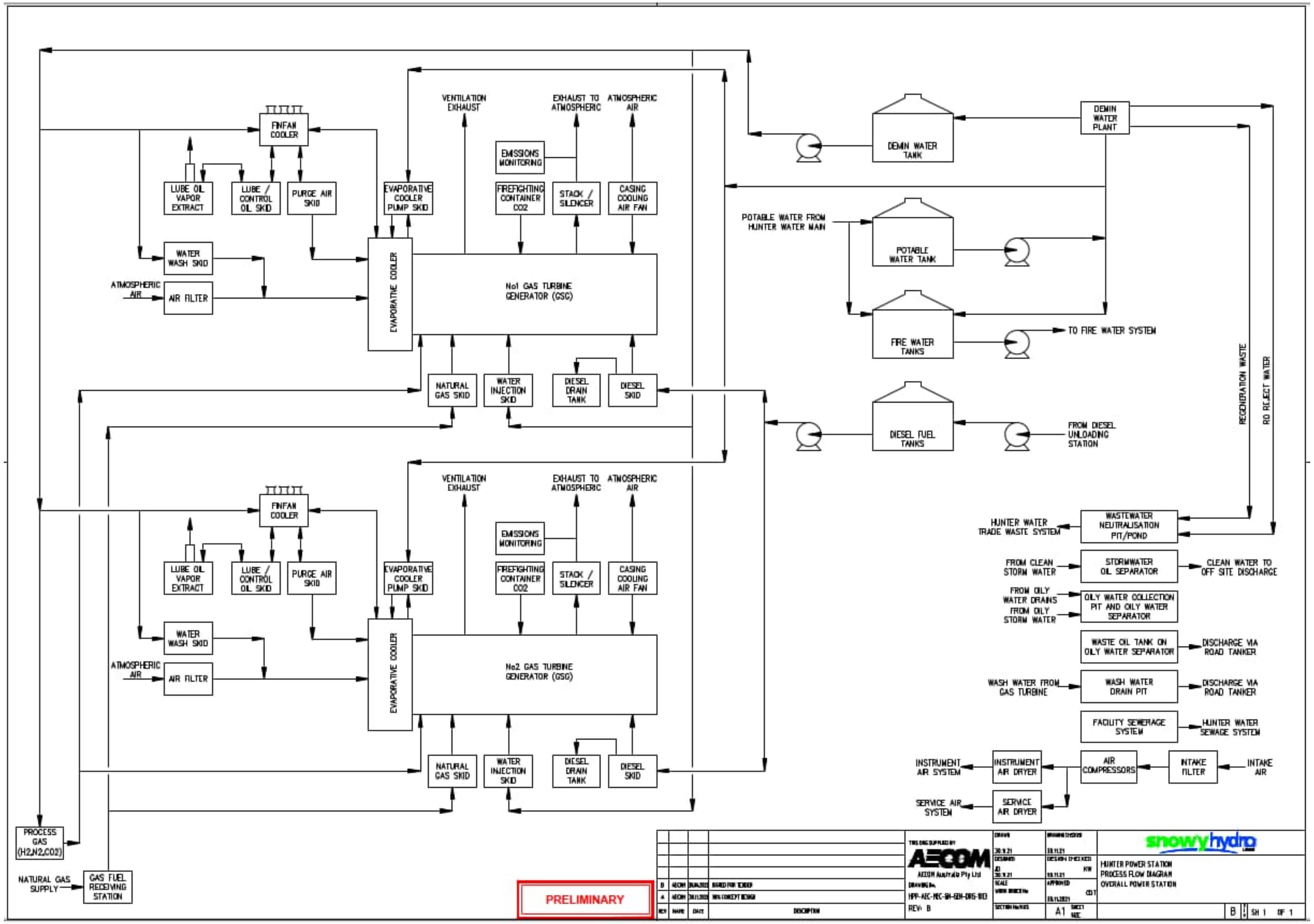

Figure 3 Overall Plant Block Flow Diagram

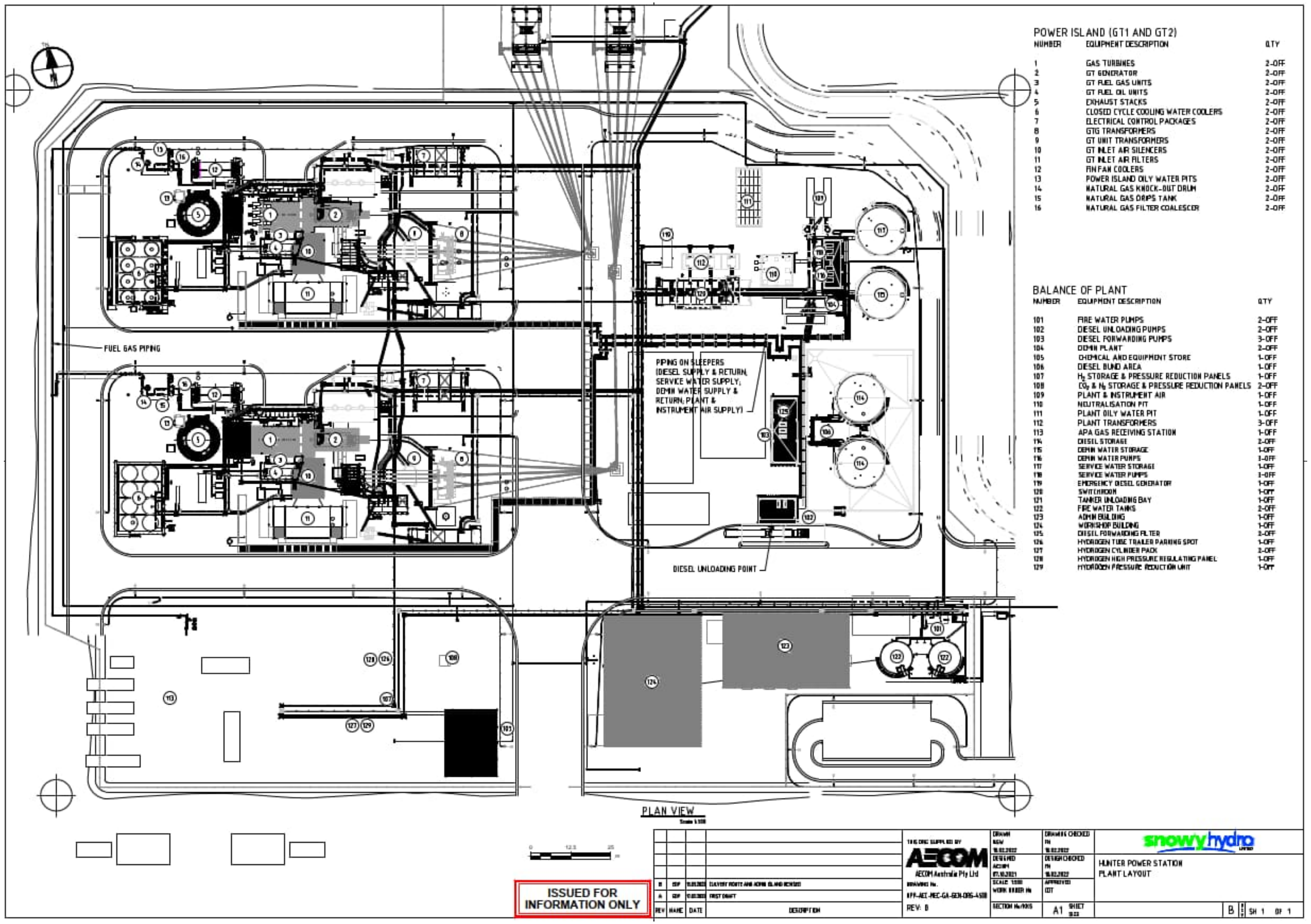

Figure 4 Site Layout

3.3 Operating Hours and Occupancy

3.3.1 Operating Hours

As the facility is a peaking power station it will have a high availability requirement but low operating hours; it will be in “standby” mode for most of the time. Table 2 indicates the key parameters in this regard.

Table 2 Plant Operating Hours

Parameter	Units	Details	Comment
Design annual operating hours for environmental assessments	Hours/year	1051	As per above capacity factor, based on 100% load operation 876 hours on gas 175 hours on diesel
Long term expected average annual operating hours at 100% load	Hours/year	350 or approximately 4% (typically 2-10 hours per run)	Realistic long-term average is expected to be 2-4% based on 100% load operation
Long term average annual starts per year	No. per year	50	
Maximum expected annual starts	No. per year	200	
Anticipated operating hours at minimum load	Hours/year		Half the normal runs per year would have 1 hour at minimum load

3.3.2 Occupancy

Due to the operating regime of the peaking power station, the site will only be normally attended during the day on Monday to Friday.

There will be up to 10 permanent snowy Hydro personnel plus contracted maintenance representatives (potentially up to 20 individuals per week but highly variable).

Another 2 people per day are expected to visit the site for short durations, associated with scheduled tasks, on Monday to Friday.

3.4 Main Codes and Standards

The codes and standards most applicable to the fire safety strategy for the facility are listed below:

Power Station General

- NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

Flammable Gas Storage and Piping Systems

- NFPA 2 Hydrogen Technologies Code
- CGA G-5.5 Hydrogen Vent Systems, US Compressed Gas Association
- NFPA 55 Compressed Gases and Cryogenic Fluids Code

Tanks and Piping Systems

- AS 1692 Steel Tanks for Flammable and Combustible Liquids
- AS 1940 The storage and handling of flammable and combustible liquids
- API SPEC 6FA Specification for Fire Test for Valves
- API STD 607 Fire Test for Soft-Seated Quarter-Turn Valves

Transport of Dangerous Goods

- Australian Code for Transport of Dangerous Goods by Road and Rail (ADG Code), 7th Ed.

Fire Pumps, Hydrants, Extinguishers and Firewater

- AS 2941 Fixed fire protection installations – Pump set systems
- AS 2419.1 Fire hydrant installations – System design, installation and operation
- AS 2118.1 Automatic fire sprinkler systems Part 1: General systems
- AS 2441 Installation of fire hose reels
- AS 2444 Portable fire extinguishers and fire blankets – Selection and location
- NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection

Medium and High Voltage Electrical Systems

- AS 2067:2016 Substations and high voltage installations exceeding 1 kV a.c.
- CIGRE 537 Guide for Transformer Fire Safety Practices
- CIGRE 436 Experiences in service with new insulating liquids
- FM Global Property Loss Prevention Data Sheet 5-4 – Transformers
- AS 60296:2017 Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear

Electrical

- AS/NZS 1020 The control of undesirable static electricity
- AS/NZS 1768 Lightning Protection
- AS/NZS 60079.10 Electrical apparatus for explosive gas atmospheres – Classification of hazardous areas
- AS/NZS 2381 Electrical equipment for explosive gas atmospheres – Selection, installation and maintenance
- AS/NZS 3000 Electrical installations – “Wiring Rules”

Buildings and Enclosures

- National Construction Code of Australia (NCCA), Building Code of Australia (BCA)
- AS 3959 Construction of buildings in bushfire-prone areas
- AS 1530 Fire resistance test on elements of building construction
- AS 1905.1 Components for the protection of openings in fire-resistant walls - Fire-resistant door sets
- AS 4072.1 Components for the protection of openings in fire-resistant separating elements – Service penetrations and control joints
- AS 1668.2 The use of ventilation and air-conditioning in buildings - Mechanical ventilation in buildings
- AS 2220-1978 Rules for emergency warning and intercommunication systems for buildings
- AS/NZS 2293 Emergency escape lighting and exit signs for buildings - System design, installation and operation
- AS 4214 Gaseous fire-extinguishing systems
- NFPA 12 Standard on Carbon Dioxide Extinguishing Systems

Firewalls

- AS 3600:2018 Concrete structures

Emergency Control

- New South Wales Work Health & Safety Act 2011
- New South Wales Work Health & Safety Regulation 2011
- AS3745 Planning for emergencies in facilities
- New South Wales Hazardous Industry Planning Advisory Paper No 1 - Emergency Planning
- New South Wales Hazardous Industry Planning Advisory Paper No 2 – Fire Safety Study Guidelines
- National Construction Code of Australia (NCCA), Building Code of Australia (BCA)
- AS 1670 Fire detection, warning, control and intercom systems – System design, installation and commissioning Part 1: Fire

4.0 Fire Hazard Identification

4.1 Fire Hazard Substances

The fire hazard substances that are located onsite in significant quantities are identified in Table 3.(small quantities of other combustible or flammable substances

Table 3 Fire Hazard Substances identification and Inventories

Substance	Vessel	DG Class	HAZCHEM Code	UN Code	Maximum Storage Quantity
Natural Gas	Not Stored	2.1	2SE	1971 (as methane)	Nil in storage. 150 tonnes per hour in process (includes all vessels and piping)
Hydrogen	G-Size Cylinders in Crate Packs	2.1	2SE	1049	1.5 actual m3 in G-size cylinders
	Tubes in Trailer Pack				23.45 actual m3 in Tubes (TBC)
Diesel[1]	2x Vertical storage tanks	Not a DG. Combustible liquid C1 as per AS1940 (flash point >61.5°C)	N/A	N/A	4242 m3 in bulk storage
Lube Oil[2] (for rotating equipment), Seal Oil (for Generator)	Compressors, Pumps, Turbines, Generators, Fire pumps,	Not a DG. Combustible liquid C2 as per AS1940 (flash point >150°C)	N/A	N/A	Up-to 100kL inventory within rotating equipment per Unit. Up-to 65.8kL in lube oil reservoir per GTG Unit.
Control Oil[3] (hydraulic power)	Turbine Control system	Not a DG. Combustible liquid C2 as per AS1940 (flash point >150°C)	N/A	N/A	Up-to 28kL in control oil reservoir per GTG Unit.

Substance	Vessel	DG Class	HAZCHEM Code	UN Code	Maximum Storage Quantity
Transformer Oil[4]	Transformers	Not a DG. Combustible liquid C2 as per AS1940 (flash point >140°C)	N/A	N/A	73m^3 in the Generator Step-Up Transformer (largest) and 10m^3 in the Unit Transformer separated by a firewall Other transformers are distributed through the facility.

1. Caltex Australia Petroleum Pty Ltd, Safety Data Sheet CAL0027601 – Automotive Diesel Fuel, 1st July 2016
2. Chevron U.S.A. Product Description Sheet IO-87 – ISOCLEAN, GST® Premium 32 ISOCLEAN® Certified Lubricant, 1st July 2016
3. Chevron Australia Downstream Pty Ltd, Safety Data Sheet 55367 - Rando HD 32, 46, 68, 100, 150, 22nd July 2021
4. Nynas AB, Safety Data Sheet NYTRO® LIBRA, 28th May 2021

4.2 Fire Hazard Incident Scenarios

The focus of the hazard identification process is to identify potential significant fire incident scenarios at the facility. A significant fire incident for the purpose of this Study is an incident involving the potential for a large or aggressive fire which, in the absence of control measures, has the potential to cause severe harm or damage to multiple people and infrastructure.

Other possible fire incidents, which would be highly localised with virtually no escalation potential onsite, e.g., a fan motor, and therefore no offsite risk have been recognized to be present in plant throughout the facility during the study activity and are able to be dealt with via the general fire protection facilities provided on site, i.e., power isolation, portable fire extinguishers and fire hose reels. These items are not called out explicitly in this study.

Significant fire incident scenarios involving flammable and combustible fluids have been identified below in Table 4. Non-fluid significant fire incidents are identified in Table 5 and relate to:

- Fire in buildings
- Fire in electrical switch rooms

Several scenarios must be considered because of flammable and combustible fluids loss of containment (LOC). These include:

- immediate ignition of low-pressure leaks of flammable and combustible liquids resulting in a pool fire
- immediate ignition of high-pressure leaks resulting in a jet fire for flammable gases and a spray fire for flammable and combustible liquids
- delayed ignition allowing formation of a flammable liquid pool and vapour cloud above it for flammable liquids. Subsequent ignition of the vapour cloud may result in either a flash fire or vapour cloud explosion depending on conditions. (The combustible liquids in The Project are stored and transferred at ambient temperature and therefore do not present a credible vapour cloud risk).

The significant fire incidents that can arise from a LOC scenario include the following:

- Jet fire
- Pool fire
- Flash fire
- Vapour cloud explosion

Transformer fire events are included as pool fire incidents.

Modelling shows that the heat radiation from flash fires is similar to that of jet fires, for the same size release. Further, flash fires are extremely short, so the thermal dose is significantly lower than for jet fires and is only problematic for people but not plant or structures. Therefore, the analysis of jet and pool fires is considered sufficient to assess the impact of fire incidents associated with a loss of containment of flammable material.

The significant hazardous events associated with flammable and combustible fluids storage and handling on site that will be carried forward for analysis are summarised in Table 4. The scenario coding used has three fields, structured as AA_NN_NN, whereby:

- Field 1, AA, is a two-character alphabetic field identifying the fluid of concern
- Field 2, NN, is a two-digit numeric field for a specific loss of containment (LOC) scenario for the fluid of concern in Field 1
- Field 3, NN, is a two-digit numeric field for each hazard effect associated with a specific loss of containment scenario for the fluid of concern, identified by Fields 1 and 2, e.g., Jet Fire, Flash Fire, Pool Fire, etc

The combination of Field 1 and Field 2 represents all the flammable and combustible fluid LOC incidents carried forward for detailed analysis.

The following flammable and combustible fluid codes are used:

- NG – Natural Gas
- HY – Hydrogen
- DO – Diesel Oil
- TO – Transformer Oil
- LCO – Lubricating Oil (which is also used as Seal Oil for the Generator Casing) and Control Oil (hydraulic oil)

In Table 4, the reference to "Design Model Zone" is a reference to division of the site into areas to facilitate design coordination, as shown in Figure 5; use of the term "zone" is not to be construed as having any other meaning.

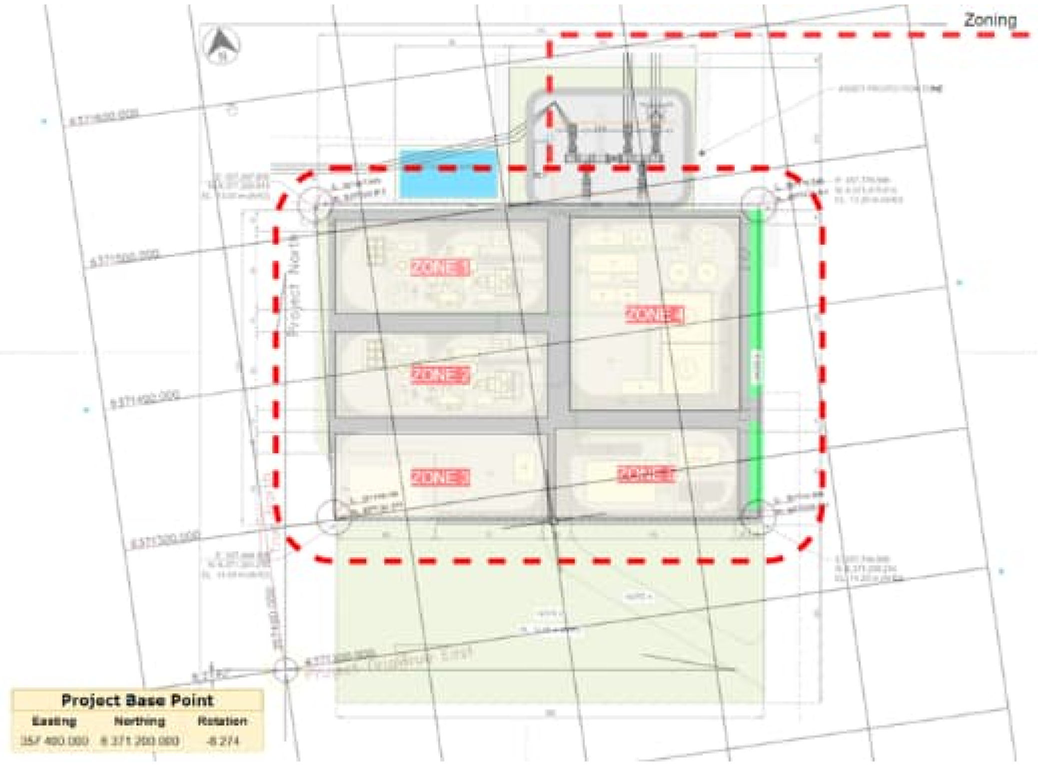

Figure 5 Design Model Zones

The identified consequences from LOC incidents in these flammable and combustible fluids storage and handling operations on site are documented in Table 6 in the context of the facility and planned control measures, whilst identified consequences from significant non-fluid fire hazards are documented in Table 7.

Numbers preceded by a "#" in the following tables are MHI standard plant identifiers, e.g., Fuel Gas Unit is (#11). MHI's Standard Power Island Plot Plan with MHI standard plant identifiers for this project is included in Appendix B.

Table 4 List of Significant Flammable or Combustible Fluid Handling Fire Incidents

LOC Incident	Design Model Zone	Incident Title	Hazard Scenario
NG_01	Zone 3	LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	NG_01_01 Jet fire NG_01_02 Flash fire NG_01_03 Fireball NG_01_04 VCE
NG_02	Zone 3	LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	NG_02_01 Jet fire NG_02_02 Flash fire NG_02_03 Fireball NG_02_04 VCE
NG_03	Zone 3	LOC of natural gas from Fuel gas main header (including calorie meter and PRU) at Zone 3	NG_03_01 Jet fire NG_03_02 Flash fire NG_03_03 Fireball
NG_04	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	NG_04_01 Jet fire NG_04_02 Flash fire NG_04_03 Fireball NG_04_04 VCE
NG_05	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters (01EKE01AT004, 01EKE02AT004 and 02EKE01AT004, 02EKE02AT004) at Zone 1/2	NG_05_01 Jet fire NG_05_02 Flash fire NG_05_03 Fireball NG_05_04 VCE
NG_06	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	NG_06_01 Jet fire NG_06_02 Flash fire NG_06_03 Fireball NG_06_04 VCE
NG_07	Zone 1	LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 1) at Zone 1	NG_07_01 Jet fire NG_07_02 Flash fire
NG_08	Zone 2	LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 2) at Zone 2	NG_08_01 Jet fire NG_08_02 Flash fire
NG_09	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	NG_09_01 Jet fire NG_09_02 Flash fire NG_09_03 VCE
NG_10	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	NG_10_01 Jet fire NG_10_02 Flash fire NG_10_03 VCE
NG_11	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	NG_11_01 Jet fire NG_11_02 Flash fire NG_11_03 VCE
NG_12	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) - Associated piping to/ from Fuel Gas Unit (#11) at Zone 1/2	NG_12_01 Jet fire NG_12_02 Flash fire NG_12_03 VCE
NG_13	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) – Fuel Gas Unit (#11) at Zone 1/2	NG_13_01 Jet fire NG_13_02 Flash fire NG_13_03 VCE

LOC Incident	Design Model Zone	Incident Title	Hazard Scenario
NG_14	Zone 1/2	LOC of natural gas from OCGT (Unit 1/2) – Turbine Enclosure (#1) at Zone 1/2	NG_14_01 Jet fire
			NG_14_02 Flash fire
			NG_14_03 VCE
HY_01	Zone 3	LOC of hydrogen from hydrogen tube trailer (90QJH01BB901) at Zone 3	HY_01_01 Jet fire
			HY_01_02 Flash fire
			HY_01_03 Fireball
			HY_01_04 VCE
HY_02	Zone 3	LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	HY_02_01 Jet fire
			HY_02_02 Flash fire
			HY_02_03 Fireball
			HY_02_04 VCE
HY_03	Zone 3	LOC of hydrogen from Trailer to high pressure piping at Zone 3	HY_03_01 Jet fire
			HY_03_02 Flash fire
			HY_03_03 VCE
HY_04	Zone 3	LOC of hydrogen from Trailer to low pressure piping at Zone 3	HY_04_01 Jet fire
			HY_04_02 Flash fire
			HY_04_03 VCE
HY_05	Zone 3	LOC of hydrogen from Hydrogen manifold at Zone 3	HY_05_01 Jet fire
			HY_05_02 Flash fire
HY_06	Zone 1	LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 1) at Zone 1	HY_06_01 Jet fire
			HY_06_02 Flash fire
HY_07	Zone 2	LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 2) at Zone 2	HY_07_01 Jet fire
			HY_07_02 Flash fire
HY_08	Zone 1/2	LOC of hydrogen from OCGT (Unit 1/2) – Hydrogen Gas Control Unit (#107) at Zone 1/2	HY_08_01 Jet fire
			HY_08_02 Flash fire
HY_09	Zone 1/2	LOC of hydrogen from OCGT (Unit 1/2) – Generator Enclosure (#101) at Zone 1/2	HY_09_01 Jet fire
			HY_09_02 Flash fire
			HY_09_03 VCE
DO_01	Zone 4	LOC of diesel from Diesel Fuel Storage Tanks (90EGB01BB001 and 90EGB02BB001) at Zone 4	DO_01_01 Bund fire
DO_02	Zone 4	LOC of diesel from Diesel Forwarding Pumps (90EGC01AP001, 90EGC02AP001 and 90EGC03AP001) at Zone 4	DO_02_01 Spray fire
DO_03	Zone 4	LOC of diesel from Diesel Forwarding Filters (90EGD01AT001 and 90EGD02AT001) at Zone 4	DO_03_01 Spray fire
DO_04	Zone 4	LOC of diesel from Aboveground diesel fuel manifold (section 1) at Zone 4	DO_04_01 Spray fire
DO_05	Zone 4	Combined into DO_04	DO_05_01 Spray fire
DO_06	Zone 1	LOC of diesel from Piping from diesel fuel manifold to OCGT (Unit 1) at Zone 1	DO_06_01 Spray fire
DO_07	Zone 2	LOC of diesel from Piping from diesel fuel manifold to OCGT (Unit 2) at Zone 2	DO_07_01 Spray fire

LOC Incident	Design Model Zone	Incident Title	Hazard Scenario
DO_08	Zone 1/2	LOC of diesel from OCGT (Unit 1/2) - Fuel Oil Drain Tank & Pit (#38) at Zone 1/2	DO_08_01 Spray fire
DO_09	Zone 1/2	LOC of diesel from OCGT (Unit 1/2) - Fuel Oil Unit (#24) at Zone 1/2	DO_09_01 Bund Fire
			DO_09_02 Spray Fire
DO_10	Zone 1/2	LOC of diesel from OCGT (Unit 1/2) – Turbine Enclosure (#1) at Zone 1/2	DO_10_01 Spray fire
			DO_10_02 Flash fire
			DO_10_03 VCE
DO_11	Zone 4	LOC of diesel from Diesel Fuel Tanker at Zone 4	DO_11_01 Bund fire
DO_12	Zone 4	LOC of diesel from Diesel Unloading Pump House (90EGC05AP001 and 90EGC06AP001) at Zone 4	DO_12_01 Spray fire
LCO_01	Zone 1/2	LOC of lube oil and control oil from circulation pumping and filtering system (Unit 1/2) (#3, #5, #6, #9, #13, #15, #160) at Zone 1/2	LCO_01_01 Bund Fire
			LCO_01_02 Spray Fire
LCO_02	Zone 1/2	LOC of seal oil from circulation pumping system (Unit 1/2) (#103) at Zone 1/2	LCO_02_01 Bund Fire
			LCO_02_02 Spray Fire
TO_01	Zone 1/2	Transformer Fire (oil) - Unit Transformer (Unit 1/2) (#121) at Zone 1/2	TO_01_01 Bund fire
TO_02	Zone 1/2	Transformer Fire (oil) - Generator Step-Up Transformer (Unit 1/2) (#113) at Zone 1/2	TO_02_01 Bund fire
TO_03	Zone 1/2	Transformer Fire (oil) – Static Frequency Converter Transformer at (Unit 1/2) (#123) Zone 1/2	TO_03_01 Bund Fire
TO_04	Zone 1/2	Transformer Fire (oil) – Auxiliary Transformer (#390) at Zone 1/2	TO_04_01 Bund Fire
TO_05	Zone 4	Transformer Fire (oil) – Utility Transformer at Zone 4 (three transformers co-located: 90BBT01, 90BBT02 and 90BFT01)	TO_05_01 Bund Fire

The Snowy Hydro High Voltage Switch Yard equipment contains only a small volume of insulating oil and is not considered to present a significant fire risk from this perspective and is therefore not included in the detailed analysis of flammable and combustible fluids (the risk of high voltage arcing to adjacent bushland is considered under non-fluid fire incidents).

Table 5 List of Significant Non-Fluid Fire Incidents.

Fire Incident	Design Model Zone	Incident Title	Incident Scenario Description
NF_01	Zone 5	Control & Administration Building Fire	Building fire
NF_02	Zone 5	Workshop & Storage Building Fire	Building fire
NF_03	Zone 1/2	Gas Turbine Generator Electrical Control Equipment (#43) Building Fire	Electrical equipment fire
NF_04	Zone 1/2	Generator Static Frequency Converter Electrical Equipment (#127) Building Fire	Electrical equipment fire
NF_05	Zone 1/2	Generator Excitation Electrical Equipment (#117) Building Fire	Electrical equipment fire
NF_06	Zone 1/2	GTG Auxiliary Electrical Equipment Building Fire	Electrical equipment fire
NF_07	Zone 4	Balance of Plant Electrical Equipment and Battery Room Building Fire	Electrical equipment fire, hydrogen fire/explosion
NF_08	n/a	High Voltage Switch Yard High Energy Release Incident-Initiated Bush Fire	High energy electrical discharge initiated bush fire

The Chemical Store Building is excluded as a significant fire risk in the context of the present study, i.e., minimal or no fire risk to adjacent land users including bushland, onsite occupants or potential for fire escalation to other site infrastructure on the basis that the building is non-combustible construction and the quantity of flammable and combustible substances planned for storage in the building is small, i.e., approximately 3 m^3 (~15 drums) of C2 combustible liquid (primarily lube oil and hydraulic oil) and less than 120 litres of flammable liquid (primarily acetone) in small packages; other chemicals stored in the building do not have a subsidiary fire risk; no processing of chemicals is planned in the building; no repackaging of chemicals is planned in the building; the building does not include an office; and the building is widely separated from other site infrastructure and bushland. It is noted that AS1940:2017, Table 11.3 does not recommend a Fire Safety Study for a Package Store until the stored quantity exceeds 1000 m^3.

Table 6 Significant Flammable or Combustible Fluid Storage and Handling Fire Incident Scenarios, Consequences and Control Measures.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
NG-01, NG-02	Zone 3 Only portion of APA Gas Receival Station extending into south-west corner of SHL site	Various (refer to Table 4) Collectively the scope of these is LOC of natural gas from Fuel gas manifolds and equipment in section of GRS that extends into the Snowy Hydro site in the south-west corner of the Snowy Hydro site	Pipe rupture or leak in natural gas lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** Jet fire, Flash fire, Fireball, VCE **NG_01_01 to NG_01_04** **NG_02_01 to NG_02_04** (VCE is considered relevant due to creation of a degree of space congestion from the number of objects present in the Gas Receival Station. Fireball is considered relevant for catastrophic failure of the natural gas containing vessels and large bore, high pressure piping.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Gas detection triggering alarm. Fire detection triggering alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. APZ due to equipment proximity to site boundary (a copy of the Bushfire Assessment Report is provided in Appendix H). Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
NG-03	Zone 3	LOC of natural gas from Fuel Gas main header (including calorie meter and PRU)	Pipe rupture or leak in natural gas lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** **NG_03_01** Jet fire **NG_03_02** Flash fire **NG_03_03** Fireball	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Gas detection triggering alarm. Fire detection triggering alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. APZ due to equipment proximity to site boundary (a copy of the Bushfire Assessment Report is provided in Appendix H). Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
NG_04, NG_05, NG_06, NG_07, NG_08, NG_09, NG_10, NG_11, NG_12	Zone 1/2	Various (refer to Table 4) Collectively the scope of these is LOC of natural gas from the outdoor fuel gas piping and equipment on each Power Island	Pipe rupture or leak in natural gas lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** Jet fire, Flash fire, Fireball, VCE **NG_04_01 to NG_04_04** **NG_05_01 to NG_05_04** **NG_06_01 to NG_06_04** **NG_07_01 and NG_07_02** **NG_08_01 and NG_08_02** **NG_09_01 to NG_09_03** **NG_10_01 to NG_10_03** **NG_11_01 to NG_11_03** **NG_12_01 to NG_12_03** (VCE is considered relevant due to creation of a degree of space congestion from the number of objects present on the western end of the Power Island. Fireball is considered relevant for catastrophic failure of the natural gas containing vessels and large bore, high pressure piping.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Gas detection triggering alarm. Fire detection triggering alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. APZ due to equipment proximity to site boundary (a copy of the Bushfire Assessment Report is provided in Appendix H). Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
NG_13, NG_14	Zone 1/2	Various (refer to Table 4) Collectively the scope of these is LOC of natural gas from OCGT (Unit 1/2) – Fuel Gas Unit (#11) and Turbine Enclosure	Pipe rupture or leak in natural gas lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak into Fuel Gas Unit enclosure or Turbine enclosure, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** Jet fire, Flash fire, VCE **NG_13_01 to NG_13_03** **NG_14_01 to NG_14_03** (VCE is considered relevant due to confinement by enclosures.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); enclosure ventilation (to prevent flammable gas accumulation from leaks); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Gas detection triggering alarm and shutdown. Fire detection triggering CO_2 suppression, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Carbon Dioxide gas suppression of enclosures per requirements of NFPA 12. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
HY_01, HY_02, HY_03, HY_04	Zone 3	Various (refer to Table 4) Collectively the scope of these is LOC of hydrogen gas from the hydrogen storage and pressure letdown facility	Pipe rupture or leak in hydrogen lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** Jet fire, Flash fire, Fireball, VCE **HY_01_01 to HY_01_04** **HY_02_01 to HY_02_04** **HY_03_01 to HY_03_03** **HY_04_01 to HY_04_03** (VCE is considered relevant due to creation of a degree of space congestion from objects associated with the Tube Trailer Shelter. Fireball is considered relevant for catastrophic failure of the tubes on the Tube Trailer.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Gas detection triggering alarm. Fire detection triggering deluge system, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Deluge system for Tube Trailer. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
HY_05	Zone 3	LOC of hydrogen from Hydrogen manifold at Zone 3 and along site western road	Pipe rupture or leak in hydrogen lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** **HY_05_01** Jet fire **HY_05_02** Flash fire (VCE was not considered credible due to small pipe diameter and clear outdoor location. No vessel in section therefore Fireball is not relevant)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Not recommended considering open location, small pipe diameter, welded piping, no instrument fittings and very minimal branches in section and mechanical impact barriers. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
HY_06, HY_07	Zone 1/2	LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 1) at Zone 1/2	Pipe rupture or leak in hydrogen lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to atmosphere, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. Potential for injury and fatality. **Hazard Scenarios:** Jet fire, Flash fire **HY_06_01 and HY_06_02** **HY_07_01 and HY_07_02** (VCE was not considered credible due to small pipe diameter and clear outdoor location. No vessel in section therefore Fireball is not relevant)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Not recommended considering open location, small pipe diameter, welded piping, no instrument fittings and very minimal branches in section and mechanical impact barriers. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
HY_08	Zone 1/2	LOC of hydrogen from OCGT (Unit 1/2) – Hydrogen Gas Control Unit (#107) at Zone 1/2	Pipe rupture or leak in hydrogen lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak into semi-open space adjacent the Hydrogen Gas Control Unit and potential for entry into the Generator enclosure, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **HY_08_01** Jet fire **HY_08_02** Flash fire **HY_08_03** VCE (VCE is considered relevant due to confinement by enclosure.)	**Prevention:** Safety in design and construction process (Codes and Standards, Quality Assurance); enclosure ventilation (to prevent flammable gas accumulation from leaks); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** Fire detection at adjacent seal oil unit (linked to seal oil unit sprinkler system. Escalation prevention). No gas detection. Health of generator enclosure ventilation monitored. **Protection:** Multiple isolation points and remote shutdown. Seal oil unit sprinkler system. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
HY_09	Zone 1/2	LOC of hydrogen from OCGT (Unit 1/2) – Generator Enclosure at Zone 1/2	Pipe rupture or leak in hydrogen lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak into Generator enclosure, i.e., loss of containment of flammable gas with potential for fire and explosion if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **HY_09_01** Jet fire **HY_09_02** Flash fire **HY_09_03** VCE (VCE is considered relevant due to confinement by enclosure.)	**Prevention:** Safety in design and construction process (Codes and Standards, Quality Assurance); enclosure ventilation (to prevent flammable gas accumulation from leaks); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Hazardous area classification, Permit to Work – Hot Work (PTW). **Detection:** No fire and gas detection. Health of generator enclosure ventilation monitored. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_01	Zone 4	LOC of diesel from Diesel Fuel Storage Tanks (90EGB01BB 001 and 90EGB02BB 001) at Zone 4	Damage to tank or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings or tank nozzles impacted, differential settlement between pipe supports outside bund and tank, vacuum, mechanical failure or poor weld quality leads to LOC. Tank overfill.	Leak into fuel oil bund, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **DO_01_01** Bund fire (Fuel oil, i.e., diesel, is not co-located with other flammable substances that could act as an external heating source or otherwise receive sufficient heating in the bund and will not generate sufficient vapour to develop into a bund fire; however, due to the large volume the bund is designed for, a bund fire has been modelled only to demonstrate that there is adequate separation distance to occupied buildings onsite, i.e., Control & Administration Building and Workshop & Storage Building as well as the hydrogen and natural gas facilities.)	**Prevention:** Safety in design and construction process (Codes and Standards, esp. AS1940, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); overfill protection; large free vent to protect against vacuum; leak response procedures. **Ignition Source Control:** Per requirements of AS1940. Permit to Work – Hot Work (PTW). **Prevention of exposure to heat radiation:** Combustible liquid spill in the bund is graded away from the tanks towards the bund sump. **Detection:** Fire detection triggering alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Portable extinguishers, fire-fighting equipment, i.e., hydrants and monitors per requirements of AS1940. Cooling water available to cool adjacent equipment if needed. Process systems and occupied buildings separation through physical location of equipment. Bund and sump capacity in accordance with AS1940.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_02, DO_03, DO_04, DO_05	Zone 4	LOC of fuel oil from fuel oil forwarding equipment and piping in Zone 4	Equipment damage or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to grade, i.e., loss of containment of combustible liquid with potential for flash fire if ignition source present. Limited opportunity for damage to structures and neighbouring equipment. **Hazard Scenarios:** Spray fire **DO_02_01** (Forwarding pumps) **DO_03_01** (Filters) **DO_04_01** (Above ground forwarding piping) **DO_05_01** (Above ground forwarding piping) (Fuel oil, i.e., diesel, is not co-located with other flammable substances that could act as an external heating source or otherwise receive sufficient heating in the locations of potential LOC and will not generate sufficient vapour to develop into a pool fire. A spray fire is unlikely given the lack of external heating sources but still considered.)	**Prevention:** Safety in design and construction process (Codes and Standards, esp. AS1940, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection in forwarding pump equipment shelter triggering alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Portable extinguishers, fire-fighting equipment, i.e., hydrants per requirements of AS1940. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_06, DO_07, DO_08	Zone 1/2	LOC of fuel oil from fuel oil forwarding and return piping and equipment (i.e., Fuel Oil Drain Tank (#38)) in Zone 1/2	Equipment damage or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak to grade, i.e., loss of containment of combustible liquid with potential for flash fire if ignition source present. Limited opportunity for damage to structures and neighbouring equipment. **Hazard Scenarios:** Spray fire **DO_06_01** (Delivery and return piping Unit 1) **DO_07_01** (Delivery and return piping Unit 2) **DO_08_01** (Fuel Oil Drain Tank (#38)) (Fuel oil, i.e., diesel, is not co-located with other flammable substances that could act as an external heating source or otherwise receive sufficient heating in the locations of potential LOC and will not generate sufficient vapour to develop into a pool fire. A spray fire is unlikely given the lack of external heating sources but still considered.)	**Prevention:** Safety in design and construction process (Codes and Standards, esp. AS1940, pipe stress analysis, Quality Assurance); vehicle impact barriers (trench and pit covers, bollards, rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** By operators either through CCTV or direct onsite observation. Manual Alarm Call Point to trigger alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_11, DO_12	Zone 4	LOC of fuel oil from Tanker Bay, including unloading pumping equipment	Damage to tanker or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings or tank nozzles impacted, tanker vacuum, mechanical failure or poor weld quality leads to LOC. Tanker overfill.	Leak into fuel oil bund, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **DO_11_01** Bund fire **DO_12_01** Spray fire (Fuel oil, i.e., diesel, is not co-located with other flammable substances that could act as an external heating source or otherwise receive sufficient heating in the bund and will not generate sufficient vapour to develop into a bund fire; however, due to the volume to be handled, a bund fire has been modelled only to demonstrate that there is adequate separation distance to occupied buildings onsite, i.e., Control & Administration Building and Workshop & Storage Building as well as the hydrogen and natural gas facilities.)	**Prevention:** Safety in design and construction process (Codes and Standards, esp. AS1940, pipe stress analysis, Quality Assurance); vehicle impact barriers (bollards and rails); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); tanker overfill protection; tanker vacuum protection, leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Prevention of exposure to heat radiation:** Combustible liquid spill in the tanker bay is graded away from the tanker towards the tanker bay sump. **Detection:** By attending personnel (equipment in area is only used under continuous operator supervision). Manual Alarm Call Point to trigger alarm and shutdown. **Protection:** Multiple isolation points, local and remote shutdown. Portable extinguishers, fire-fighting equipment, i.e., hydrants per requirements of AS1940. Cooling water available to cool adjacent equipment if needed. Tanker bay spill containment and sump capacity in accordance with AS1940. Process systems

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
					and occupied buildings separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_09	Zone 1/2	LOC from Fuel Oil Unit (#24)	Equipment damage or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak into Fuel Oil Unit enclosure, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **DO_09_01** Bund fire **DO_09_02** Spray fire (At the Fuel Oil Unit, fuel oil is pressurised to high pressure. Under this condition a leak of fuel oil can result in a spray, which is at risk of ignition from the static charge associated with creation of the spray)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection (via fusible element) in Fuel Oil Unit enclosure triggering sprinkler system, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Bund and firewater sprinkler system per requirements of NFPA850. Fuel Oil Unit enclosure of non-combustible construction. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
DO_10	Zone 1/2	LOC from OCGT (Unit 1/2) Turbine enclosure (#1)	Equipment damage or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	Leak into Turbine enclosure, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **DO_10_01** Spray fire **DO_10_01** Flash fire **DO_10_01** Explosion (In the Turbine enclosure, fuel oil is at high pressure. Under this condition a leak of fuel oil can result in a spray, which is at risk of ignition from the static charge associated with creation of the spray or contact with hot equipment on the turbine.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection in Turbine enclosure triggering CO_2 suppression, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. CO2 gas suppression system per requirements of NFPA 12. Turbine enclosure of non-combustible construction. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
LCO_01	Zone 1/2	LOC of lube oil and control oil from circulation pumping and filtering system (Unit 1/2) (#3, #5, #6, #9, #13, #15, #160) at Zone 1/2	Damage to tank or equipment or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC. Tank overfill.	Leak into Auxiliary enclosure, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **LCO_01_01** Bund fire **LCO_01_02** Spray fire (In the Auxiliary enclosure, oil is at high pressure. Under this condition a leak of oil can result in a spray, which is at risk of ignition from the static charge associated with creation of the spray or contact with hot equipment on the turbine.)	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection in enclosure (via fusible element) triggering sprinkler system, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Portable fire extinguishers (small, i.e., incipient fires only), firewater sprinkler system and bund per requirements of NFPA850 and BCA. Enclosure of non-combustible construction. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
LCO_02	Zone 1/2	LOC of seal oil from circulation pumping system (Unit 1/2) (#103) at Zone 1/2	Damage to tank or equipment or pipe rupture or leak in fuel oil lines due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC. Tank overfill.	Leak to grade, i.e., loss of containment of combustible liquid with potential for fire if ignition source present, potential damage to structures and neighbouring equipment leading to further releases. **Hazard Scenarios:** **LCO_02_01** Bund fire **LCO_02_02** Spray fire	**Prevention:** Safety in design and construction process (Codes and Standards, pipe stress analysis, Quality Assurance); integrity inspection and maintenance; multiple process instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection (via fusible element) triggering sprinkler system, alarm and shutdown. **Protection:** Multiple isolation points and remote shutdown. Portable fire extinguishers (small, i.e., incipient fires only), firewater sprinkler system and bund per requirements of NFPA850. Cooling water available to cool adjacent equipment if needed. Process systems separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
TO_01, TO_02, TO_03	Zone 1/2	Transformer Fire – Mineral Oil-based Transformer: Generator Step-Up Transformer, Unit Transformer, Static Frequency Converter Transformer at Zone 1/2	Internal arc fault, damage to transformer due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	An internal arc fault directly provides an ignition source that can result in a fire of the transformer oil. An arc fault may also provide enough energy to damage the integrity of the transformer casing allowing spill or leak from the transformer casing. Mineral oil will sustain a fire. A tank fire and bund fire are credible events. Potential damage to structures and neighbouring equipment leading to further releases (adjacent transformers) or event escalation. **Hazard Scenarios:** Tank/Bund fire **TO_01_01** **TO_02_01** **TO_03_01**	**Prevention:** Safety in design and construction process (Codes and Standards, Quality Assurance); integrity inspection and maintenance; multiple equipment instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection (via fusible element) triggering deluge system, alarm and shutdown. **Protection:** Electrical isolation. Separation, fire walls, deluge system, drain via flame trap to remote sump (to minimise oil pooling at base of transformer) per requirements of AS2067. Cooling water available to cool adjacent equipment if needed. Plant separation through physical location of equipment.

LOC Incident	Design Model Zone	Incident Title	Causes and Initiating Events	Potential Consequences	Prevention and Protection Measures
TO_04, TO_05	Zone 1/2, (TO_04) Zone 4 (TO_05)	Transformer Fire – Fire-resistant oil-based: Auxiliary Transformer at Zone 1/2 and Utility Transformers at Zone 4	Internal arc fault, damage to transformer due to impact, corrosion, small bore fittings impacted, mechanical failure or poor weld quality leads to LOC.	An internal arc fault directly provides an ignition source that can result in a fire of the transformer oil. An arc fault may also provide enough energy to damage the integrity of the transformer casing allowing spill or leak from the transformer casing. Fire resisting oil has difficulty sustaining a fire. Theoretically, a tank fire and bund fire are still possible with potential damage to structures and neighbouring equipment leading to further releases (adjacent transformers) or event escalation. **Hazard Scenarios:** Tank/Bund fire **TO_04_01** **TO_05_01**	**Prevention:** Safety in design and construction process (Codes and Standards, Quality Assurance); integrity inspection and maintenance; multiple equipment instrumented trips and alarms (for precursor abnormal conditions); leak response procedures. **Ignition Source Control:** Permit to Work – Hot Work (PTW). **Detection:** Fire detection via fusible element triggering alarm and shutdown. **Limitation:** Fire resistant oil. A study by CIGRE (Report 436) [ref.18] cited IEC 60695-1-40, section 7.1, which states: *"even if spray ignites (..) the resulting pool of liquid rapidly ceases to burn"* **Protection:** Electrical isolation. Separation, fire walls and bund per requirements of AS2067. Portable fire extinguishers for small, i.e., incipient fires. Cooling water available to cool adjacent equipment if needed. Plant separation through physical location of equipment.

The Excitation Transformer (#115) is a small, dry transformer and not considered a significant fire risk.

Table 7 Significant Non-Fluid Fire Incidents Scenarios, Consequences and Potential Control Measures.

Number	Area	Non-Fluid Incident Title	Causes and Initiating Events	Potential Consequences	Potential Prevention and Protection Measures
NF_01	Zone 5	Control and Administration Building Fire	Causes of building fire in the Control & Administration Building include electrical fault, bushfire, arson.	Building fire with potential to result in damage to building contents and structure personnel injury or fatality. (Escalation to other project areas is not considered credible due to separation distance.)	Buildings designed in accordance with the BCA and associated Standards. Non-combustible construction. Specific prevention, detection and protection measures are enumerated in Appendix G. The following measures provide additional protection for specific initiating events: Site security (arson) Asset Protection Zone (bushfire)
NF_02	Zone 5	Workshop and Storage Building Fire	Causes of building fire in the Workshop and Storage Building include electrical fault, spill of flammable or combustible liquids (used in workshop activities), welding, grinding, cutting, bushfire, arson.	Building fire with potential to result in damage to building contents and structure personnel injury or fatality. (Escalation to other project areas is not considered credible due to separation distance.)	Buildings designed in accordance with the BCA and associated Standards. Non-combustible construction. Specific prevention, detection and protection measures are enumerated in Appendix G. The following measures provide additional protection for specific initiating events: Site security (arson) Asset Protection Zone (bushfire)
NF_03, NF_04, NF_05, NF_06	Zone 1/2	Electrical Equipment Building Fire – Various Gas Turbine Generator (GTG) Electrical	Causes of building fire in Electrical Equipment Room include electrical fault, bushfire, arson.	Building fire with potential to result in damage to structure and electrical equipment needed to operate the Gas Turbine Generator plant equipment, personnel injury or fatality.	Buildings designed in accordance with the BCA and associated Standards. Specific prevention, detection and protection measures are enumerated in in Appendix G. The following measures provide additional protection for specific initiating events: Site security (arson)

Number	Area	Non-Fluid Incident Title	Causes and Initiating Events	Potential Consequences	Potential Prevention and Protection Measures
		Control Building, GTG Auxiliary Switch Room, GTG Static Frequency Converter Electrical Equipment Building, GTG Excitation Electrical Equipment Building, 6.6kV Switch Room			Asset Protection Zone (bushfire)

Number	Area	Non-Fluid Incident Title	Causes and Initiating Events	Potential Consequences	Potential Prevention and Protection Measures
NF-07	Zone 4	Balance of Pant Electrical Equipment and Battery Room Building Fire	Causes of building fire in the Auxiliary Electrical Equipment and Battery Room Building Fire include electrical fault, accumulated hydrogen (battery charging), bushfire, arson.	Building fire with potential to result in damage to structure and electrical equipment needed to operate the Gas Turbine Generator plant equipment, personnel injury or fatality. (Escalation to other project areas is not considered credible due to separation distance.)	Buildings and shelters designed in accordance with the BCA and associated Standards. Specific prevention, detection and protection measures are enumerated in in Appendix G. The following measures provide additional protection for specific initiating events: • Battery room ventilation and hydrogen gas detection Site security (arson) Asset Protection Zone (bushfire)
NF-08	n/a	High Voltage Switch Yard High Energy Release Incident-Initiated Bush Fire	Causes of a high energy release from high voltage equipment in the high voltage switch yard with potential to initiate a bush fire include electrical fault, extreme weather events, i.e., high wind breaks aerial power lines, cyclic aerial power line stress leads to broken aerial power line, corrosion.	Bush fire adjacent the site, resulting in radiant heat damage to plant, bushfire embers falling on plant and creating secondary fires in plant, personnel or members of the public injury or fatality, exposed to bushfire damage to other properties adjacent the affected bush.	**Prevention:** Safety in design and construction process (Codes and Standards, Quality Assurance); integrity inspection and maintenance; electrical equipment protection trips and alarms (for precursor abnormal conditions). **Detection:** By operators either through CCTV or direct onsite observation. Manual triggering of alarm and shutdown. **Protection:** Electrical isolation. Switch yard kept free of vegetation. APZ due to equipment proximity to site boundary (a copy of the Bushfire Assessment Report is provided in Appendix H). Plant setback distance from site boundary to reduce incident radiant heat level and potential for damage. Firewater hydrants on northern boundary of site can be used to suppress a

Number	Area	Non-Fluid Incident Title	Causes and Initiating Events	Potential Consequences	Potential Prevention and Protection Measures
					grass fire. NSW RFS Bushfire Appliance connection on site water tanks. Cooling water available to cool adjacent equipment if needed.

4.3 Bushfire

A bushfire hazard assessment was conducted by Jacobs Group (Australia) Pty Ltd in 2021, which identified the facility as bushfire prone arising mainly from the large patch of bushfire prone vegetation located to its north and west. Smaller fragments of this vegetation are also located to the east of the Project Site. Significant bushfires occurred in the 2002-03 and 2016-17 seasons. These burnt from the north-west towards the south-east and affected bushland and adjacent rural land areas. They burnt to the boundary of the former Kurri Kurri aluminium smelter site. The 2002-03 bushfire burned through area of the planned switchyard at the northern end of the facility. There are also anecdotal reports of other smaller fires in the area around the facility that are not included in NSW fire history data sets.

The bushfire impact assessment for the planned facility plant and infrastructure is discussed in Section 5.5.

A full copy of the Jacobs Group (Australia) Pty Ltd 2021 Bushfire Assessment Report [ref.20] containing the detailed analysis and recommendations is included in Appendix H.

5.0 Consequences of Significant Incidents

Table 6 and Table 7 in the preceding section indicate the possible consequences for the identified hazardous incidents. This section assesses the severity of the consequences of each of the significant fire incidents considering the proximity to vulnerable infrastructure and personnel as well as their resilience. Qualitative assessment is generally used where the scenario occurs within an enclosure or building, where such enclosure or building is of non-combustible construction and able to contain the effects of the event, i.e., prevent exposure of adjacent plant, enclosures or buildings to the effects. Quantitative consequence modelling is generally used for loss of containment (LOC) to outdoor spaces to properly understand the reach of effects and potential impacts.

PHAST™ Version 6.7 software is adopted for the determination of thermal radiation and explosion overpressure effects from the LOC incidents. The software is developed by DNV AS, which is a consequence analysis tool that predicts the outcome of accidental releases of hazardous materials to the atmosphere. The hazard models implemented in PHAST™ have been verified against field measured data. Verification reports are available directly from DNV AS.

5.1 Quantitative Consequence Modelling Inputs and Assumptions

For quantitative consequence modelling of those scenarios carried forward for such modelling, the input data and assumptions for the consequence models were based on the location and isolatable section at which the scenario was assumed to occur. This provided a basis for estimating the materials, process conditions, inventory, and leak sizes modelled. The location of a release was generally taken to be at the centre of the isolatable section of interest. The list of inputs and assumptions for the models are included in Appendix E.

5.2 Effects of Heat Radiation and Overpressure

The effects and impact of heat radiation and overpressure on people and infrastructure are shown in Table 8 and Table 9.

Table 8 Effects of Heat Radiation

Radiant Heat Level (kW/m^2)	Physical Effects (Appendix 8 in ref.5) (Effect depends on exposure duration on unprotected skin)
1.2	Received from the sun at noon in summer.
2.1	**People:** Minimum to cause pain after 1 minute.
2.9	**People:** Will cause pain in 30 seconds (Table 8 in ref.17).
4.7	**People:** Will cause pain in 15-20 seconds and injury after 30 seconds' exposure (at least second-degree burns will occur). Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding but with appropriate clothing. (Appropriate clothing consists of hard hat, long-sleeved shirts with cuffs buttoned, work gloves, long-legged pants and work shoes. Appropriate clothing minimizes direct skin exposure to thermal radiation.) (Table 9 in ref.17). **Objects:** No significant issue.
12.6	**People:** Significant chance of fatality for extended exposure. High chance of injury. **Objects:** After long exposure, causes the temperature of wood to rise to a point where it can be ignited by a naked flame. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.

Radiant Heat Level (kW/m²)	Physical Effects (Appendix 8 in ref.5) (Effect depends on exposure duration on unprotected skin)
23	**People:** Likely fatality for extended exposure and chance of fatality for instantaneous exposure. **Objects:** Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failure. Pressure vessel needs to be relieved or failure would occur.
35	**People:** Significant chance of fatality for people exposed instantaneously **Objects:** Cellulosic material will ignite within one minute's exposure

Table 9 Effects of Explosion Overpressure

Explosion Overpressure Level (kPa)	Physical Effects (Appendix 9 in ref.5)
3.5	**People:** No fatality and very low probability of injury. **Objects:** 90% glass breakage.
7	**People:** Probability of injury is 10%. No fatality. **Objects:** Damage to internal partitions and joinery but can be repaired.
14	**Objects:** House uninhabitable and badly cracked.
21	**People:** 20% chance of fatality to a person in a building. **Objects:** Reinforced structures distort. Storage tanks fail.
35	**People:** Threshold of eardrum damage. 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open. **Objects:** House uninhabitable. Wagons and plants items overturned.
70	**People:** Threshold of lung damage. 100% chance of fatality for a person in a building or in the open. **Objects:** Complete demolition of houses.

5.3 Fire Protection Criteria

The hazard distances for jet fire and pool fire scenarios are reported at five radiant heat levels range from 3 to 32 kW/m^2 and the corresponding requirement for fire protection measures are summarised in Table 10.

Table 10 Fire Protection Criteria

Radiant Heat Level (kW/m^2) Note 1	Objective	Criteria Reference
3	Positioning of firewater monitors – maximum level specified for a fire fighter to connect a portable monitor or activate a monitor and aim needing less than 10 minutes to perform.	AS1940-2017, Cl.11.5.7.(d)
6.31	Assessment of vulnerability of escape paths. Areas where people wearing appropriate clothing will require immediate access to Temporary Refuge.	API521, Table 9 [ref.17]
8	Assessment of Aboveground Atmospheric Storage Tanks vulnerability. Should have water cooling applied to outer surface. Can be from mobile devices.	Energy Institute, Model Code of Safe Practice Part 19 – Fire precautions at petroleum refineries and bulk storage installations, Cl.2.6.2
23	Assessment of critical structural steel vulnerability. Bare, unprotected structural steel can fail. Fire protection required.	NSW DPE, HIPAP-2 Fire Safety Study
32	Assessment of Plant and equipment vulnerability. Level at which dedicated fixed water cooling must be available.	Energy Institute, Model Code of Safe Practice Part 19 – Fire precautions at petroleum refineries and bulk storage installations, Cl.2.6.2

Note 1: As operator presence is envisaged within 3 and 6.31 kW/m^2 contours, contribution from solar radiation is considered as a conservative approach.

5.4 Scenario Impact Assessment

The following sections describe the types of potential fire and explosion events at the facility. Where consequence modelling has been performed, modelling results represent the worst-case scenarios for each type of incident, in accordance with HIPAP 2 [ref 5], and do not take into account the controls that the facility has put in place to manage and reduce the impact of these incidents (i.e. the likelihood of the event occurring is not taken into account). For the presentation of risk results that take into account the prevention and mitigation control measures implemented in the Hunter Power Project, Snowy Hydro is preparing a separate Project Final Hazard Analysis.

5.4.1 Pool Fires (Including Transformer Fires)

Background

Pool fires are a type of event resulting from the combustion of a flammable or combustible hydrocarbon liquid spill or tank. Pool fires have the potential to escalate into larger fires, and cause damage to infrastructure, the immediate environment and personnel onsite. In this study, “transformer fire” is taken as synonymous with pool fire in terms of the designation of models in PHAST™.

Pool fire scenarios

A potential consequence of a loss of containment (LOC) scenario for fuel oil and transformer oil, in the presence of an ignition source in the immediate vicinity of the release or introduction of an ignition source into the open oily water pit, would be a pool fire occurring within the:

- Fuel oil storage bund (DO_01_01)
- Tanker bay (DO_11_01)

- Transformer bunds (TO_01_01, TO_02_01, TO_03_01, TO_04_01, TO_05_01)
- Fuel oil and GTG lube oil, seal oil and control oil pumping and circulation systems (LCO_01_01, LCO_02_01)
- Oily water pit (OW_01_01).

Qualitative Impact Assessment

Fuel oil pumping system

The fuel oil pumping system associated with the bulk storage is not carried forward for pool fire consequence modelling to assess escalation potential or offsite impact potential because of its small footprint, i.e., potential spill size, and separation from other plant, infrastructure, occupied buildings and the site boundary. Further, fuel oil (diesel) is combustible liquid but requires a significant external heat source to ignite *and sustain* a fire. In this project the fuel oil (diesel) is not operated at elevated temperature and therefore will not generate sufficient vapour to transition to a flammable liquid. There is no equipment planned for the pumping system or co-located with it that could generate a sufficiently hot surface in prolonged contact with the fuel oil that could transition it to a flammable condition. Accordingly, the electrical equipment in the area, e.g., pump motors, is not required to be Hazardous Area classified. It is not co-located with any flammable liquid or gas operations which, if ignited, could provide external heating. The risk of spray fire is discussed in Section 5.4.2.

By comparison with the quantified thermal radiation effects of the significantly larger bund fire scenario (Appendix E, Figure 11(a)), other important site infrastructure, i.e., hydrogen storage, Chemical Store, fuel gas delivery systems (upstream of the Fuel Gas Unit), Workshop & Storage Building, Control & Administration Building and the firewater tanks, pumps and booster brigade connection are well separated and will not be affected by thermal radiation from a fuel oil pumping system fire.

GTG lube oil, seal oil and control oil pumping and circulation systems

The GTG lube oil, seal oil and control oil pumping and circulation systems are not carried forward for pool fire consequence modelling to assess escalation potential or offsite impact potential because these systems are housed in an enclosure (seal oil system excepted) primarily of non-combustible construction, bunded and equipped with a water sprinkler system therefore the effects of a fire, i.e., damage are expected to be contained to the confines of the enclosure. Though the seal oil system itself is not in an enclosure it is surrounded by other equipment enclosures, primarily of non-combustible construction.

There is no fire risk to other important site infrastructure, i.e., hydrogen storage, Chemical Store, fuel gas delivery systems (upstream of the Fuel Gas Unit), Workshop & Storage Building, Control & Administration Building and the firewater tanks, pumps and booster brigade connection, which are well separated and isolated from the effects of thermal radiation from a GTG lube oil, seal oil and control oil pumping and circulation systems fire.

The lube oil (which is also used as seal oil) is a mineral oil with no fire-retardant additives. At ambient temperature these oils are combustible only; however, due to the way in which these oils are used, they will operate at an elevated temperature but insufficient to transition to a flammable condition. A major leak can result in an oil pool on the floor and due to the elevated operating temperature will generate an increased amount of vapour above it (compared with unheated oil). In the absence of a sufficient external heat source this pool would not be expected to ignite; however, if the pool is created coincident with an ignited spray from the origin of the leak, there is the possibility that the pool could be exposed long enough to the spray fire to ignite the pool resulting in a sustained pool fire. The risk of spray fire is discussed in Section 5.4.2.

Oily water pit

The oily water pit is not carried forward for pool fire consequence modelling to assess escalation potential or offsite impact potential because it is remote from other plant, infrastructure, occupied buildings, firewater tanks, pumps and booster brigade connection and the site boundary and does not represent an exposure risk to those items in the event of a fire.

All large sources of oil onsite are from combustible liquids rather than flammable liquids and the volume of water in contact with the oil will act as a heat sink for the oil reducing the presence of vapour above the pit, further diminishing ignition risk. However, a credible ignition threat to the oily water pit is from bushfire, in particular ember attack. This is discussed further in Section 5.5.2.

Quantitative impact assessment - Consequence modelling

Consequence modelling has been performed for pool fires in the fuel oil storage bund, tanker bay and transformer bunds, due to the large liquid volume that can potentially be involved, to characterise the reach of thermal radiation from a pool fire at the Fire Protection Criteria levels indicated in Table 10. In all cases the pool has been considered to cover the entire area of the bund. The results are shown in Table 11 below and the contours are overlaid on the site plan in Appendix E in Figure 11(a), (b), (c) and (d).

Table 11 Heat Radiation from Pool Fires in Bunds

Significant Incident Scenario – Pool Fires[1]	Heat Radiation (Distance from centre of incident (m))				
	3.0 kW/m²	6.31 kW/m²	8 kW/m²	23 kW/m²	32 kW/m²
DO_01_01 Bund fire from LOC of diesel from Diesel Fuel Storage Tanks (90EGB01BB001 and 90EGB02BB001) at Zone 4	91	65	43	-	-
DO_11_01 Bund fire from LOC of diesel from Diesel Fuel Tanker at Zone 4	44	31	27	10	7
TO_01_01 Bund fire from LOC of transformer oil from OCGT (Unit 1/2) – GT Unit Transformer (#121) at Zone 1/2	35	26	22	11	7
TO_02_01 Bund fire from LOC of transformer oil from OCGT (Unit 1/2) – GT Step-Up Transformer (#113) at Zone 1/2	49	35	31	10	10

Note 1: These results are for a non-drained, unshielded pool fire but it is acknowledged that in the case of the transformers firewalls are provided on three sides of the bund to isolate a bund fire from adjacent plant and infrastructure.

<u>Fuel Oil Bund (Modelled Scenario DO-01-01)</u>

For a full bund area pool fire in the fuel oil storage bund, thermal radiation levels capable of damaging equipment, shelters or buildings are confined to the bunded area. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate extend into the adjacent plant areas and at the northern apron of the Control & Administration Building and Workshop & Storage Building. See contour overlays in Appendix E, Figure 11(a). This space is open and would permit effective evacuation. The Control & Administration Building and Workshop & Storage Building would retain their integrity and would permit refuge for their occupants or safe escape passage to the southern building exits as part of a site evacuation response. The firewater tanks, pumps and booster brigade connection would likely experience elevated thermal radiation levels between 6.3kW/m^2 and 8kW/m^2.

A full bund area pool fire in the fuel oil storage bund is considered to be bordering on a non-credible event. Fuel oil (diesel) is combustible liquid but requires a significant external heat source to ignite *and sustain* a fire. In this project the fuel oil (diesel) is not co-located with any flammable liquids or gases which, if ignited, could provide such external heating. Further, there is no hot equipment located within the confines of the bund that could also act as an external heat source. The pre-cursor event to a full bund fire is a prolonged leak into the bund. The fuel oil tanks will be equipped with tank inventory monitoring so a leak sufficient to cover the full area of the bund will be alerted to operators by a tank inventory error. Given the lack of external heating source, operations personnel will have ample time to confirm a leak and implement spill emergency response procedures.

A fuel oil tank fire is not considered credible for this project.

<u>Tanker Bay (Modelled Scenario DO-11-01)</u>

For a full containment area pool fire in the fuel oil tanker bay, thermal radiation levels capable of damaging equipment, shelters or buildings are confined to the tanker and associated unloading equipment. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate extend into the adjacent plant areas and at the northern apron of the Control & Administration Building and Workshop & Storage Building. See contour overlays in Appendix E, Figure 11(b). This space is open and would permit effective evacuation. The firewater tanks, pumps and booster brigade connection would likely experience elevated thermal radiation levels but less than $3kW/m^2$.

Other important site infrastructure, i.e., hydrogen storage, Chemical Store and fuel gas delivery systems (upstream of the Fuel Gas Unit) are well separated and will not be affected by thermal radiation from a fuel oil pumping system fire

A full containment area pool fire in the tanker bay has a low likelihood but, unlike the bulk fuel storage, hot surfaces associated with the tanker truck, i.e., engine, exhaust, brakes, etc introduce an external heat source. The tanker bay design recognizes this and is provided with a sump, offset from the bay, to reduce the likelihood of accumulation of a fuel oil spill beneath the tanker. The tanker bay is also dedicated to fuel oil therefore there is no co-location with any flammable liquids' activities, which, if ignited, could provide external heating. Further, the tanker bay is also not co-located with any flammable gases, which, if ignited, could provide external heating.

The pre-cursor event to a full tanker bay fire is a prolonged leak into the tanker bay. Most of the tanker operations will be unloading the tanker to the site bulk storage tanks; however, provision has been made for tanker filling also. All tanker operations will be continuously supervised locally by the tanker operator and a leak will be quickly recognized. In addition to the manual tanker compartment isolation valves normally used by the tanker operator, tankers are equipped with onboard quick-acting emergency shut-off capability. During filling, the transfer is monitored automatically by a Load Controller, which includes overfill protection and features a local, manually operated emergency stop function. Isolation of the tanker contents is therefore achievable by the tanker operator before the tanker bay sump can fill and back-up across the entire tanker bay surface and any chance of contacting hot surfaces on the tanker. Given the design arrangements, operations personnel will have ample time to confirm a leak and implement spill emergency response procedures.

In this project, a tanker bay fire is considered unlikely.

<u>Transformer Fires (Modelled Scenarios TO-01-01 and TO-02-01)</u>

Two transformers were modelled to determine impact distances and act as a basis for impact assessment of all site transformers. The GT Step-Up Transformer (#131) was chosen because it is the largest transformer on site and the Unit Transformer (#121) was chosen because of its "trapped" location and orientation; it is considerably smaller than the GT Step-Up Transformer but still larger than the other site transformers. All transformers on site are provided with firewalls on three sides of the bund, dimensioned in accordance with AS2067, and the open side is oriented toward open space.

For a full bund area pool fire in the GT Unit Transformer bund and GT Step-Up Transformer, thermal radiation levels capable of damaging equipment, shelters or buildings beyond the perimeter of the integrated bund/firewall are confined to the immediate area outside the unshielded side of the bund. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate extend into the adjacent plant areas. See contour overlays in Appendix E, Figure 11(c) and (d). The unshielded space outside the GT Step-Up Transformer is the main internal north-south road in the centre of the site, which provides an adequate buffer against the elevated thermal radiation levels. Insulated phase buses and aerial power lines, intimately related to these transformers, necessarily traverse the space above them and would be exposed to damaging heat levels; however, they will not propagate a fire. The unshielded space immediately outside the GT Unit Transformer is open space reserved for removal of the generator. Setback on the other side of this reserved space and directly opposite is the GT Auxiliary Transformer (#390), which has an interposing firewall; to the north-east is the GTG Electrical Control Building (#43) and to the north-west is the GT Auxiliary Building. The GT Auxiliary Transformer and both buildings would retain their integrity and the buildings would permit refuge for their occupants or safe escape passage to the northern building exits as part of a site evacuation response. Personnel present in the open plant areas adjacent the transformers, which would experience elevated thermal radiation levels, have multiple simple and direct escape paths enabling safe evacuation.

In the event of a fire in the Unit 1 GT Auxiliary Transformer "pockets" of elevated thermal radiation, less than $3kW/m^2$, are estimated to occur in a small area beyond the northern site boundary in the APZ occupied by a bush fire trail. At this thermal radiation level and given the open space, persons in the area would be able to safely evacuate the area.

Considering the effect distances estimated for the GT Unit Transformer, by inspection there will be no significant impact offsite or to site plant or infrastructure from a fire event in the Static Frequency Converter Transformer (#123), Auxiliary Transformer (#390) or Utility Transformers.

5.4.2 Jet Fire

Background

A jet fire may occur where there is a point source release and ignition from a pressurised system, resulting in a turbulent diffusion jet flame. The high heat fluxes and spontaneous rapid development from jet fires on engulfed/impinged objects can result in structural or equipment failure. In this study, “spray fire” is taken as synonymous with jet fire in terms of the designation of models in PHAST™.

Jet fire scenarios

A potential consequence of a loss of containment (LOC) scenario for high pressure fuel gas, hydrogen, fuel oil, lube oil and control oil, in the presence of an ignition source in the immediate vicinity of the release, would be a jet fire occurring within the:

- Fuel gas receipt area
- Fuel gas distribution piping to the Power Islands
- Fuel gas equipment and piping on the Power Islands
- GT (Turbine) enclosure and Fuel Gas Unit
- Hydrogen storage area
- Hydrogen distribution piping to the Power Islands
- Hydrogen equipment and piping on the Power Islands
- Fuel oil unit on the Power Islands
- GTG lube oil, seal oil and control oil pumping and circulation systems (LCO_01_02)

A leak under pressure in the fuel oil pumping system associated with the bulk storage is not considered a credible jet fire scenario because it is not operated at elevated temperature, which increases vapour evolution, and there is no equipment planned for the pumping system or co-located with it that has a hot surface, which can act as an ignition source to a spray leak.

Qualitative Impact Assessment

<u>GT (Turbine) enclosure and Fuel Gas Unit</u>

The GT (Turbine) enclosure and Fuel Gas Unit are not carried forward for jet fire consequence modelling to assess escalation potential or offsite impact potential because these are housed in an enclosure primarily of non-combustible construction and equipped with a CO_2 gas suppression system therefore the effects of a fire, i.e., damage, are expected to be contained to the confines of the enclosures. Additionally, to prevent accumulation of small gas leaks to a level where an explosive concentration is reached in the enclosure, it is being provided with forced ventilation and gas detection.

<u>Fuel oil unit (Power Islands)</u>

The GT (Turbine) Fuel Oil Unit is not carried forward for jet fire consequence modelling to assess escalation potential or offsite impact potential because it is housed in an enclosure primarily of non-combustible construction and equipped with a firewater sprinkler system therefore the effects of a fire, i.e., damage, are expected to be contained to the confines of the enclosure.

<u>GTG lube oil, seal oil and control oil pumping and circulation systems</u>

The GTG lube oil, seal oil and control oil pumping and circulation systems are not carried forward for jet fire consequence modelling to assess escalation potential or offsite impact potential because these systems are housed in an enclosure primarily of non-combustible construction and equipped with a firewater sprinkler system therefore the effects of a fire, i.e., damage, are expected to be contained to the confines of the enclosure.

Oil in these systems is operated at high pressure and elevated temperature. Some equipment will develop high surface temperature during operation. Under these conditions a leak can result in an oil spray with small droplets, which may be readily ignited by contact with the hot surfaces present. Additionally, the process of creating the spray also causes generation of static electricity charge on the droplets. Static discharge from the droplets to equipment or structures at a different electrical potential can ignite the droplets resulting in a spray fire.

Quantitative impact assessment – Consequence modelling

Consequence modelling has been performed for jet fires in the outdoor parts of the fuel gas system and hydrogen system to characterise the reach of thermal radiation from a jet fire at the Fire Protection Criteria levels indicated in Table 10. The heat radiation results correspond to the initial heat radiation (for the first few seconds) in case of an immediate ignition prior to any isolation and depressurisation. The results are shown in Table 12 below and the contours are overlaid on the site plan in Appendix E in Figure 10(a) to (r). In Table 12 the acronym “RUP” means “rupture”, i.e., a complete cross-sectional failure of piping, alternatively referred to as full-bore rupture.

Table 12 Heat Radiation from Jet Fires

Significant Incident Scenario – Jet fire	Hole Size (mm)	Heat Radiation (Distance from centre of incident (m))				
		3 kW/m²	6.31 kW/m²	8 kW/m²	23 kW/m²	32 kW/m²
NG_01_01 Jet fire from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_02_01 Jet fire from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	10	15	13	12	-	-
	25	41	34	32	28	27
	50	82	68	63	55	52
NG_03_01 Jet fire from LOC of natural gas from Fuel gas main header (including calorie meter and PRU) at Zone 3	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	295	230	210	172	163
NG_04_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_05_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters (01EKE01AT004, 01EKE02AT004 and 02EKE01AT004, 02EKE02AT004) at Zone 1/2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_06_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	10	-	-	-	-	-
	25	6	-	-	-	-
	50	6	-	-	-	-
NG_07_01 Jet fire from LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 1) at Zone 1	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	314	244	223	182	172

Significant Incident Scenario – Jet fire	Hole Size (mm)	Heat Radiation (Distance from centre of incident (m))				
		3 kW/m²	6.31 kW/m²	8 kW/m²	23 kW/m²	32 kW/m²
NG_08_01 Jet fire from LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 2) at Zone 2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	343	266	242	197	186
NG_09_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	10	13	12	11	-	-
	25	37	31	30	26	24
	50	75	62	59	51	48
NG_10_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	10	11	10	9	-	-
	25	32	27	26	22	21
	50	65	54	51	44	42
NG_11_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	10	11	9	8	-	-
	25	31	26	25	21	20
	50	63	53	50	43	41
HY_01_01 Jet fire from LOC of hydrogen from Hydrogen tube trailer (90QJH01BB901) at Zone 3	10	26	24	23	21	21
	25	57	49	48	45	44
	50	113	89	86	78	77
HY_02_01 Jet fire from LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	10	24	22	21	20	19
	25	53	46	45	42	41
	50	103	82	79	73	71
HY_03_01 Jet fire from LOC of hydrogen from Trailer to high pressure piping at Zone 3	10	26	24	23	21	21
	RUP	47	42	40	37	37
HY_04_01 Jet fire from LOC of hydrogen from Trailer to low pressure piping at Zone 3	10	5	-	-	-	-
	RUP	12	11	11	-	-
HY_05_01 Jet fire from LOC of hydrogen from Hydrogen manifold at Zone 3	10	5	-	-	-	-
	25	15	14	14	12	-
	RUP	7	-	-	-	-
HY_06_01 Jet fire from LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 1) at Zone 1	10	5	-	-	-	-
	RUP	7	-	-	-	-
HY_07_01 Jet fire from LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 2) at Zone 2	10	5	-	-	-	-
	RUP	5	-	-	-	-

Provided a LOC at the facility is quickly isolated through the closure of remote operated valves, either through manual activation from the control room or through automatic shutdown following gas or fire detection, the supply of gas to the leaking pipe or vessel would result in a rapid reduction in gas pressure within the isolated pipework and an associated reduction in release rate of flammable material to atmosphere.

Closure of shutdown valves would be expected to be initiated within seconds for an automatic-initiated closure or minutes for manual initiation.

From initiation of a closure of isolation valves, scenario modelling, Table 13, predicts a rapid reduction in outflow rate from a rupture or large hole in a pipeline containing high pressure gas on the facility.

The results show that releases from hole sizes of 50mm diameter or greater, up to pipe rupture, will rapidly diminish in 5 to 10 minutes and likely self-extinguish before an active fire response can be mounted. Further, the length of the jet flame will rapidly diminish with loss of leak pressure, quickly reducing the heat exposure of adjacent plant or structures. Smaller hole size releases, from 25mm diameter and below, will be sustained for longer and may require deployment of active fire protective equipment to minimise damage to adjacent plant and structures.

The thermal radiation isopleths provided in Appendix E in Figure 10 are for 25mm leaks only for fuel gas. For the hydrogen forwarding manifold to the Power Islands only 10mm leaks are modelled because of the provision of emergency isolation from the hydrogen storage. For the hydrogen storage both 10mm and 25mm leaks have been modelled because of the stored volume and piping configuration. These represent the most severe results, i.e., flame length and duration.

Table 13 Initial Release Rates as a Function of Time and Pressure

Significant Incident Scenario – Jet Fires	Hole Size (mm)	Initial Release Rate (kg/s)	Fraction of Initial Release Rate at time:				
			1 min	3 min	10 min	30 min	60 min
NG_01_01 Jet fire from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	10	0.6	100%	99%	97%	89%	80%
	25	3.6	98%	93%	79%	50%	27%
	50	14.3	91%	75%	41%	9%	6%
NG_02_01 Jet fire from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	10	0.7	100%	99%	95%	84%	70%
	25	4.1	96%	89%	69%	34%	14%
	50	16.4	86%	64%	25%	2%	0%
HY_01_01 Jet fire from LOC of hydrogen from Hydrogen tube trailer (90QJH01BB901) at Zone 3	10	0.7	83%	60%	22%	3%	0%
	25	4.3	36%	8%	5%	0%	0%
	50	17.2	5%	0%	0%	0%	0%
HY_02_01 Jet fire from LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	10	0.6	3%	0%	0%	0%	0%
	25	3.6	5%	0%	0%	0%	0%
	50	0.8	100%	0%	0%	0%	0%
HY_04_01 Jet fire from LOC of hydrogen from Trailer to low pressure piping at Zone 3	10	0.004	10%	0%	0%	0%	0%

<u>Gas Receival Station Jet Fires – Potential Impact on Snowy Hydro Site Only (Modelled Scenarios NG-01-01 and NG-02-01)</u>

A formal fire safety study of the Gas Receival Station (GRS) is being prepared by APA, who will be the owner and operator of that facility. AECOM has performed some “indicative modelling” only of the GRS, using the available preliminary information from APA, to assess any potential impacts to the Snowy Hydro facility from significant LOC incidents in the GRS.

Appendix E, Figure 10(a) and (b) indicate that the damaging thermal radiation from a significant LOC incident in the GRS is expected to be contained within the GRS. Slightly elevated thermal radiation levels only, i.e., around $3kW/m^2$, are estimated to occur in the corner of the Snowy Hydro site where its southern boundary meets the eastern fence line of the GRS. There is no estimated impact on the nearby hydrogen storage facilities on the Snowy Hydro site. At this thermal radiation level and given the open space, persons in the area would be able to safely evacuate the area.

Fuel Gas and Hydrogen Forwarding Manifolds (Modelled Scenarios NG-03-01 and HY-05-01)

For a jet fire from the high-pressure fuel gas forwarding manifold, thermal radiation levels capable of damaging equipment, shelters or buildings extend onto the western portion of the Power Island. See thermal radiation isopleths in Appendix E, Figure 10(c). The equipment encroached upon are the fuel gas filtration and the close cooling water fin-fan coolers. This equipment and its supporting structures are primarily of non-combustible construction, which will prevent immediate incident escalation; however, prolonged exposure will result in damage. Containment integrity failure of the fuel gas filtration equipment could escalate the fire event, though the event would be expected to be limited to the fuel gas filtration equipment rather than propagating further through the plant. The fuel gas filtration equipment is all mounted at grade and adequately separated from other plant. The fire safety approach for the fuel gas forwarding manifold is based on rapid isolation of the leak source and depressurisation of the gas. The closed cooling water system does not handle flammable or combustible substances and is mounted at grade and adequately separated from other plant such that structural failure would not impact the safety of any other plant areas.

Damaging thermal radiation levels do not encroach on the hydrogen storage facilities, which are near the start of the fuel gas forwarding manifold. There are no occupied buildings on site or off site exposed to elevated levels of thermal radiation from a fuel gas manifold jet fire. The western site boundary borders bushland and is separated from it by an APZ. Thermal radiation levels capable of igniting bushland extend across the western site fence into the APZ. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate also extend into the western portion of the Power Island and across the western site boundary. These spaces are relatively open and, combined with the highly localised effect and directional nature of a jet fire, would permit effective evacuation.

A jet fire from the hydrogen forwarding manifold has a significantly shorter effect range and duration than that from a fuel gas manifold jet fire and is estimated not to encroach on plant or structures on the Power Island. It will; however, also encroach into the APZ adjacent the western site fence but to a lesser distance than for a fuel gas jet fire. Rapid isolation of the leak source and depressurisation of the gas is also the fire safety strategy for the hydrogen forwarding manifold.

Fuel Gas Filtration, Metering and Heating (Modelled Scenarios NG-04-01 to NG-11-01)

For a jet fire from the high-pressure fuel gas filtration equipment or piping, thermal radiation levels capable of damaging equipment, shelters or buildings impact plant on the western portion of the Power Island. See thermal radiation isopleths in Appendix E, Figure 10(d) to (k) (the isopleths do not include the shielding effect of plant and enclosures, i.e., the isopleths are for the completely unshielded reach of thermal radiation from a jet fire. Further, for piping, the isopleths have been drawn to show the locus of the thermal radiation about the piping routes; an actual jet fire will only occur from a point source and its actual isopleth will be local to the point source). This equipment and its supporting structures are primarily of non-combustible construction, which will prevent immediate incident escalation; however, prolonged exposure will result in damage. Containment integrity failure of other portions of the fuel gas filtration equipment could escalate the fire event, though the event would be expected to be limited to the fuel gas filtration equipment rather than propagating further through the plant. The fuel gas filtration equipment is all mounted at grade and adequately separated from other plant. The fire safety approach for the fuel gas forwarding manifold is based on rapid isolation of the leak source and depressurisation of the gas.

There are no occupied buildings on site or off site exposed to elevated levels of thermal radiation from a fuel gas manifold jet fire. The north-western and western site boundary borders bushland and is separated from it by an APZ. Thermal radiation levels, from a jet fire from a piping integrity failure of piping associated with the fuel gas filtration equipment, capable of igniting bushland extend across the northern and western site fences into the APZ. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate also extend into adjacent plant areas in the western portion of the Power Island and across the north-western and western site boundary. Much of this space is relatively open and, combined with the highly localised effect and directional nature of a jet fire, would permit effective evacuation. Closer to the GT enclosure, on its southern side, the space is more congested with equipment and enclosures, but being primarily of non-combustible construction and grade-mounted, also creates shielding to a potential jet fire and would provide cover for escape.

<u>Hydrogen Forwarding Manifold on the Power Island (HY-06-01 and HY-07-01)</u>

A jet fire from the hydrogen forwarding manifold on the Power Island has a very short effect range and duration. See thermal radiation isopleths in Appendix E, Figure 10(q) and (r) (the isopleths do not include the shielding effect of plant and enclosures, i.e., the isopleths are for the completely unshielded reach of thermal radiation from a jet fire. Further, for piping, the isopleths have been drawn to show the locus of the thermal radiation about the piping routes; an actual jet fire will only occur from a point source and its actual isopleth will be local to the point source). The piping run from the manifold on the Power Island is fully welded without branches, valves, instruments or vents or drains until it reaches the Hydrogen Control Unit at the Generator. This section of piping is protected from mobile plant impact and provided it is well maintained against corrosion, a jet fire from it is extremely unlikely. Should a jet fire from it occur, if rapid isolation of the breached section of piping is performed, damage is expected to be very minimal and extremely local to the piping. There are no occupied buildings on site or off site exposed to elevated levels of thermal radiation from a hydrogen manifold jet fire on the Power Island and there is no risk to bushland adjacent the site.

Because of the short effect range, avoidance of an identified jet fire by personnel is easily achievable (it should be noted that hydrogen flames are not visible to the human eye and special precautions are required by personnel working in the vicinity of hydrogen containing plant).

<u>Hydrogen Storage Area (HY-01-01 and HY-05-01)</u>

As indicated earlier, jet fires for both 10mm and 25mm leaks have been modelled for the hydrogen storage area. For a jet fire from a 10mm leak from the high-pressure hydrogen storage, thermal radiation levels capable of damaging equipment, shelters or buildings are confined to the immediate vicinity of the hydrogen storage. However, a jet fire from a 25mm leak from the high-pressure hydrogen storage extends to the Power Island equipment on the southern edge of the Unit 2 Power Island and to the western wall of the Chemical Store. See thermal radiation isopleths in Appendix E, Figure 10(l) to (p).

Thermal radiation from a jet fire from the hydrogen storage facility piping heating the hydrogen tube trailer could result in containment integrity failure of the tube storage and a BLEVE. The fire safety approach for the hydrogen storage is based on rapid isolation of the leak source, de-pressuring and firewater deluge to the tube trailer.

The equipment on the Unit 2 Power Island encroached upon are: the GT air intake, SFC transformer and SFC Electrical Equipment Room. This equipment or enclosure and its supporting structures are primarily of non-combustible construction, which will prevent immediate incident escalation; however, prolonged exposure will result in damage. Containment integrity failure of the SFC transformer could escalate the fire event, though the event would be expected to be limited to the transformer rather than propagating further through the plant. Activation of the hydrogen storage firewater deluge system would diminish the thermal radiation level at the Unit 2 Power Island thereby providing protection.

Damaging thermal radiation levels do not encroach on the Gas Receival Station (GRS) equipment and piping, which is nearby. There are no other occupied buildings on site or off site exposed to elevated levels of thermal radiation from a fuel gas manifold jet fire. There is no impact to the APZ or bushland adjacent the western site boundary. Thermal radiation levels requiring personnel wearing site standard clothing to evacuate also extend to adjacent plant areas as well as the north-east corner of the GRS. These spaces are relatively open and, combined with the highly localised effect and directional nature of a jet fire, would permit effective evacuation.

5.4.3 Vapour Cloud Explosion

Background

Vapour cloud explosions (VCE) are a type of event resulting from delayed ignition of flammable vapour or gas that has accumulated in an environment in which turbulence is created by objects within the cloud, i.e., congestion, or the cloud is confined by an enclosure. Vapour cloud explosions have the potential to cause damage to infrastructure, the immediate environment and personnel onsite and where the damage occurs to other flammable or combustible fluid containing plant can result in secondary fire events.

The Multi-Energy Model [ref.14] as implemented in PHAST™ has been used to model the effects of VCE. Amongst other inputs it requires an estimation of the degree of “congestion”, which is reflected in a “source strength” class. Various combinations of congestion or confinement and reactivity of the flammable substance involved are represented by ten source strength classes in which “10” represents total confinement and “1” represents no confinement or congestion. The selection of source strength class is discussed within each scenario that is modelled.

Vapour cloud explosion scenarios

A potential consequence of a loss of containment (LOC) scenario for high pressure fuel gas and hydrogen with delayed ignition in the presence of a significant amount of fixed plant structures or enclosures, would be a vapour cloud explosion occurring within the:

- Gas Receival Station (NG_01_04)
- Fuel gas filtration area on the Power Islands (NG_04_04)
- GT (Turbine) enclosure and Fuel Gas Unit (NG-12-03, NG-13-03)
- Hydrogen storage area (HY_01_04)
- GT Generator enclosure (HY-09-03)

Qualitative impact assessment

<u>GT (Turbine) enclosure and Fuel Gas Unit (NG-12-03, NG-13-03)</u>

The GT (Turbine) enclosure and Fuel Gas Unit are considered confined environments. Leak of gas into these enclosures with delayed ignition would result in a VCE and damage of the enclosure and equipment contained within it. It is highly likely that damage caused by the VCE would result in secondary localised jet fires from gas supply equipment. Whilst serious damage to the equipment and enclosure at the source of the VCE would be likely, peak side-on overpressure effects are expected to be limited in plant beyond the enclosures by virtue of the loss of explosion energy absorbed by the enclosure damage. Other important site infrastructure, i.e., occupied buildings, hydrogen storage, fuel gas delivery systems (upstream of the Fuel Gas Unit) and the firewater tanks, pumps and booster brigade connection are well separated and isolated from the residual overpressure wave by interposing plant structures.

In recognition of the damage potential, the design of the GT (Turbine) enclosure and Fuel Gas Unit includes ventilation to prevent accumulation of leaking fuel gas; gas detection in the ventilation system; multiple parallel ventilation fans to guard against a single fan failure; fan monitoring and GT trip if the minimum number of fans operating is not sustained.

<u>GT Generator enclosure (HY-09-03)</u>

The GT Generator enclosure is considered a confined environment. Leak of gas into this enclosure with delayed ignition would result in a VCE and damage of the enclosure and equipment and piping contained within it, potentially resulting in secondary localised jet fires from damaged gas piping. Whilst serious damage to the equipment and enclosure at the source of the VCE would be likely, peak side-on overpressure effects are expected to be limited in plant beyond the enclosures by virtue of the loss of explosion energy absorbed by the enclosure damage. Other important site infrastructure, i.e., occupied buildings, hydrogen storage, fuel gas delivery systems (upstream of the Fuel Gas Unit) and the firewater tanks, pumps and booster brigade connection are well separated and isolated from the residual overpressure wave by interposing plant structures.

In recognition of the damage potential, the design of the GT Generator enclosure includes ventilation to prevent accumulation of leaking hydrogen gas and ventilation health monitoring with GT Generator trip if ventilation is lost.

Quantitative impact assessment – Consequence modelling

Consequence modelling has been performed for VCEs in the outdoor parts of the fuel gas system and hydrogen system to characterise the reach of peak side-on overpressure from a VCE at the Damage levels indicated in Table 9. The results are shown in Table 14 below. Overpressure isobars for the worst VCE scenario only in each of the main gas handling areas are overlaid on the site plan in Appendix E in Figure 12(a) to (c).

Table 14 Peak Side-on Overpressure from Vapour Cloud Explosions

Significant Incident Scenario - VCE	Explosion Overpressure (Distance from centre of incident (m))			
	7 kPa	14 kPa	21 kPa	35 kPa
NG_01_04 VCE from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	137	75	54	33
NG_02_04 VCE from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	137	75	54	33
NG_04_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	189	103	74	46
NG_05_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters at Zone 1/2	189	103	74	46
NG_06_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	96	53	38	23
NG_09_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	189	103	74	46
NG_10_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	189	103	74	46
NG_11_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	189	103	74	46
HY_01_04 VCE from LOC of hydrogen from Hydrogen tube trailer (90QJH01BB901) at Zone 3	80	46	34	25
HY_02_04 VCE from LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	80	46	34	25
HY_03_03 VCE from LOC of hydrogen from Trailer to high pressure piping at Zone 3	32	18	14	10
HY_04_03 VCE from LOC of hydrogen from Trailer to low pressure piping at Zone 3	32	18	14	10

Gas Receival Station (NG-01-04, NG-02-04)

A formal fire safety study of the Gas Receival Station (GRS) is being prepared by APA, who will be the owner and operator of that facility. AECOM has performed some “indicative modelling” only of the GRS, using the available preliminary information from APA, to assess any potential impacts to the Snowy Hydro facility from significant LOC incidents in the GRS.

Based on the available information from APA regarding the design of the GRS, AECOM has conservatively selected a VCE source strength class of “6”, being a moderate degree of plant congestion and low reactivity substance.

For a VCE from the high-pressure fuel gas equipment in the GRS, peak side-on overpressure levels capable of damaging equipment, shelters or buildings extend to the southern edge of the Unit 2 Power Island, Process Gases Storage Area and the Chemical Store. See VCE isobars in Appendix E, Figure 12(a). Peak side-on overpressure levels up to 14kPa could be experienced in the hydrogen storage equipment, which could cause moderate damage to the hydrogen storage shelter but damage to piping is unlikely. The tube trailer could experience some disturbance and, depending on the spatial nature of disturbance, could cause leaks in the tube trailer hook-up with the potential to result in a secondary hydrogen fire. Other parts of the Snowy Hydro facility that could experience elevated peak side-on overpressure levels around 7kPa include equipment on the southern edge of the Unit 2 Power Island and the Chemical Store, which could result in superficial damage.

No damage is foreseen at damage at the Bulk Fuel Oil facilities, Workshop & Storage Building, Control & Administration Building and the firewater tanks, pumps and booster brigade connection.

At this peak side-on overpressure level on the Snowy Hydro facility persons in the area might be injured but fatalities would not be expected (refer Table 9).

A sensitivity analysis of the results to the selected VCE source strength class was performed (results tabulated in Appendix E), which indicated a substantial reduction in effect distance – about 50% - if a VCE source strength class of “5” is selected. Calculations (not included in this report) were also performed at a VCE source strength class of “10” (maximum congestion/confinement), which show that the results exhibit little sensitivity to source strength classes between “6” to “10” at the effect distances of interest.

Given the low likelihood of a VCE from the GRS, low to moderate Snowy Hydro facility damage potential and low occupancy level on the Snowy Hydro facility in the areas predicted to experience elevated peak side-on overpressures, no special control measures on the Snowy Hydro facility for protection from a VCE on the GRS are planned.

<u>Fuel Gas Filtration, Metering and Heating (NG-04-04, NG-05-04, NG-06-04, NG-09-03, NG-10-03, NG-11-03)</u>

AECOM has considered the amount and arrangement of equipment, piping and structures in this location and selected a VCE source strength class of “6”, being a moderate degree of plant congestion and low reactivity substance.

For a VCE from the high-pressure fuel gas filtration, metering and heating equipment on the Power Islands, peak side-on overpressure levels capable of damaging equipment, shelters or buildings impact the western end of the Power Islands, the GRS and extend offsite into bushland to the west and north. See VCE isobars in Appendix E, Figure 12(b). Severe peak side-on overpressure levels could be experienced in the western end of the Power Island for both GTG Units, irrespective of the origin of the VCE. The VCE isobars in Figure 12(b) do not take credit for the shielding effect of interposing structures so though peak side-on overpressure wave effects are indicated to have significant reach to the east of the site, this is unrealistic because of the shielding effect of the structures interposed between the fuel gas equipment and the eastern area of the site. This shielding is expected to prevent damage at the hydrogen storage facility, Chemical Store, Bulk Fuel Oil facilities, Workshop & Storage Building, Control & Administration Building and the firewater tanks, pumps and booster brigade connection.

There are no occupied buildings, including small offices or toilets, located on the Power Islands. All “buildings” are equipment enclosures only.

There are few interposing structures in the direction of the GRS and elevated peak side-on overpressure levels could be experienced in the GRS; at the location of the GRS compressors the model predicts peak side-on overpressure levels around 14kPa. At this level, some damage to compressor enclosures could occur but not piping or the compressors themselves (refer Table 27).

There are no interposing structures in the direction of the western site boundary and the model predicts peak side-on overpressure levels that could result in disturbance to some types of vegetation beyond the APZ.

At the peak side-on overpressure level predicted by the model on the Power Island persons outdoors in the western end of the Power Islands could be fatally impacted depending on exact location at the time of the VCE; with reference to Table 9 there is a 15% chance of fatality at 35kPa. Persons, who have entered accessible equipment enclosures are more likely to be fatally impacted because of failure of the enclosure itself; with reference to Table 9 the chance of fatality within an enclosure increases to 50% for an external 35kPa peak side-on overpressure.

A sensitivity analysis of the results to the selected VCE source strength class was performed (results tabulated in Appendix E), which indicated a substantial reduction in effect distance – about 50% - if a VCE source strength class of “5” is selected. Calculations (not included in this report) were also performed at a VCE source strength class of “10” (maximum congestion/confinement), which show that the results exhibit little sensitivity to source strength classes between “6” to “10” at the effect distances of interest. Whilst the isobars for the sensitivity case contract substantially, severe peak side-on overpressure levels are estimated for the western end of the Power Island, but serious damage is more likely to be limited to the GTG Unit Power Island it originates in.

It is not practical to design plant to withstand this level of peak side-on overpressure. Given the low likelihood of a VCE from the fuel gas filtration, metering and heating equipment and low Power Island occupancy level, the project has followed good gas industry practice by locating occupied buildings and storage of flammable, combustible and other hazardous chemicals and the firewater tanks, pumps and booster brigade connection sufficiently remote from the Power Islands to avoid the effects of a VCE. Apart from separation of the key items highlighted, the key safety strategy is to prevent a VCE by ensuring good mechanical containment integrity through integrity management.

Gas detection and alarm is discussed in section 7.0, which may provide some advantage to persons working in the area with respect to escape though the speed with which the effects of a VCE manifest is problematic for reliable escape.

Hydrogen Storage Facility (HY-01-04, HY-02-04, HY-03-03, HY-04-03)

AECOM has considered the amount and arrangement of equipment, piping and structures in this location and selected a VCE source strength class of “10”, reflecting parallel confinement, i.e., tube trailer shelter roof and ground, a moderate degree of plant congestion if a second tube trailer is parked in the shelter and high reactivity substance.

For a VCE from the high-pressure hydrogen storage, peak side-on overpressure levels capable of damaging equipment, shelters or buildings extend to the southern side of the Unit 2 Power Island, GRS, Process Gases Storage Area, Chemical Store and the Workshop & Storage Building. See VCE isobars in Appendix E, Figure 12(c). Severe peak side-on overpressure levels would be experienced in the process gases storage area and Chemical Store in the southern area of the site.

A peak side-on overpressure level of around 21kPa is predicted at the location of the Chemical Store, which would be expected to sustain substantial damage (refer Table 9) with the integrity of packaging of some stored chemicals potentially compromised. The type and quantity of chemicals stored (refer Appendix J) are not likely to result in a significant secondary fire event but spillage beyond the building perimeter bund may occur for this extreme event. The facility is completely sealed and any liquid chemical spillage to the area outside the Chemical Store may enter the stormwater drains. The stormwater outlet is fitted with a remote-operated penstock valve that can be closed to prevent contaminated runoff leaving site. Whilst better separation of the Chemical Store would have been ideal, the planned chemicals to be stored have been considered in the context of a VCE event. Further, the Chemical Store does not have an integral Store Office and is therefore not classed as an occupied building, i.e., presence of personnel in the Chemical Store will be short duration associated with packaged chemical retrieval or delivery.

At the location of equipment on the Unit 2 Power Island the model predicts peak side-on overpressure levels around 14kPa. At this level, some damage to the GT air intake and SFC Electrical Equipment Room could be expected (refer Table 9). Damage to the SFC transformer is not expected (refer Table 27). Minor to moderate damage to other Unit 2 Power Island items could occur but is difficult to estimate due to the partial shielding from the peak side-on overpressure wave by the highlighted equipment on the southern edge of the Unit 2 Power Island.

At the location of the GRS compressors the model predicts peak side-on overpressure levels around 14kPa. At this level, some damage to compressor enclosures could occur but containment integrity damage to piping or the compressors is unlikely (refer Table 27).

At the location of the Workshop & Storage the model predicts peak side-on overpressure levels around 7kPa. At this level, no or minor damage to the building could occur but structural integrity is expected to be maintained. There are no windows planned in the exposed western side or northern and southern ends of the building, which could shatter.

Other than impact in the GRS the model does not predict elevated side-on overpressures of a level to cause damage or harm offsite.

Considering where damage could occur, its severity and area occupancy combined with the low likelihood of a VCE from the hydrogen storage, the project has followed good gas industry practice, to the extent practicable, by locating occupied buildings, bulk fuel storage and receipt and the firewater tanks, pumps and booster brigade connection sufficiently remote from the hydrogen storage to either avoid the effects of a VCE or avoid damage that could pose a serious threat to occupants, i.e., the Workshop & Storage Building.

Apart from separation of the key items highlighted, the key safety strategy is to prevent a VCE by ensuring good mechanical containment integrity through integrity management.

Gas detection and alarm is discussed in section 7.0, which may provide some advantage to persons working in the area with respect to escape though the speed with which the effects of a VCE manifest is problematic for reliable escape.

5.4.4 Building Fire

In the context of this study building fires are considered as a type of event resulting from propagation of an incipient fire through any combustible items related to the building and its use, e.g., fixtures, furnishing, substances normally used inside the building, etc. This project has pursued building designs which are mostly non-combustible construction to limit the potential for fire growth and escalation to adjacent facility elements. In the absence of control measures a building fire has the potential to fatally impact building occupants and, depending on the quantity of combustible items may have the potential to escalate to adjacent property.

By virtue of the design of the buildings in this project, a fire event associated with the building is expected to be contained locally, i.e., to the building. No offsite impacts from building fire are foreseen. Building fire protection assessment is summarised in Appendix G.

5.4.5 High Voltage Switchyard Arcing

A failure in the high voltage switchyard resulting in arcing to ground (NF_08) can provide a powerful ignition source to flammable or combustible material present. There is very little flammable or combustible material in the Snowy Hydro high voltage switchyard; high voltage conductors will be bare and high voltage insulators will also be ceramic, i.e., non-combustible. Only a very small quantity of insulated control cabling will be present. There will not be any power transformers, so there is no risk of major insulating oil spill or leak in the area (there will only be control transformers, which have an insignificant volume of insulating oil in the context of fire risk).

Arcing to ground igniting vegetation is considered. The high voltage switchyard will be sealed, so there will be no vegetation able to grow within the perimeter of the switchyard, which eliminates a grass fire that could propagate into adjacent bushland.

The fire risk of the adjacent Ausgrid high voltage switchyard is excluded from this study, other than the observation that it appears to have similar characteristics to the Snowy Hydro high voltage switchyard therefore no interacting fire risks are foreseen between the two switchyards.

5.5 Bushfire Impact Assessment

Unlike the scenarios discussed in Section 5.4, bushfire is generally not a facility-initiated event; however, the facility is in a location that can be impacted by bushfire, so it is appropriate to consider the impact of bushfire on the facility.

5.5.1 Bushfire threat assessment

As noted in Section 4.3, a bushfire hazard assessment was conducted by Jacobs Group (Australia) Pty Ltd in 2021 [ref.20], in accordance with NSW Rural Fire Service (RFS), *Planning for Bushfire Protection* [ref.19]. A full copy of the report is included in Appendix H.

The assessment notes that facility site was previously occupied by the Kurri Kurri aluminium smelter and that, except for two small areas within the location of the electrical switchyard, the entire Project Site has been cleared of native vegetation. It found that parts of the electrical switchyard include land that is currently classified as high and moderate bushfire risk (Bushfire Prone Land (BPL), categories 1 and 3, respectively). The northern and western edges of the facility are located within buffer areas for category 1 and 3 vegetation, with the remainder of the facility not classified as bushfire prone.

The assessment found that landscape bushfire risks to facility arise mainly from the large patch of bushfire prone vegetation (Coastal Swamp Oak Forest vegetation community) located to its north and west. Smaller fragments of this vegetation community are also located to the east of the facility.

5.5.2 Facility Impacts from Bushfire

In assessing the impacts of bushfire on the facility existing bushfire management arrangements for the region in which the facility is located are considered in evaluating the impact on specific elements of the facility to determine whether additional facility-based protections are warranted. The existing bushfire management arrangements for the region are described in the Hunter Bush Fire Management Committee's (HBMC) Bush Fire Risk Management Plan (BFRMP) [ref.21] for the Cessnock and Maitland local government areas.

The Hunter BFRMP identifies the former Kurri Kurri aluminium smelter (within which the facility is located) as a priority 1C (extreme risk) area and specified several risk mitigation strategies, including hazard reduction and property planning. The former Kurri Kurri aluminium smelter site is set within an Asset Protection Zone (APZ) and is surrounded by a Strategic Fire Advantage Zone (SFAZ) that extends over the surrounding native vegetation and grassland.

Native vegetation areas of relatively high bushfire risk to the north and west of the facility are managed by RFS under the Hunter BRMP as SFAZs. Bushfire fuel hazard in these areas is actively controlled (including by planned burning) to reduce bushfire risk, as well as radiant heat and ember attack exposure. With reduced bushfire fuel hazard, the behaviour of any established fire is likely to be moderated.

The bushfire assessment determined the need for an Asset Protection Zone (APZ) between the surrounding bush and the facility, which would provide a defendable space around the structures, and avoid flame contact and radiant heat which could pose a threat to the integrity of the facility (refer Appendix B, Figure 7). It would also reduce opportunities for any fire igniting on the facility to escape to surrounding areas. A 10 m wide APZ is provided and will be maintained along the perimeter of the facility in areas where there is an interface with bushfire prone vegetation. The project has adopted the recommendations from the earlier bushfire assessment and all woody vegetation is being removed from the APZ.

All vegetation (including grasses) is also being removed from the switchyard location to reduce opportunities for a fire entering the facility or for vegetation being accidentally ignited by a fault in electrical infrastructure resulting in a fire that could escape from the facility into the surrounding bush.

In addition to the removal of woody vegetation from within the APZ, vegetation is being removed from within the facility during construction and will be maintained clear during operation. It will reduce the risk of landscape fire from offsite ember attack in the facility (e.g., from embers landing within it) as well as the risk of a facility-initiated landscape fire occurring within it.

Considering the APZ, the maximum Bushfire Attack Level (BAL) experienced at the location of any facility plant or buildings is BAL-19, in the northern portion of the facility. The BAL-12.5 contour encroaches on the utilities and bulk fuel oil storage area, Unit 1 Power Island and partially on the south-west corner of the Unit 2 Power Island. The Control & Administration Building, Workshop & Storage Building and Chemical Store are located beyond the BAL-12.5 contour. The BAL at key facility infrastructure items and hazardous material storage is summarised in Table 15.

Table 15 Key Facility Infrastructure/Hazardous Material Storage and Bushfire Attack Level Exposure

Facility Infrastructure	BAL, kW/m^2	Comments
Hydrogen Storage	less than 12.5 kW/m^2	High pressure flammable gas
Fuel Gas Receival Station	12.5 to 19 kW/m^2	High pressure flammable gas The Gas Receival Station is being developed in a separate project by APA Group. It is mentioned here in recognition of escalation risk to the Snowy Hydro facility only.
Bulk Fuel Oil Storage	12.5 to 19 kW/m^2	Combustible liquid

Facility Infrastructure	BAL, kW/m^2	Comments
Chemical Package Storage	less than 12.5 kW/m^2	Drums of lube oil and control oil and minor storage of flammable and combustible liquids. Other chemicals are non-combustible.
Occupied Buildings	less than 12.5 kW/m^2	Control & Administration, Workshop & Storage
HV Switchyard	12.5 to 19 kW/m^2	Range for Snowy Hydro portion of Switchyard.
Unit 1 Gas Turbine Generator	12.5 to 19 kW/m^2	Included in recognition of Project as Critical State Significant Infrastructure.
Unit 2 Gas Turbine Generator	less than 12.5 kW/m^2	Included in recognition of Project as Critical State Significant Infrastructure.
Firewater Storage, Pumps and Booster Connection	less than 12.5 kW/m^2	Safety Critical Equipment

The main structures in the High Voltage Switchyard, which have the potential to be exposed to thermal radiation close to 19kW/m^2 are expected to tolerate the exposure without loss of integrity so no specific control measures for them are planned. Aerial power cables connected to the facility may be prone to damage but will not cause further escalation of the fire event on the facility.

The enclosures and outdoor plant on the northern side of the Unit 1 Power Island and the utilities area in the north of the site will experience thermal radiation less than 19 kW/m^2 but greater than 12.5 kW/m^2. Some damage to the architectural elements of the enclosures may occur; however, loss of structural integrity is not foreseen so no specific control measures for them are planned. The outdoor plant in this location, except for the potable water and demineralised water tanks, is foreseen to be tolerant of this exposure though, any plastic tubing or other small plastic parts of plant may be damaged. Prolonged exposure to 19 kW/m^2 has the potential to damage an atmospheric tank if cooling is not applied. The Energy Institute (2007), Model Code of Safe Practice, Part 19: Fire Precautions at Petroleum Refineries and Bulk Storage Installations [ref.22] recommends that above 8 kW/m^2 access to cooling water should be available and dedicated fixed tank cooling should be planned at exposure levels of 32 kW/m^2 or greater. The cause for the estimated thermal radiation at the location of the tanks is a very small patch (~0.7ha) of trees adjacent the north-east corner of the site. It is expected that a bushfire in this patch, would be short and the peak thermal radiation level, represented by the BAL, would be even shorter. It is also likely that bushfire fighting will have been commenced with pre-emptive control of this patch of trees, resulting in much lower thermal radiation. Considering these circumstances, dedicated fixed on tank cooling is not recommended but provision of some fixed firewater monitors on the site firewater hydrant system to enable site personnel to direct cooling water onto the exposed surface of the tanks is recommended. No other specific control measures for plant in this area are planned.

The bulk fuel oil storage tanks will experience thermal radiation less than 19 kW/m^2 but greater than 12.5 kW/m^2. As indicated in the discussion of the potable and demineralised water tanks, prolonged exposure to 19 kW/m^2 has the potential to damage an atmospheric tank if cooling is not applied. Unlike the potable and demineralised water tanks, the fuel oil is a combustible liquid, which must also be considered. The planned storage tanks have been designed in accordance with the requirements of AS1940 and AS1692. The tanks have a fixed roof design, which eliminates the fire risks associated with floating roof designs. The tank vent is designed with a flame arrestor, which will inhibit ember ingress and prevent flame ingress from ignition of any vapour that occurs outside the vent because of any elevation in fuel oil temperature during a bushfire exposure event. Other than the specific design requirements of AS1940 and AS1692, the protection rationale and recommendations for the bulk fuel oil tanks is identical to that described for the potable and demineralised water tanks.

The hydrogen storage is located beyond the 12.5kW/m^2 bushfire thermal radiation contour, though ember attack remains a threat. The hydrogen trailer tubes and smaller cylinder crates will be of steel construction and tolerant of the degree of ember attack expected. The balance of equipment and piping in the hydrogen storage facility will be tolerant of ember attack and no other specific control measures for plant in this area are planned.

The fuel gas and hydrogen forwarding piping is routed above-ground along the western boundary of the facility and will experience thermal radiation less than 19 kW/m^2 but greater than 12.5 kW/m^2. The piping is of steel construction and foreseen to be tolerant of this level of exposure; however, it is expected that the facility will be shut down in preparation for the passing of the bushfire so the piping will not benefit from the cooling effect of the flowing gas therefore the heating will increase the internal pressure of the gas. The effect is anticipated to be less pronounced for the hydrogen piping because of the small, exposed pipe surface area (i.e., in the direction of the bushfire) associated with the small diameter, 32mm reducing to 25mm. The effect will be more pronounced for the fuel gas piping because of its greater exposed pipe surface area associated with its diameter, 300mm. The system is protected against excessive pressure via a self-acting pressure relief valve on the fuel gas knockout pot. It is recommended that Snowy Hydro consider including de-pressuring the fuel gas forwarding piping as a precautionary measure in its bushfire response procedure. No other specific control measures for the fuel gas and hydrogen forwarding piping in this area are planned.

The Chemical Store is located beyond the 12.5kW/m^2 bushfire thermal radiation contour, though ember attack remains a threat. The Chemical Store is naturally ventilated, which could permit ember ingress. The design of the ventilation will obstruct ingress of a portion of the embers arriving at the building so it is anticipated that the lower density of embers that successfully enter the Chemical Store could ignite some light-weight packaging in that area. Oils (combustible liquids) will be stored in closed 200L steel drums and small containers of flammable materials will be stored in certified steel Flammable Liquid Storage Cabinets. Other chemicals are non-flammable or combustible (refer Appendix J for the preliminary inventory of chemicals planned for the Chemical Store). Considering the chemicals planned to be stored and the types of packaging a large fire in the contents of the Chemical Store is not considered credible. It is recommended that Snowy Hydro develop protocols for preparing the Chemical Store for bushfire to minimise the risk associated with ember ingress. No other specific design control measures are provided.

The Control & Administration Building and Workshop & Storage Building, being occupied buildings, are located beyond the 12.5kW/m^2 bushfire thermal radiation contour, though ember attack remains a threat. These buildings are of non-combustible construction and internal spaces that are furnished are sealed from ember ingress. A significant storage and large tooling space in the workshop are naturally ventilated, which could permit ember ingress. The design of the ventilation will obstruct ingress of a portion of the embers arriving at the building so it is anticipated that the lower density of embers that successfully enter the Workshop & Storage could ignite some light-weight combustible packaging associated with spare equipment and small spare parts. Small quantities of flammable liquids used in the Workshop & Storage, e.g., degreasers, touch-up paint spray cans, etc, will be stored separate from any equipment or small parts combustible packaging in certified steel Flammable Liquid Storage Cabinets. Any steel oxyacetylene cylinders used in the workshop will also be kept separate from any equipment or small parts combustible packaging. Considering the planned use of the area and the non-combustible construction of the Workshop a large fire threatening the integrity of the building is not considered credible. It is recommended that Snowy Hydro develop protocols for preparing the Workshop & Storage Building for bushfire to minimise the risk associated with ember ingress. No other specific design control measures are provided.

All parts of the site are expected to be exposed to ember attack; however, given the mostly non-combustible construction of the site, ember attack is not foreseen to escalate generally to onsite fires. Good housekeeping to prevent accumulation of wind-blown combustible material or combustible liquid spills will help to reduce the risk of spot fires.

The oily water pit in the utilities area (north-eastern area of the facility) is an open top pit, 17.5m x 17.5m, with a shelter to minimise rainwater ingress and a chain-link perimeter fence to prevent accidental fall into the pit. The pit includes a deep corner, 4.5m x 7.4m, which will be where the normal operating level sits; the remainder of the pit is for handling extreme inflow events. The design does not foresee continuous oil flow into the pit. Flow into the pit will be intermittent and primarily related to rainfall into unroofed bunds, i.e., transformers, bulk fuel oil storage and tanker bay. This flow is only expected to carry trace quantities of oil. In the normal operating condition for the pit very little oil is expected to be floating on the surface of the pit from rainfall events. Only in an oil leak or spill incident is when oil is expected to be in the pit in measurable amounts. In this condition, there is a risk of ignition of the oil floating on the surface of the pit by ember attack. The pool fire size would likely be limited by the surface area of the deep corner of the pit, 4.5m x 7.4m, and its duration would be contingent on the volume of oil in it. The fire is expected to be very smoky and obstruct flame thermal radiation. Damage to the roof of the shelter is likely but due to the separation of the pit from other site infrastructure a pit fire is not foreseen to impact other facility plant and infrastructure. Provided oil leaks and spills to the pit are promptly dealt with, i.e., the accumulated oil in the deep corner is pumped out rather than left to sit for a prolonged time, then the likelihood of the coincident events of a significant oil leak or spill to the pit and bushfire is very low. Considering the combination of very low event likelihood and severity no specific design control measures for protection from bushfire ember attack are planned.

6.0 Fire Prevention Strategy and Measures

6.1 General

Specific design fire prevention measures in relation to the significant incidents identified in Section 4.2, Table 4 and Table 5 are discussed below. It should be noted that there are also a range of administrative control measures required, which are normal practice, to complete management of the fire risk, e.g., Work Permits (especially control of hot work), maintenance inspection/testing, housekeeping, training, site vehicle speed limits, etc.

The generic fire prevention strategy for process fluids is:

- Prevention and containment of leaks
- Prevention of ignition sources within hazardous areas
- Ventilation, both natural and forced, to prevent accumulation of flammable vapour.

Fire and gas detection is discussed in Section 7.0 whilst fire protection is discussed in Section 8.0.

6.2 Gas Turbine Generator Plant

The following specific features are incorporated in the Gas Turbine Generator plant design to minimise the risk of fire:

- Systems to prevent or limit releases, e.g., system sectioning with associated remote operable valves.
- Minimisation of flanges and joints to the extent practicable to minimise potential leak points from equipment and/or piping systems.
- Provision of guard railing and bollards for plant equipment and piping to prevent impact from vehicles.
- Measures to confine or divert spills of lube, seal and control oil using curbs, bunds and trenches where necessary.
- Spill Kit Stations to facilitate prompt spill clean-up.
- Forced ventilation of enclosures to prevent accumulation of flammable gas (fuel gas and hydrogen).
- Open plant layout for the fuel gas filtration, metering and heating equipment to facilitate natural ventilation to prevent accumulation of flammable gas (fuel gas and hydrogen).
- Static electricity control through plant bonding and grounding.
- Ignition source control, by application of area classification guidelines.
- Process control and instrumented protective systems, providing an early warning when normal process parameters are approaching or exceeding their limits.
- Emergency shutdown systems, providing means to bring the plant or plant sections to a safe and steady state.
- Emergency relief vents to relieve excess pressure to a safe discharge location to prevent containment integrity failure and leak amongst plant.
- Prevention of building fires through materials of construction and housekeeping.
- Prevention of arson-related fires through site security, e.g., perimeter fencing, access control, CCTV.

6.3 Hydrogen and Fuel Gas Facilities

The following specific features are incorporated in the hydrogen and fuel gas facilities design to minimise the risk of fire:

- Systems to prevent or limit releases, e.g., system sectioning with associated remote operable valves, minimum flanges and small-bore connections.
- Provision of guard railing and bollards for plant equipment and piping to prevent impact from vehicles.
- A layout, which promotes natural ventilation and dispersion of potential vapour clouds, which is at a safe distance from uncontrollable ignition sources outside the fence.
- Ignition source control, by application of area classification guidelines and by using adequate equipment separation distances.
- Static electricity control through plant bonding and grounding, including portable hydrogen storage equipment, i.e., tube trailer and cylinder crates.
- Process control and instrumented protective systems, providing an early warning when normal process parameters are approaching or exceeding their limits.
- Emergency shutdown systems, providing means to bring the plant or plant sections to a safe and steady state.
- Emergency relief vents to relieve excess pressure to a safe discharge location to prevent containment integrity failure and leak amongst plant.
- Prevention of arson-related fires through site security, e.g., perimeter fencing, access control, CCTV.

6.4 Bulk Fuel Oil Facilities

The following specific features are incorporated in the Bulk Fuel Oil Facilities design to minimise the risk of fire:

- Systems to prevent or limit releases, e.g., tank overfill protection, dry-break couplings for drive-away protection at the tanker bay, minimum use of sight glasses, minimum flanges and small-bore connections, fire-safe valves and remote operable shutdown valves.
- Measures to confine or divert spills, using curbs, bunds and trenches where necessary, including separate drain systems for stormwater runoff and oily water.
- Spill Kit Stations to facilitate prompt spill clean-up.
- Prevention of arson-related fires through site security, e.g., perimeter fencing, access control, CCTV.

Table 16 Bulk Fuel Oil Bunds Capacity

Bund	Dimensions Length and Width (m)	Depth (m)	Volume (m^3)	Design Basis
Bulk fuel oil storage bund	33 x 50 Surface area: 1,650### m^2 (includes the area taken up by the tanks which are each 177m^2)	1.8	2,300	Contains the 110% of the contents of a fuel oil tank (both tanks are identical volume)
Bulk fuel oil tanker bay	26 x 5.7	0.3	17	Contains the

Bund	Dimensions Length and Width (m)	Depth (m)	Volume (m^3)	Design Basis
	Surface area: 148 m^2			the contents of one compartment of the fuel oil tanker

6.5 Electrical Equipment

The following specific design features are incorporated in the high voltage electrical facilities design to minimise the risk of fire:

- Measures to confine or divert transformer oil spills, using curbs, bunds and closed drains where necessary. Bund capacity information is given in Table 17.

Table 17 Transformer Bunds Capacity

Bund	Dimensions Length and Width (m)	Depth (m)	Volume (m^3)	Design Basis
Generator Step-Up Transformer bund	13 x 16.9 Surface area: 220 m^2	0.6	106	Contains 110% of the contents of the transformer plus max 5 m^3 of firefighting medium. Bund is drained directly to remote primary containment pit.
Unit Transformer bund	7.3 x 9.8 Surface area: 71m2	0.5	26	Contains 110% of the contents of the transformer plus remainder 15 m^3 allowance for firefighting medium. Bund is drained directly to remote primary containment pit.
SFC Transformer bund	7.3 x 6 Surface area 44m2	0.4	12	Contains 110% of the contents of the transformer plus remainder 7.1 m^3 allowance for firefighting medium. Bund is drained directly to remote primary containment pit.
GTG Auxiliary Transformer bund	5.4 x 5 Surface area: 27m2	0.4	9	Contains 110% of the contents of the transformer plus remainder (7.1 m^3) allowance for

Bund	Dimensions Length and Width (m)	Depth (m)	Volume (m^3)	Design Basis
				firefighting medium. Bund is drained directly to remote primary containment pit.
Utilities Area Transformers bunds (per transformer)	5.5 x 5 Surface area: 28m2	0.4	9	Contains 110% of the contents of the transformer plus remainder (6.3 m^3) allowance for firefighting medium. Bund is drained directly to remote primary containment pit.

6.6 Buildings

6.6.1 Electrical Equipment Rooms

The following specific features are incorporated in electrical equipment rooms design to minimise the risk of fire:

- Room constructed mostly of non-combustible materials.
- Forced ventilation of Battery Rooms to prevent accumulation of flammable gas (hydrogen).

Fire and smoke detection is summarised in Section 7.2.

6.6.2 Occupied Buildings

Specific fire prevention and protection measures for occupied buildings are mostly codified through the BCA and associated Standards. The project design approach with respect to buildings has been conducted to maintain compliance with the BCA and associated Standards.

A summary of the Fire Protection Measures for Buildings is included in Appendix G.

6.7 Backup Power Supply

Backup power supply upon loss of main power supply, in the context of fire prevention, is important because it prevents occurrence of a facility condition with the potential to create the preconditions for a fire event.

Energy to the plant emergency systems, including to critical alarms, will be backed up by the emergency generator and the 220VDC battery backup. The 220VDC systems will be sized to provide power for safe plant operation and shutdown, rated for 4-hour backup autonomy (with both A and B batteries healthy).

Critical egress lighting systems in the plant are provided with integral battery packs to provide required level of light to enable safe egress with a minimum 90-minute back-up duration compliant to Australian Standards. This critical egress lighting will remain operational in case of normal power failure prior to the emergency generator source coming online.

An emergency diesel generator will be provided for plant essential loads including: 220VDC system, lighting, control systems (including alarms and emergency shutdown equipment), instruments and other critical safety devices.

The Control & Administration Building will have backup power supplied from the site battery backup to switchboards Communications Room ‘A’ 220VDC Distribution Board and Communications Room ‘B’ 220VDC Distribution Board. These boards in general supply rack mounted equipment in the communication rooms and lighting circuits in Communications Room A 01, Communications Room B 02 and Control Room 03.

7.0 Fire Detection and Alert Strategy and Measures

7.1 General

Separation of fuel, oxygen and ignition sources is the primary approach to *prevent* fires, as discussed in the previous sections; however, history has shown that despite best endeavours in this regard, breakdowns in the approach have resulted in fires. Early identification of a fire creates the best possible chance to take actions to minimise the fire size and its impact. Instrumented fire detection and automated response is specified for this purpose.

7.2 System Description

A comprehensive detection and alarm system is specified for the facility that will have the ability to detect and respond to fire situations or potential fire situations.

The project will be provided with a Main Fire Indicator Panel (MFIP) complete with a graphics screen located in the Fire Pump Room and is networked to the site Sub Fire Indicator Panels (SFIP). There will also be a graphics screen in the Control & Administration Building Control Room for staff interaction and control.

Emergency alert initiators, triggering control room alarm, will be:

- Fire and gas detection
- Initiation of Emergency Shutdown
- Deluge at:
  - Generator Step-Up Transformers
  - Unit Transformers (Power Island)
  - Static Frequency Converter Transformers
  - Bulk hydrogen storage
  - Fuel oil units (Power Island)
- Firewater sprinkler system at:
  - Auxiliary Plant Enclosures (Power Island)
  - Seal oil systems (Power Island)
  - Electrical Equipment Rooms (under floor)

An emergency alert can also be manually initiated by any person on site via Manual Call Points located throughout the facility.

The generalised scope of the fire detection and alarm system specified is comprised of:

- Fire indicator panels
- Fire detectors
- Manual call points
- Fire alarm evacuation sounders and strobe lights.

The implementation of detection equipment in buildings and enclosures is summarised in Table 18.

Table 18 Detection Equipment locations in buildings and enclosures.

Building	Detection Equipment	Response
GT and Fuel Gas Enclosure	Gas and Flame detectors, Manual Call Points (MCPs)	Gas detectors will be located in the ventilation exhaust and optical flame detectors will cover the fuel gas and fuel oil connections on the turbine. Activation of these will trigger a Unit ESD in the particular Unit on the Power Island as well as an alarm via the Fire Indicator Panel (FIP) and activation of the enclosure fire evacuation alarm.
GT Fuel Oil Unit	Heat detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Fuel Oil Units, which upon activation will send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.
Electrical Equipment/Control/Switch Rooms	Point type smoke/heat detectors, Aspirating smoke detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Electrical Rooms and MCPs at each FIP, which upon activation will operate the BOWS, send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.
Auxiliary Plant Enclosure	Heat detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Auxiliary Plant Enclosure and MCP at the FIP, which upon activation will operate the BOWS, send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.
Chemical Store	Heat detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Chemical Store and MCP at the FIP, which upon activation will operate the BOWS, send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.
Workshop & Storage Building	Heat detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Workshop & Storage Building and MCP at the FIP, which upon activation will operate the BOWS, send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.
Control & Administration Building	Point type smoke detectors, Aspirating smoke detectors, Manual Call Points (MCPs)	Detectors will be positioned within the Control & Administration Building and MCP at the FIP, which upon activation will operate the BOWS, send a fire alarm signal to the MFIP and a fire alarm call to the fire brigade.

Other structures across the Project that aren't a specific Building having a detection or protection system have MCPs located adjacent to them for means of alerting of fire situations, e.g., utility transformers, oily water system, auxiliary transformers, water pumps shelter, fuel oil pump shelter.

The MFIP will be linked to the FRNSW through an approved third-party Automatic Fire Alarm Service Provider (AFASP).

An operator can also manually alert FRNSW.

8.0 Fire Protection and Suppression Strategy and Measures

8.1 Passive Fire Protection

Passive fire protection performs its function without relying on activation and is applied where immediate protection is required.

8.1.1 General

To the extent practicable for this type of facility, separation of project elements has been pursued to limit the opportunity for fire escalation between project elements. Key separations include:

- Hydrogen storage is located on its own and separated from all other parts of the site by yards and internal roads.
- Fuel gas receipt is located on its own and separated from all other parts of the site by yards and internal roads.
- Bulk fuel oil is located with utility plant that does not involve flammable or combustible fluids, which is separated from all other parts of the site by yards and internal roads.
- The High Voltage switchyard is located on its own and separated from all other parts of the site by yards and internal roads.
- Gas Turbine Generator Units 1 and 2 are separated by internal roads.
- The Chemicals Store is located on its own and separated from all other parts of the site by yards and internal roads.
- The occupiable buildings (Control & Administration and Workshop & Storage) are located adjacent each other but separated from all other parts of the site by yards and internal roads.

Other forms of passive fire protection planned generally for the facility include:

- Actuated shutdown valves will fail safe upon loss of air or signal, e.g., due to fire damage to electrical cables, instrument conduits and hydraulic tubing critical to enable emergency isolation, shutdown or depressurisation as required for fire protection systems.
- Provision of an Asset Protection Zone (APZ) to minimise thermal radiation at plant and infrastructure on the facility.
- Buildings, equipment enclosures and shelters have generally been specified as non-combustible construction. Other structures and mechanical plant are generally of non-combustible construction and manufacture.

8.1.2 Gas Turbine Generator Plant

The following specific passive fire protection features are incorporated in the Gas Turbine Generator Plant design:

- Plant equipment housed in enclosures primarily of non-combustible construction and without windows to minimise the risk of fire break-out and escalation to adjacent enclosures or plant.
- Prevention of fire event escalation between enclosures and equipment also enhanced by using adequate equipment separation distances.

8.1.3 Hydrogen and Fuel Gas Facilities

The following specific passive fire protection features are incorporated in the hydrogen and fuel gas facilities design:

- Systems to limit release of hydrogen or fuel gas into a fire event, e.g., system sectioning with associated remote operable valves.
- Protection from grass fires that originate from beyond the plant fence will include the 10m wide APZ. (On the facility the surfaces are fully sealed, i.e., no on facility grass fire potential).

8.1.4 Bulk Fuel Oil Facilities

The following specific passive fire protection features are incorporated in the bulk fuel oil facilities design:

- Fuel oil Tanker Bay sump to minimise the accumulation of a fuel oil spill on the tanker standing pad and tanker exposure to thermal radiation in case of ignition of the spill.
- Fuel oil storage bund sloped to its north-west corner to minimise the accumulation of a small fuel oil leaks in the bund and tank exposure to thermal radiation in case of ignition of the leak.
- Fire-safe tank valves rated according to API-6FA.

8.1.5 Electrical Equipment

The following specific passive fire protection features are incorporated in the electrical equipment facilities design:

- In the High Voltage Switchyard on the northern boundary of the site, whilst there are only small quantities of insulating oil involved and therefore large fires are not foreseen, equipment is still provided with adequate separation distances to prevent fire event escalation between electrical equipment.
- Transformers on the Power Island are co-located with other equipment including other transformers. Firewalls have been located and designed in accordance with AS 2067:2016 and AS 3600:2018 to prevent fire event escalation to adjacent equipment or buildings.
- For the Generator Step-Up Transformer (#113), Unit Transformer (#121) and Static Frequency Converter Transformer (#123), free-draining bunds via flame traps to the oily water pit to minimise the accumulation of a transformer oil leak at the base of the transformer and transformer exposure to thermal radiation in case of ignition of the leak.
- Use of fire-retardant transformer oil for the Auxiliary (#390) and Utility transformers (90BBT01, 90BBT02 and 90BFT01).
- The GT Generator Excitation Transformers (#115) are specified as dry type.
- Facility Control, Data and Communications equipment in the Control & Administration Building is protected from fire ingress from the other building compartments by 2-hour fire rated walls.

Fire protection measures for enclosures housing electrical switchgear is described in Appendix G.

8.1.6 Buildings, Enclosures and Shelters

As indicated in Section 8.1.1, the project has pursued non-combustible construction and separation of buildings, enclosures and shelters where possible to deal with fire risks external to the buildings, enclosures and shelters rather than pursuing a “hardened” design. For fire risks internal to each individual building, enclosure and shelter the project has implemented passive fire protection elements in accordance with the requirements of the BCA and its associated Standards.

The following specific passive fire protection features, in addition to those required by the BCA, are incorporated in the buildings, enclosures and shelters design:

- Electrical control, data and communications equipment rooms in the Control & Administration Building are divided from other areas of the building and each other by 2-hour fire-rated walls.

8.2 Active Fire Protection and Suppression

An active fire protection and suppression system is a dormant system that needs to be activated to perform its function (e.g., fire sprinkler system). Such systems are activated once the information is received from the scene of the fire that protection and suppression is required. Their function is to protect against escalation of the fire emergency and avoid the need for manual intervention in the fire area.

8.2.1 First Response - General

The first response for flammable or combustible fluid fires is to isolate the fire from the source of flammable or combustible fluid, rather than trying to extinguish the fire. This is usually accomplished by shutting off valves or emergency shutoff devices located in the piping. Fire detectors are specified to identify when action is needed. Some permanent detectors will generate alarms and trigger automated shutdown; others will generate an alarm only and require manual operator intervention such as activating an Emergency Shutdown. All fire detectors and suppression systems activated via a fusible element signal the integrated site Fire Indicator Panel System, as described in Section 7.0.

8.2.2 First Response – Power Island Equipment

Confirmed detection of a fire in a Unit gas turbine enclosure or fuel gas unit via the plant fire detector system will activate the CO_2 gas suppression system in the gas turbine enclosure and fuel gas control unit and initiate a Unit Emergency Shutdown, which will include isolation of supply of fuel gas, hydrogen and fuel oil to the Unit.

Confirmed detection of a fuel gas leak in a Unit Gas Turbine Enclosure or Fuel Gas Unit via the plant gas detector system will initiate a Unit Emergency Shutdown.

Confirmed detection of a fire in a Unit gas filtration, metering and heating equipment via the plant fire detector system will initiate a Unit Emergency Shutdown, which will include isolation of supply of fuel gas, hydrogen and fuel oil to the Unit.

Relief valves installed on equipment and in piping systems will protect it from overpressure during a fire.

A fire in the gas turbine auxiliary enclosure (lubrication and control oil plant) or generator seal oil system will activate the respective firewater sprinkler system via fusible elements and will initiate Unit Emergency Shutdown.

8.2.3 First Response – Hydrogen Storage

In the event of a fire in or near the bulk hydrogen (i.e., tube trailer) storage facility, in addition to the system actions described previously, the following system elements may be triggered:

- Water deluge system for keeping hydrogen trailer tubes cool. Activation of the water deluge system will be via fusible elements located around the perimeter of the tube trailer.
- Site-based safety relief system to safely dispose of hydrogen from the hydrogen storage exposed to a fire event where the water deluge system does not successfully manage the heat input to the tubes causing their internal pressure to rise excessively.

The intent of providing cooling water and safety relief is to avoid failure of the tubes resulting in an explosion event.

Each individual hydrogen tube is fitted with a pressure relief device, which relieves to atmosphere in the immediate vicinity of the tube. The strategy of the project is to provide relief to a “safe location” at a relief setting below that of the individual tube relief devices when the tubes are connected to the site hydrogen infrastructure to minimise the severity of the incident. This safety relief system is a self-acting mechanical system, i.e., safety relief valve.

A confirmed hydrogen gas leak will initiate Plant Emergency Shutdown.

8.2.4 First Response – Electrical Equipment

In the event of a fire in or near the Generator Step-Up Transformers, Unit Transformers or Static Frequency Converter Transformers, in addition to the system actions described previously, the following fixed system elements may be triggered:

- Transformer water deluge system. Activation of the water deluge system will be via fusible elements located around the perimeter of the transformers.

8.2.5 First Response – Electrical Equipment Rooms

In the event of a fire under the platform of a raised Electrical Equipment Room, in addition to the system actions described previously, the following fixed system elements may be triggered:

- Automatic fire sprinkler system. Activation of the automatic fire sprinkler system will be via fusible elements located under the platform.

In the event of a fire inside an Electrical Equipment Room, in addition to the system actions described previously, the following fixed system elements may be triggered:

- Gaseous suppression system. Activation of the gaseous suppression system within the Electrical Equipment Room will be via smoke detection devices located within the room.

8.2.6 Tactical Fire Plans

Tactical fire plans will be prepared as a basis for training as well as input to emergency procedures to ensure correct action by operators and emergency services personnel. These plans will provide details on foreseeable fire scenarios, fire protection equipment location, plant isolation and shutdown specifics, and provide guidance on the actions to take to manage specific fire emergencies (an example template has been provided in Appendix I but alternative formats may also be used). These plans will be available at the main entry to the site. FRNSW and NSW RFS personnel will also receive copies of these plans.

These plans will be completed in consultation with the emergency services.

8.3 Fire Fighting Equipment and Systems Available

8.3.1 General Design Considerations

No requirement for fire protection systems under the NCC/BCA are foreseen, based on AECOM's preliminary interpretation of the NCC/BCA. The fire detection and fire protection systems for the buildings are provided for business continuity criticality and property protection and are designed in accordance with the relevant Australian Standards or National Fire Protection Association Codes (NFPA) where there is no applicable Australian Standard.

Fire protection for plant has been guided by NFPA-850 and its referenced standards. Where an Australian Standard exists for a specific plant item or system it has been used (e.g., AS 1940 for the fuel oil system, AS 2067 for transformers) and in the absence of an Australian Standard then the relevant NFPA standards have been used (e.g., NFPA-2 and its referenced standards for the hydrogen storage).

8.3.2 Fixed Water Infrastructure

A fire hydrant ring main will be reticulated underground throughout the site (refer Appendix B, Figure 8). The ring main will also supply fire hose reels, fire sprinkler and water spray deluge systems. The ring main will be DN300 HDPE pipe belowground and galvanised pipe aboveground, with isolation valves around the system to provide a level of redundancy should there be a pipe failure or for maintenance purposes. Permit To Work (PTW) system will apply on site, including excavation permit to manage the risk of interference.

Water supply to the fire ring main is via fire pumps drawing water from the dedicated fire water tanks. The fire water tanks contain 100% capacity split evenly between two tanks. The fire water tanks will further be automatically refilled via a connection from the local potable water authority main.

8.3.2.1 Fire Hydrants

The fire hydrants will have a minimum flow rate: 20 L/s at the two most hydraulically disadvantaged hydrants and the minimum outlet pressure each hydrant outlet: 700 kPa @ 10 L/s for each hydrant boosted.

8.3.2.2 Fire Hose Reels

The hose reels will be 25 mm hose and require a minimum discharge flow rate of two hose reels operating at 0.41 L/s each. The hose length will be 36m. The system is specified in accordance with

AS 2441 and hose reels will be strategically located to ensure that firewater is available to that relevant area.

8.3.3 Portable Fire Extinguishers

Fire extinguishers are specified in accordance with the design drawings as detailed by AS 2444. Generally, portable fire extinguishers are implemented into the design of the project as indicated in Table 19.

Table 19 Portable Fire Extinguisher Types Required Generally

Area	Types	Rating	Minimum Capacity
Electrical switch rooms	CO_2	5B (E)	5kg
Auxiliary Plant Enclosure	Dry Chemical Foam	3A: 60B:(E) 3A: 60B	4.5kg 9L
Offices	Dry Chemical	3A: 60B:(E)	4.5kg
Workshop & Storage	Dry Chemical	3A: 60B:(E)	4.5kg
Chemical Store	Dry Chemical Foam	3A: 60B:(E) 3A: 60B	4.5kg 9L
Transformers	Dry Chemical	3A: 60B(E)	4.5kg
Water Pump Shelters	Dry Chemical	3A: 60B(E)	4.5kg
Fuel Pump Shelters	Dry Chemical Foam	3A: 60B:(E) 3A: 60B	4.5kg 9L

8.3.4 Specific Requirements for the Mineral Oil Filled Transformers

8.3.4.1 Water Spray Deluge Systems

The following mineral oil filled transformers are protected with fixed water spray deluge systems designed in accordance with NFPA15:

- Generator Step-up Transformers (GSUT)
- Unit Transformers
- Static Frequency Converter Transformers

The water spray deluge systems will be activated by fusible bulb sprinklers or manual release valve actuation.

The water spray deluge systems have a design density of 10.2mm/min/m^2 on the surfaces of the transformer and 6.1mm/min/m^2 on the bund floor. The design duration for a system as per NFPA15 is 60 minutes. In addition, a fire hydrant allowance of 5 L/s for two hydrants has been made to the fire pump demand.

The GSUT Transformer has the largest fire demand on site and this has been used in determining the fire water tank and fire pump sizing.

8.4 Fire Brigade Response

8.4.1 Access to Facility

Fire brigade access to the facility will be required in the event of an emergency or initiation of an Automatic Fire Alarm.

Day plant operators will provide first response to site emergencies. Action by emergency services personnel will be required in those instances where the event has escalated to a point where it is no longer feasible or safe for the operators to provide sole response (e.g., a very large fire or explosion) or where the event has incapacitated the operators and impaired their ability to respond. Under these circumstances, external emergency services will require an emergency response procedure by Snowy

Hydro to ensure that the response is adequate to bring the emergency under control. This is discussed in greater detail in Section 10.3.

The main access to the site is off Hart Road, this road is a (minimum) 6 metres wide sealed surface. It is relatively flat and at no point does the grading exceed 10 degrees. There are no turning circles other than at the entry and exit from the road or site.

8.4.2 Access to High Voltage Electrical Switchyard

Access to the integrated Snowy Hydro and Ausgrid switchyard is from the south via the access road along the eastern boundary of the Snowy Hydro site.

8.4.3 Isolation of Gas, Fuel Oil and Electrical Power

Fuel gas (natural gas) to the site can be isolated locally on the Snowy Hydro site adjacent the southern boundary with the APA Gas Receival Station and remotely within the APA Gas Receival Station. Fuel gas to each Power Island, i.e., Unit 1 or Unit 2, can be independently isolated locally along the western site road adjacent the western site boundary and remotely on the edge of each Power Island.

Hydrogen to both Power Island Units can be isolated locally and remotely at the hydrogen storage area. Hydrogen to each Power Island, i.e., Unit 1 or Unit 2, can be independently isolated locally and remotely along the western site road adjacent the western site boundary.

Fuel oil (diesel) to both Power Island Units can be isolated locally and remotely at the bulk fuel oil storage and pumping facility. Fuel oil to each Power Island, i.e., Unit 1 or Unit 2, can be independently isolated locally on the edge of the Utilities Island along the centre north-south site road.

Distribution of power to plant and infrastructure on the facility can be locally isolated at the 132kV control building, 6.6kV switch rooms and 400V switch rooms which feed the respective areas as well as remotely switched from the DCS (for all 132kV and 6.6kV circuit breakers and a portion of 400V circuit breakers) as required.

The isolation of power to the equipment fed from the 220VDC system, which are required for safe monitoring and control of the plant in shut-down mode; although possible from the 400V switch rooms, should only be done as a last resort.

The electrical supply to the Control and Administration Building and the Workshop & Storage Building can be locally isolated at the main switch and life safety services main switch(s) of the Main Distribution Board of each building respectively. Switchboards Communications Room ‘A’ 220VDC Distribution Board and Communications Room ‘B’ 220VDC Distribution Board in the Control and Administration Building comms rooms will need to be isolated separately.

As discussed in Section 8.2.5, tactical fire plans will be available for the fire brigade and will provide details on plant isolation and shutdown specifics, including fuel and electrical isolation.

8.4.4 Access to Potable and Demineralised Water for NSW RFS

The facility will have two water tanks storing potable and demineralised water, each of 1,700 m^3 working capacity, which NSW RFS will be able to access in the event of responding to a local bushfire event. A spare nozzle has been provided on each tank with a valve and blind flange (for dust protection of the valve internals). The facility will have an adapter that can be fitted to this nozzle that is then suitable for NSW RFS to connect to.

8.5 Firewater

While fuel gas and hydrogen will not be fought using water, firewater is provided on site to allow for cooling of adjacent equipment.

8.5.1 Basis of Firewater Demand Rate

AS 2118.1, NFPA 15 and AS 2419.1 all provide guidance on firewater demand requirements. For this study, worst case demand rates have been calculated using the approaches outlined in these standards and the most conservative approach adopted.

The worst-case firewater demand scenario was identified following NFPA 15 deluge demand methodology and relate to a GSUT Transformer fire with fire hydrant assistance where cooling of adjacent plant equipment would be required for an extended period.

The maximum firewater demand for the fire pumps has been calculated utilising the ACADS-BSG Program, HYENA - Version 7.0.0, as 11,600 L/min, which includes the following users:

- GSUT Transformer Water Spray Deluge 11,000 L/min for 60 minutes per NFPA15
- Two fire hydrants flowing at 5 L/s each for 60 minutes

8.5.2 Firewater Supply

Snowy Hydro has been advised by the Developer of the precinct of the following water supply conditions in the Hunter Water Corporation main in Dickson Road at the planned connection point:

Table 20 Hunter Water Corporation Water Supply Conditions at Planned Dickson Road Connection Point [ref.23]

The linked image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the link points to the correct file and location.

Note 1: This table is *Table 3 – Boundary Conditions of DN200 CICL Water Main on Dickson Road for Interim Development Connection* reproduced from reference document [ref.23].

Considering this information and advice from Hunter Water Corporation (refer to Appendix D) regarding security of supply and the firewater demand by the required site systems, a site store of firewater is planned.

Two firewater tanks will be permanently installed at the facility and will have a combined capacity of 1,000m^3. This capacity is adequate for the fire pump demand of 11,600 L/min for 60 minutes (per NFPA15) for a GSUT Transformer fire scenario, thereafter the remaining capacity is adequate for two fire hydrants flowing at 10 L/s each for 4 hours (per AS 2419.1) via either fire brigade boosting appliances or isolation of the transformer deluge system and utilising the fire pumps for fire hydrants only.

The firewater tanks will also be provided with an automatic infill rate of 20 L/s via connection to the Hunter Water Corporation supply main. This equates to a full capacity refill time of 14 hours.

The steel panel tanks will be designed and constructed in accordance with AS 2304 Water storage tanks for fire protection systems.

The firewater tanks will be located such that they will not be damaged in a credible fire scenario. This is achieved through ensuring adequate separation distance between the fire risks and the tanks as well as ensuring that the tanks are automatically filled from the municipal water supply if the water level was to drop.

The firewater tanks provide water to fire pumps. The fire pumps are 100% duty and standby arrangement and in accordance with AS 2941. The electric pump will be the designated duty pump and the diesel pump will be the designated standby pump. Both pumps are housed in a dedicated Fire Pump Room located adjacent to the fire water tanks and fire appliance hardstand for accessing the tanks suction and system booster assemblies.

The Fire Pump Room also contains, within a separate room, the Fire Control Centre with the Main Fire Indicator Panel. This provides FRNSW with a single command point having the Fire Control Centre adjacent to the hardstand and booster assemblies.

The fire pumps will be automatically activated in the event of pressure drop in the fire ring main system.

An automatic jockey pump will maintain the pressure in the fire ring main system and will be adequately sized to provide the required flow and pressure demand for the operation of two hand-held fire hose reels in operation to prevent starting of the main fire pump.

8.5.3 Booster Assembly

The hardstand adjacent to the Fire Pump Room provides parking (dimensions as per FRNSW Fire safety guideline - Access for fire brigade vehicles and firefighters) for two fire pumping appliances to reverse into providing access to the tank suction and system booster connections.

The tank suctions will consist of 1 large bore and 4 small bore connections per assembly. The boost connections will be 4 inlets per assembly.

8.5.4 Fire Hydrants

Dual pillar fire hydrants are located throughout the site to ensure that coverage is available utilising 60 metres of fire hydrant hose from two directions to each area of risk. The fire ring main will provide a minimum of 10 L/s at a minimum of 700 kPa per fire hydrant in accordance with AS 2419.1.

The fire pumps will not exceed the maximum operating pressure for the use of the fire hydrants.

8.5.5 Plant Water Deluge and Sprinkler Systems

Fixed water spray deluge systems designed in accordance with NFPA15 will be provided at the following:

- Hydrogen Tube Trailer Bay.
- Generator Step-up Transformers (GSUT)
- Unit Transformers
- Static Frequency Converter Transformers

The water spray deluge systems will be activated by fusible bulb sprinklers or manual release valve actuation.

Automatic fire sprinkler systems designed in accordance with AS 2118.1 will be provided at the following:

- Auxiliary enclosures (lube oil and control, i.e., hydraulic oil)
- Seal Oil Systems
- Fuel Oil Units (enclosure)
- Electrical Equipment Rooms

8.5.6 Fire Hose Reels

Fire hose reels will be located near buildings and enclosures. Each fire hose reel will be 25mm diameter and 36 metre hose length, located adjacent to exit doors/exit stairs to provide coverage to the relevant building or enclosure. The fire hose reels will be supplied water via connection to the fire ring main.

8.6 Other Fire Fighting Media

8.6.1 Gas Suppression

8.6.1.1 Gas Turbine Enclosure and Fuel Gas Unit

CO_2 fire suppression systems, complying with NFPA12, will be provided to protect the Gas Turbine and the Fuel Gas Unit associated with the Gas Turbine.

The CO_2 fire suppression systems will be automatically actuated on confirmed fire via the fire detection system. The CO_2 systems will have a “lock off” capability to enable safe maintenance within the protected enclosure.

8.6.1.2 Electrical Equipment

SIEX-NC™ 1230 gaseous suppression systems, complying with AS 4214, will be provided to protect selected areas which contain electrical equipment that is critical for plant operation or to maintain control in an emergency.

The SIEX-NC^{TM} 1230 will be automatically actuated on confirmed fire via the smoke detection system within each protected space. The activation of the smoke detection system will operate the evacuation warning system within the protected space before the gaseous suppression agent is released. The SIEX-NC^{TM} 1230 systems will have a "system isolate" capability to enable safe maintenance within the protected building or enclosure.

8.7 Portable Fire Extinguishers

Portable fire extinguishers are intended to provide a "first response" fire-fighting capability for dealing with small outbreaks of fire. Fire extinguishers will be located throughout the plant and buildings in such numbers that at least one extinguisher is readily accessible from any part of the facility and complying with AS 2444.

Extinguishers provided will be of a type most suitable for use in fighting a fire of the kind which is most likely to occur in the vicinity in which it is placed. External extinguishers will be mounted within cabinets or weatherproof covers.

8.8 Building Protection

Specific details of building protection measures are given in Appendix G.

9.0 Firewater Retention

9.1 Firewater Volumes

The firewater supply and distribution systems, will simultaneously supply water to fixed fire protection systems at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance for fire hydrant hose streams for not less than 4 hours. For firewater volumes, refer Section 8.5.1.

9.2 Firewater Retention Strategy

Firewater for oil-containing systems will be contained through the Primary and Secondary Containment system provided for the facility.

Primary Containment is provided for combustible liquid storage and handling equipment and is designed to capture a potential transformer oil, fuel oil, lube oil, seal oil or control oil leak or spill. Primary Containment for these covers the following areas:

- transformer bunds
- bulk fuel oil storage bund
- tanker bay
- lube oil, seal oil and control oil plant bunds.

These areas drain into a common oily water drain and through to the oily water pit.

In a fire event, firewater from deluge for the transformer bunds and firewater from sprinkler systems for the lube oil, seal oil and control oil plant bunds drain immediately to the oily water drain via a flame trap and into the Secondary Containment, i.e., oily water pit. Firewater or foam used at the bulk fuel oil storage or tanker bay will be contained in the Primary Containment bunds.

The design firewater flow from Primary Containment into the oily water drain is 700 m^3/hr, which is based on a flow of 11.6 m^3/minute from the Generator Step-Up Transformer (GSUT) deluge system. All other deluge system flows are significantly less than the governing GSUT flow.

The oily water pit will contain 660 m^3 of firewater, which is 56 minutes. Once the firewater level in the oily water pit reaches the level of the emergency overflow, firewater will flow directly into the stormwater system via a dedicated overflow pipe.

A penstock valve in a pit near the downstream end of the stormwater system will be closed automatically upon a fire alarm on site.

A further 400 m^3 of firewater can be contained within the closed stormwater network upstream of the penstock valve up to the level of the oily water pit overflow, which is 34 minutes of GSUT deluge.

If firewater discharge continues, 150 m^3 of firewater (13 minutes of GSUT deluge) will continue to accumulate in the closed storm water system and back up into the oily water pipe network before firewater begins to appear at the lowest finished surface level at the northern end of the site.

Firewater from a fire event will be removed from site by tanker truck to an approved liquid waste disposal facility.

10.0 Staffing, Emergency Procedures and Training

10.1 Overall Responsibility

Snowy Hydro will have the overall responsibility for the following aspects:

- Development and management of Emergency Response Plan
- Routinely review Emergency Response Plan
- Training of site personnel and Snowy Hydro management team (including media response)
- Preparation of specific roles and responsibilities
- Determine how the site will be managed if the control room needs to be abandoned
- Develop and maintain contact list (internal and external)
- Maintain emergency response systems.

10.2 Staffing

The facility will only be attended during the day, Monday to Friday, for routine site operations and maintenance. There will be up to 10 permanent snowy Hydro personnel plus contracted maintenance representatives. The site will be continuously monitored remotely from the Snowy Hydro Central Control Facility in Cooma, NSW. There will be an after-hours call out roster for site staff.

10.3 Emergency Procedures

Emergency response procedures (ERPs) and tactical fire plans will be fully integrated into the Site Safety Management System and the Snowy Hydro Corporate Safety Management System.

The ERPs will include information on external/off site evacuation.

The ERPs will be prepared in consultation with NSW DPE, SafeWork NSW, FRNSW, and the NSW RFS as well as with the local Bush Fire Management Committee and the Local Emergency Management Committee.

Communication links with emergency response teams, including the FRNSW and the NSW RFS, will be provided, as determined during the development of the emergency response plan.

If the emergency escalates and cannot be contained by the local Snowy Hydro operations site team of employees, the Snowy Hydro Crisis Management System will be activated.

The Snowy Hydro Crisis Management System supports the site emergency response team and is designed to minimise the impact of the incident or event on Snowy Hydro. The goal of the Snowy Hydro Crisis Management System is to support existing operational incident management plans, disaster recovery plans and business continuity plans. The Snowy Hydro Crisis Management System provides a consistent Crisis communications framework that supports the operational response to a crisis and enables Snowy Hydro to provide timely and accurate information to all its stakeholders. Liaisons with the Government emergency support groups, including with the NSW Police, FRNSW and the NSW EPA as appropriate will be established during preparation of the emergency response plan for the project. The ongoing requirements with any Local, District and State Emergency Management Committee will also be integrated into the emergency response plan.

10.4 Training

It is likely that Snowy Hydro site-based staff will be trained to fight small fires using fire extinguishers.

Emergency response drill and training will be required.

Regular drills will be carried out to refresh knowledge of emergency equipment and procedures and to assess the effectiveness of the Emergency Response Plan. Records of drills will be recorded and kept.

Tactical fire plans will be developed for the site and will assist in training operators and emergency personnel in emergency planning.

11.0 Conclusions

The FSS has been prepared to demonstrate that the potential for fire incidents associated with the planned facility are understood and that the design of the facility emphasises:

- minimisation of the likelihood of a fire incident occurring
- adequate mitigation of a fire incident.

The design and layout of the facility is based on the philosophy of separating key fire hazards from each other and from occupied buildings, without the need for engineered fire protection. Engineered fire protection is included in the design where sufficient separation is not feasible.

For combustible liquids, the design and layout of the facility is based on the philosophy of containing spills or leaks within bunds, remote sumps and closed oily water drain system and on locating the drain system and sumps such that the heat radiation resulting from a pool fire, including oil-filled transformer fires, will not damage neighbouring equipment and lead to incident escalation. Where separation from other equipment is impractical, firewalls have been utilised. Additionally, the fuel oil system has been designed to enable the cessation of all fuel oil movements in a major spill or leak event or a fire event.

A major fuel gas or hydrogen rupture or leak scenario has the potential to result in a substantial jet fire or explosion, if ignited. The system has been designed to enable the cessation of all gas movements. In the case of jet fires, this will cause a rapid reduction in the jet fire size within a timeframe before fire-fighting and cooling of adjacent equipment can commence.

A CO_2 gas flooding fire suppression system will be provided for the gas turbine due to the high value and business criticality of this project element.

Electrical Equipment Rooms will be provided with multi-aspirating smoke detection technology for early identification of fire and SIEX-NC 1230™ suppression systems due to the business criticality of this project element.

The bulk hydrogen storage has been designed with a firewater deluge system to keep it cool to preserve its containment integrity in the event of an external fire.

The Gas Receival Station (GRS) project is being developed by APA Group and is excluded from this FSS, though this study has considered potential incident interactions between the Snowy Hydro power station and the GRS. APA is preparing a separate and complete FSS, which considers the potential for offsite impacts from the gas supply infrastructure.

A significant number of equipment items on the Power Island are located within enclosures. The design of the enclosures is based on the philosophy of non-combustible construction to isolate an equipment fire to the enclosure perimeter and, in the case of significant fire event risk, the enclosure is provided with a fire suppression system.

The Snowy Hydro high voltage switchyard does not involve equipment with large quantities of insulation oil and therefore has a significant degree of inherent fire safety. The Ausgrid Switchyard project is being developed by Ausgrid and is excluded from this FSS. No significant fire impacts between the Snowy Hydro and Ausgrid high voltage switchyards are foreseen.

The main purpose of the firewater system on the facility is to cool adjacent equipment which may be damaged in a fire. Fire-fighting equipment will include fire hydrants, fire monitors and automatic deluge systems for the mineral oil-filled transformers and bulk hydrogen storage. Firewater sprinkler systems will be provided for the Control and Administration Building, Workshop & Storage Building, Auxiliary Plant Enclosure (i.e., lube and control oil plant), Seal Oil System and Fuel Oil Unit (associated with the GT). Firewater sprinkler systems will also be provided to the underside of the Electrical Equipment Rooms to complement the non-combustible construction material of the room walls, roof and floor rather than pursuing a fire-barrier cavity for cable entry. The fire-fighting system will be complete with connections for hook-up by FRNSW or the NSW RFS. Further, fire extinguishers will be provided throughout the facility.

The location of fire hydrants that may be called upon for cooling of neighbouring structures or equipment is adequate and has been based on fire scenarios with potential prolonged duration.

The firewater tanks, pumps and brigade booster connection are located to be clear of the effects of credible fire events (a full bund fuel oil fire has been studied and would impact this equipment; however, the scenario is considered bordering on non-credible).

The MFIP will be linked to the FRNSW through an approved third-party Automatic Fire Alarm Service Provider, given that the facility will only be attended during the day from Monday to Friday.

Firewater will be contained on the facility.

The impact of bushfire to the Snowy Hydro facility has been studied. Considering the planned APZ, all buildings, enclosures and structures on the facility are located outside the 19kW/m^2 thermal radiation isopleth. Key vulnerabilities, i.e., occupied buildings and bulk hydrogen storage, are located outside the 12.5kW/m^2. Ember attack at any location on the site is recognised. The design of all buildings, enclosures and structures is based on the philosophy of non-combustible construction and considered appropriate for the bushfire risk. The planned APZ is adequate.

The approach to fire safety specified for the project is considered appropriate for the identified fire scenarios and site manning.

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Appendix A

Conditions of Consent Relating to the Fire Safety Study

Appendix A Conditions of Consent Relating to the Fire Safety Study

B12. Prior to the commencement of the installation of the gas turbines, unless otherwise agreed by the Secretary, the Proponent must prepare and submit to the satisfaction of the Secretary:

(a) A Fire Safety Study based on the detailed design of the development. This study must cover the relevant aspects of the Department's Hazardous Industry Planning Advisory Paper No. 2, 'Fire Safety Study' and the New South Wales Government's Best Practice Guidelines for Contaminated Water Retention and Treatment Systems. The study must be prepared in consultation with NSW Rural Fire Service to verify the required Asset Protection Zone (APZ) in view of up to 14 MPa gas releases from the gas receiving station. The study must also be submitted for the approval of Fire and Rescue NSW.

(b) A Hazard and Operability Study…

(c) A Final Hazard Analysis…

Appendix B

Drawings and Diagrams

Appendix B Drawings and Diagrams

The following pages contain drawings and diagrams only referenced in the body of the report.

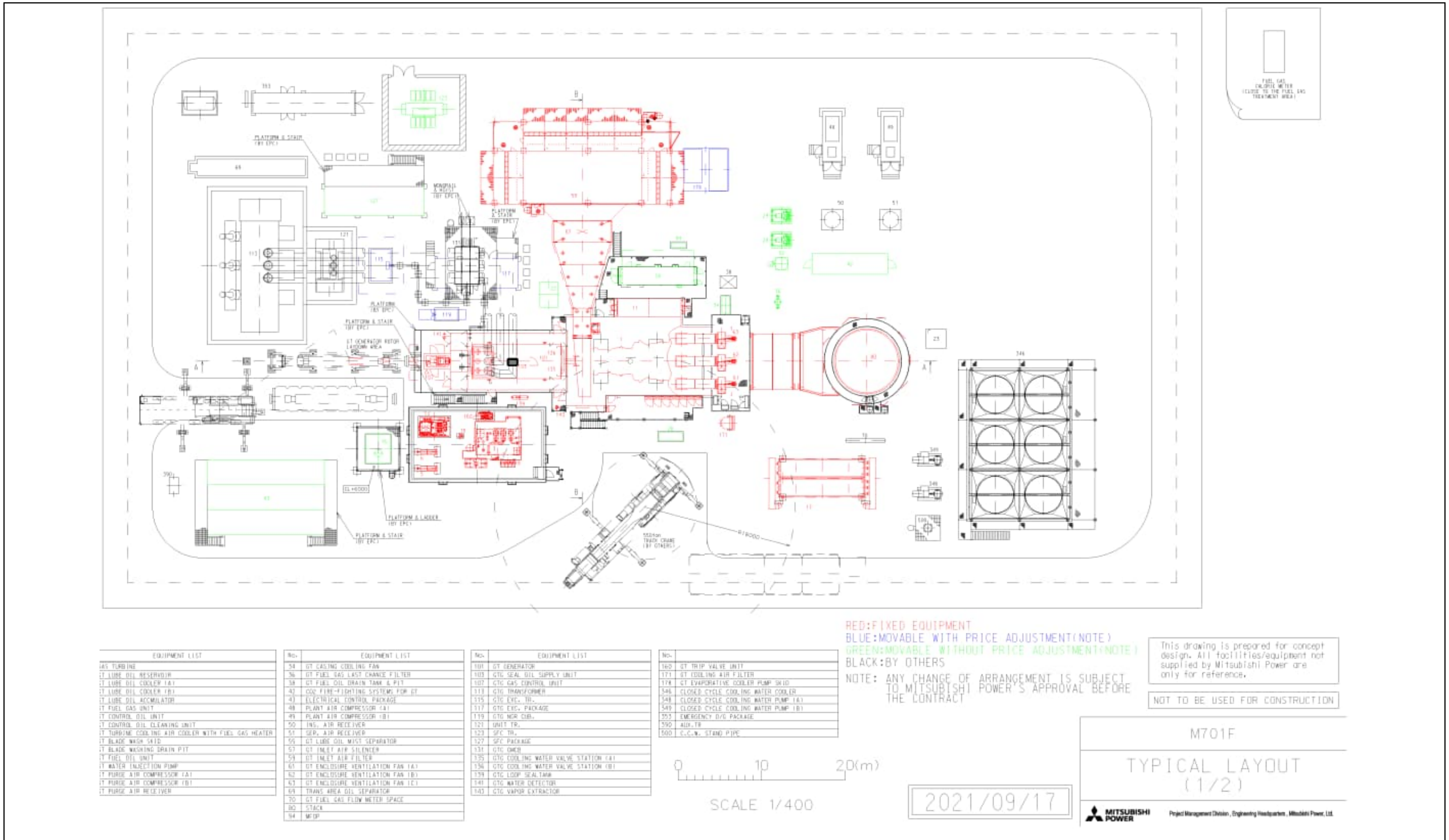

Figure 6 MHI Standard Power Island Plot Plan with Standard Equipment Identification

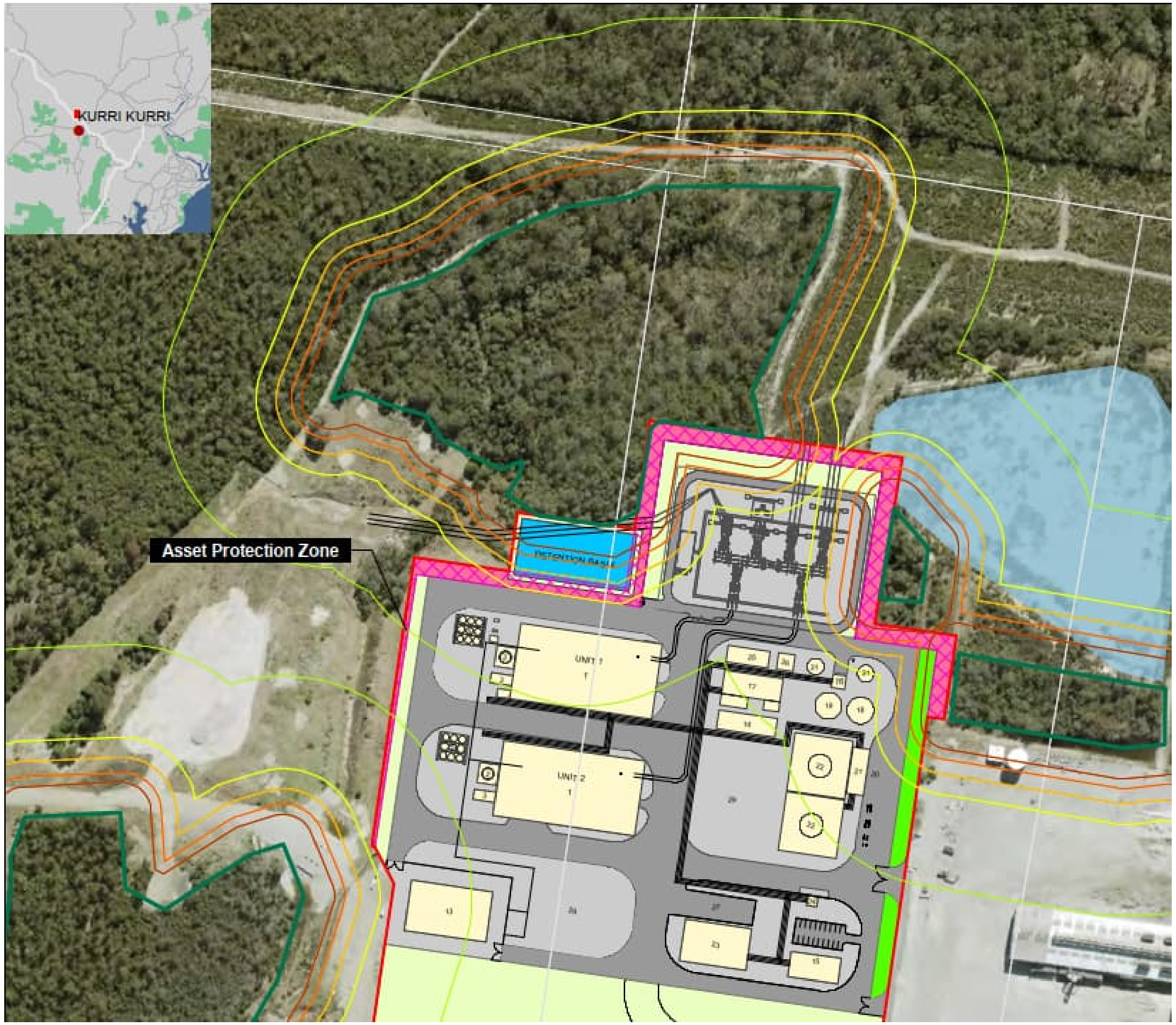

Figure 7 Asset Protection Zone for Facility

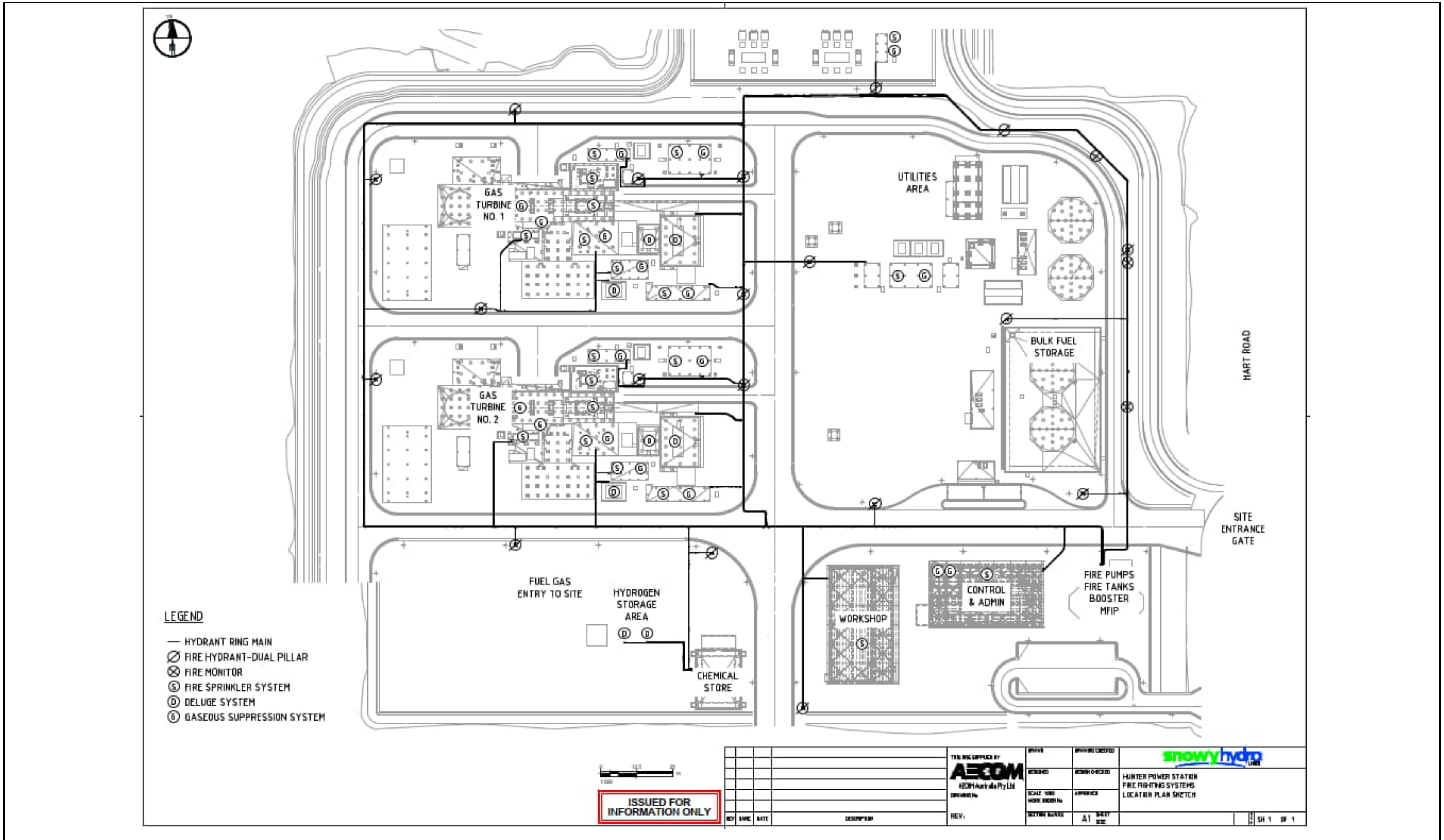

Figure 8 Hydrant Ring Main Layout

Appendix C

Inputs and Assumptions to Consequence Calculations

Appendix C Inputs and Assumptions to Consequence Calculations

General Assumptions

Meteorological Data

Meteorological data such as wind speed, stability class, humidity and solar radiation is required for consequence modelling. Wind speed dictates the degree of flame tilt and is typically chosen to represent the mean maximum wind speed at a site. Stability class determines the degree of turbulent mixing potential, thus impacting the gas dispersion. Humidity influences the degree of radiant heat interchange between two bodies because the water vapour absorbs radiant heat energy thereby reducing the incident radiant heat at the receptor. Solar radiation contributes to the pool evaporation and impacts the hazard effect of jet fire, pool fire and fireball scenarios. The meteorological data considered for this Study is summarised in Table 21.

Table 21 Meteorological Data

Parameter	Unit	Value
Wind Speed Note 1	m/s	8.3
Pasquill-Gifford stability class	-	D
Highest temperature Note 3	C	46.8
Relative humidity Note 2	%	42
Solar radiation Note 3	kW/m^2	1
Surface Roughness	m	1

Note 1: Based on a review of the wind frequency data from the nearest weather station[1] (i.e., Williamtown RAAF), 90% of all recorded wind speeds at 9am and 3pm conditions are about 8.3m/s or less and this is selected as the representative wind speed for this Study.

Note 2: The lowest mean humidity and highest temperature identified at the nearest weather station (i.e., Cessnock Airport AWS) were adopted[2].

Note 3: The solar radiation flux reaching the Project Site is predicted based on the degree of cloudiness (i.e., 0 is applied for clear sky and the maximum solar altitude[3] of 80.6° above the horizon in Pokolbin/ Cessnock (Raphael 1962) [ref.12].

Pool Fires

Oily Water Drain System is provided to collect spillages from six bunded area. These include the Step-up Transformer area, Service Transformer area, Fuel Oil Tanker area, Fuel Oil Unloading Pump area, Fuel Oil Storage area and Fuel Oil Forwarding Pump area. The Oily Water Drain System consists of an Oily Water Pit (provided with a cover) and associated piping. The decanting section of the Oily Water Pit will separate and hold bulk spill from all sources except for catastrophic failure from transformers, which will be collected at the oily pit. As per the current spill containment plan, the drain of all bunded area will remain open during normal operation except for the Fuel Oil Storage area. Thus, no accumulation is foreseen at all bunded area except for the Fuel Oil Storage area.

Additionally, a GT Fuel Oil Drain Tank and Pit is provided for each of the OCGT and the pit will be provided with a cover. In view of the pit design, provision of cover over the pit will act as a flame containment lid and will substantially reduce the thermal radiation effects to the neighbouring equipment. Thus, pool fire scenario at the Oily Water Pit and GT Fuel Oil Drain Pit are not modelled.

The pool fire scenarios were modelled as confined within the sumps and bunds as summarised in Table 22.

[1] Bureau of Meteorology - Wind Roses (bom.gov.au) [Accessed Date: 20th January 2022]
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Table 22 Bund Dimensions

Bund Description Note 1	Bund Dimensions	
	Length (m)	Width (m)
Fuel Oil Storage	50	33
Fuel Oil Tanker Bay	26	6
GT Unit Transformer	10	7
GT Step-Up Transformer	17	13

Note 1: Although no accumulation is foreseen at the GT Step-Up Transformer area and GT Unit Transformer area, pool fire scenarios were still modelled for these as a worst-case scenario.

Jet Fires

PHAST™ Version 6.7 models were used to determine outflow rates, jet flame length and heat radiation from jet fires.

Consequences from an ignition of flammable gas or liquids from leak sizes were estimated in accordance with the recommended method in the TNO Purple Book [ref.13], which is based on rupture and 10% of the maximum diameter of the pipeline in the section of interest (up to a maximum of 50mm) in order to approximate the hole size from a leak occurring at a connection point (e.g. flange, gasket or valve).

Modelling shows that releases from rupture or large hole sizes de-pressure very rapidly through the leak and their duration from initiation of isolation is very short (refer Table 13) and the deployment of fixed fire protection equipment is not possible in such a short time. Therefore, consequences from ignition of smaller leak sizes, of 25mm and 10mm diameter, have also been modelled to enable critical evaluation of the fire protection strategy. Inventories were based on a conservative estimate of vessel and pipeline volumes.

Outflow angles for jet releases were set at 0° (horizontal). This resulted in the largest (most conservative) jet flames and thermal radiation effect distance.

Zero percent of the flame was (conservatively) assumed covered in soot.

Based on information from the APA project design team and the project natural gas delivery specification, the natural gas equipment and piping operating pressure in that portion of the GRS facility extending into the south-west corner of the Snowy Hydro site was identified to be 4.5MPa.

From the Snowy Hydro project design team, the operating pressure at the start of the natural gas piping and equipment to the Fuel Gas Unit was identified to be 4.5MPa to 4.2MPa. Piping and equipment pressure drops have been ignored for the purpose of leak and effects modelling.

Vapour Cloud Explosion

The TNO Multi Energy Model (MEM), as implemented in PHAST™ Version 6.7, is used to determine the hazard distances at given overpressure levels. Four Potential Explosion Sites (PESs) have been identified and their associated congested volumes are summarised in Table 23. The congested volumes are estimated based on the plot plans and 3D model. A source strength of "6", representing a moderate congestion level has been used for the fuel gas equipment and piping, whilst a source strength of "10" has been adopted for the hydrogen equipment and piping due to its more reactive characteristic. This assumption is considered conservative given that the project facility is fairly open and both natural gas and hydrogen exhibit buoyant behaviour.

Table 23 PES Details

PES Description	Dimensions			Congested Volume (m^3)
	Length (m)	Width (m)	Height (m)	
Gas Receiving Station area	40	25	2	2000
Natural Gas Supply area	15	40	7	4200
Hydrogen Facility area	18	13	2	468
Transformer area	22	19	9.5	3971

Appendix D

Firewater Supply

Hunter Water Corporation
ABN 46 228 513 446

PO Box 5171
HRMC NSW 2310
36 Honeysuckle Drive
NEWCASTLE NSW 2300
1300 657 657 (T)
(02) 4979 9625 (F)
hunterwater.com.au

25 February 2021

Ref: 2021-90/2.001

Hydro Aluminium Kurri Kurri Pty Ltd
C/- Jacobs Group Pty Ltd
l 6 452 Flinders Street
Melbourne VIC 3000

Attention: Jeffrey Gomes

Dear Jeffrey

RE PRELIMINARY SERVICING ADVICE

Thank you for your request for Hunter Water's preliminary servicing advice for the provision of water and sewer services to the proposed development of the Snowy Hyrdo Gas Fired Power Station at Lot 317 Plan 755231, 73 Dickson Rd, Loxford.

General information on water and sewer issues relevant to the proposal is included in this correspondence. This information is indicative only and based on Hunter Water's knowledge of its system performance and other potential developments in the area at the present time. This advice may change substantially due to a range of factors and a detailed analysis of available capacity will be undertaken upon lodgement of an application for a Notice of Formal Requirements.

When you have development approval, you will may submit a Development Application to Hunter Water to determine the formal requirements for the development. Hunter Water will then issue a Notice of Formal Requirements including an offer for network capacity. You will need to comply with each of the requirements in this Notice for the issue of a Section 50 Compliance Certificate for the development.

Network Infrastructure Planning

The proposed development is located within the industrial precinct of the Hydro Aluminium (HA) redevelopment site being developed by the McCloy Group. At this stage the McCloy's have engaged ADW Johnson Consultants to prepare water and sewer servicing strategies that will confirm how the ultimate HA site is to be serviced. The Snowy Hydro Power Station development would normally be included in these strategies and the specific servicing requirements assessed and determined in the strategies. Hunter Water understands the urgent timing of the Power Station and the potential need for the Power Station to proceed prior to the overall HA Strategies being finalised. The following advice is offered on this basis to allow the Power Station development to proceed if necessary under an interim servicing arrangement.

Water Supply

The proposed development is located in Coalfields Water Supply System. The nominal water connection is the existing 200mm CICL in Dickson Road. Hunter Water's assessment indicates there is a sufficient capacity in the local network to provide the proposed development with the required operational and potable water supply demands.

The Developer will need to engage an Accredited Design Consultant to prepare and submit a Water Servicing Report to Hunter Water for review.

Security of Supply

A development of this type and scale typically requires back up water supply security, however the existing surrounding mains are unable to meet this requirement. To provide an alternative supply from Hunter Water's network it would be necessary to deliver a second watermain to the development site. The nominal point of connection for an alternative supply is the 375mm watermain in Northcote St Kurri Kurri. This watermain would need to be sized to provide capacity to the wider HA catchment.

However, Hunter Water has no objections to the operational and fire-fighting security of supply needs being provided onsite by the Developer by means of storage tanks, pumps and via the hydraulic design of the fire-fighting system. You should provide a Security of Supply Report to Hunter Water for our records. Hunter Water's Water Services Agreement with the Developer should define responsibilities of the parties for the provision of an alternative water supply in the event of a network failure.

Recycled Water

The development site is located within the Kurri Kurri Wastewater Treatment Plant (WWTP) catchment which currently has sufficient capacity to service the development.

The Kurri Kurri WWTP has treated effluent capacity of 4.5 ML/d. Given the proximity of the WWTP, the option for servicing the development with recycled water could be feasible. The availability of recycled water could also be contingent of the quality and quantity required for both your site and the overall HA site. Treatment system upgrades may be required, as well as delivery of the connecting assets. If system upgrades and connecting assets are not in place when the development proceeds, you may wish to utilise a recycled water supply in the future and make allowance for this alternative supply now in the design of your development.

Please discuss this option with Hunter Water should you wish to pursue a recycled water servicing arrangement.

Wastewater Transportation

The development site is located within the Loxford 1 Wastewater Pumping Station (WWPS) catchment, which pumps directly to Kurri Kurri WWTP. Currently the WWPS has sufficient capacity to service the development.

At this stage, the nominal wastewater point of connection for the development is Maintenance Hole W290 located at the discharge point of the 150mm CICL sewer rising main that serviced the Hydro Aluminum development. There is currently sufficient capacity in the downstream network to service the development.

The onsite servicing requirements for the HA site are still being investigated by ADW Johnson for preparation of the wastewater servicing strategy. Hunter Water recommends that you consult with ADW Johnson to determine how the servicing of your development should be covered in the strategy and to confirm any interim servicing arrangements prior to the delivery of the new local WWPS. Please advise Hunter Water of the outcome of this consultation and we can confirm the level of additional assessment you may need to undertake for your development to proceed on the proposed timeline.

Sewer Rising Main

The rising main was constructed in 1968 and recently recorded breaks tend to indicate the rising main may no longer be fit for purpose.

Hunter Water would consider recommissioning the rising main as a temporary servicing option, provided it could be demonstrated that it has capacity and is suitable to operate at the proposed pump rates. To confirm this the Developer or McCloy's will need to undertake a condition assessment including a risk analysis to ensure it is structurally sound and suitable to be recommissioned. Hunter Water understands McCloy's have engaged ADW Johnson to commence this assessment. The assessment should identify whether relining or upgrades are necessary. The report should be submitted to Hunter Water for review.

Delivery of Developer Works

Developer works will need to be delivered under Developer Works Deeds executed by the Developer and Hunter Water.

All developer works are to be designed by an Accredited Design Consultant and constructed by an Accredited Contractor.

Environmental Assessment

Hunter Water may require a Review of Environmental Factors (REF) to be submitted in accordance with the provisions of Environmental Planning and Assessment Act 1979 for the delivery of developer works. Hunter Water will assess the REF as a determining authority under provisions of Part 5 of the Act.

Trade Waste

It is expected your development will have the potential to discharge trade waste into Hunter Water's sewerage system. You will be required to execute a Trade Wastewater Agreement with Hunter Water.

These preliminary requirements are not commitments by Hunter Water and maybe subject to significant change prior to this development proceeding.

Yours faithfully

BARRY CALDERWOOD
Account Manager Major Development

Tel: 02 4979 9721
Mobile: 0437 720 845
Email: barry.calderwoo@hunterwater.com.au

Appendix E

Consequence Results – Significant Incident Scenarios

Appendix E Consequence Results – Signification Incident Scenarios

The master list of all potential incident scenarios is given in Table 4 in Section 4.2. The tables below are the results for the quantified, i.e., modelled, incident scenarios only.

Jet Fire Results

Significant Incident Scenario – Jet fire	Hole Size (mm)	Heat Radiation (Distance from centre of incident (m))				
		3.0 kW/m^2	6.31 kW/m^2	8 kW/m^2	23 kW/m^2	32 kW/m^2
NG_01_01 Jet fire from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_02_01 Jet fire from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	10	15	13	12	-	-
	25	41	34	32	28	27
	50	82	68	63	55	52
NG_03_01 Jet fire from LOC of natural gas from Fuel gas main header (including calorie meter and PRU) at Zone 3	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	295	230	210	172	163
NG_04_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_05_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters (01EKE01AT004, 01EKE02AT004 and 02EKE01AT004, 02EKE02AT004) at Zone 1/2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
NG_06_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	10	-	-	-	-	-
	25	6	-	-	-	-
	50	6	-	-	-	-
NG_07_01 Jet fire from LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 1) at Zone 1	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	314	244	223	182	172
NG_08_01 Jet fire from LOC of natural gas from Piping from fuel gas main header to OCGT (Unit 2) at Zone 2	10	14	12	11	-	-
	25	38	32	30	26	25
	50	77	64	60	52	49
	RUP	343	266	242	197	186
NG_09_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	10	13	12	11	-	-
	25	37	31	30	26	24
	50	75	62	59	51	48
NG_10_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	10	11	10	9	-	-
	25	32	27	26	22	21
	50	65	54	51	44	42

Significant Incident Scenario – Jet fire	Hole Size (mm)	Heat Radiation (Distance from centre of incident (m))				
		3.0 kW/m²	6.31 kW/m²	8 kW/m²	23 kW/m²	32 kW/m²
NG_11_01 Jet fire from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	10	11	9	8	-	-
	25	31	26	25	21	20
	50	63	53	50	43	41
HY_01_01 Jet fire from LOC of hydrogen from Hydrogen tube trailer (90QJH01BB901) at Zone 3	10	26	24	23	21	21
	25	57	49	48	45	44
	50	113	89	86	78	77
HY_02_01 Jet fire from LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	10	24	22	21	20	19
	25	53	46	45	42	41
	50	103	82	79	73	71
HY_03_01 Jet fire from LOC of hydrogen from Trailer to high pressure piping at Zone 3	10	26	24	23	21	21
	RUP	47	42	40	37	37
HY_04_01 Jet fire from LOC of hydrogen from Trailer to low pressure piping at Zone 3	10	5	-	-	-	-
	RUP	12	11	11	-	-
HY_05_01 Jet fire from LOC of hydrogen from Hydrogen manifold at Zone 3	10	5	-	-	-	-
	25	15	14	14	12	-
	RUP	7	-	-	-	-
HY_06_01 Jet fire from LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 1) at Zone 1	10	5	-	-	-	-
	RUP	7	-	-	-	-
HY_07_01 Jet fire from LOC of hydrogen from Piping from hydrogen manifold to OCGT (Unit 2) at Zone 2	10	5	-	-	-	-
	RUP	5	-	-	-	-

Bund Fire Results

Significant Incident Scenario – Bund fire	Heat Radiation (Distance from centre of incident (m))				
	3.0 kW/m²	6.31 kW/m²	8 kW/m²	23 kW/m²	32 kW/m²
DO_01_01 Bund fire from LOC of diesel from Diesel Fuel Storage Tanks (90EGB01BB001 and 90EGB02BB001) at Zone 4	91	65	43	-	-
DO_09_01 Bund fire from LOC of diesel from Diesel Fuel Tanker at Zone 4	44	31	27	10	7
TO_01_01 Bund fire from LOC of transformer oil from OCGT (Unit 1/2) - Unit Transformer (#121) at Zone 1/2	36	26	23	11	7
TO_02_01 Bund fire from LOC of transformer oil from OCGT (Unit 1/2) - Generator Step-Up Transformer (#113) at Zone 1/2	49	35	31	10	10

Explosion Overpressure Results

The TNO Multi Energy Model (MEM) source strength class used for the fuel gas (NG) scenarios is class "6" (moderate congestion and low reactivity) and for the hydrogen (HY) scenarios is class "10" (moderate congestion and high reactivity). A sensitivity case for fuel gas is provided in the next section.

Major Incident Scenario - VCE	Explosion Overpressure (Distance from centre of incident (m))			
	7 kPa	14 kPa	21 kPa	35 kPa
NG_01_04 VCE from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	137	75	54	33
NG_02_04 VCE from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	137	75	54	33
NG_04_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	189	103	74	46
NG_05_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters (01EKE01AT004, 01EKE02AT004 and 02EKE01AT004, 02EKE02AT004) at Zone 1/2	189	103	74	46
NG_06_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	96	53	38	23
NG_09_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	189	103	74	46
NG_10_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	189	103	74	46
NG_11_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	189	103	74	46
HY_01_04 VCE from LOC of hydrogen from Hydrogen tube trailer (90QJH01BB901) at Zone 3	80	46	34	25
HY_02_04 VCE from LOC of hydrogen from Back-up hydrogen pallet (90QJH02BB901) at Zone 3	80	46	34	25
HY_03_03 VCE from LOC of hydrogen from Trailer to high pressure piping at Zone 3	32	18	14	10
HY_04_03 VCE from LOC of hydrogen from Trailer to low pressure piping at Zone 3	32	18	14	10

Explosion Overpressure Results – Source Strength Sensitivity for Fuel Gas Only

For fuel gas there is little change in the effect distances of interest for source strength classes 6 to 10. Guidance on selection of source strength is soft, with the recommendation to use the maximum source strength class in the absence of correlating field trial or incident information. Source strength class “5” (less than moderate congestion and low reactivity) has been used in the following results table. In the following table “N/R” means “Not Reached”.

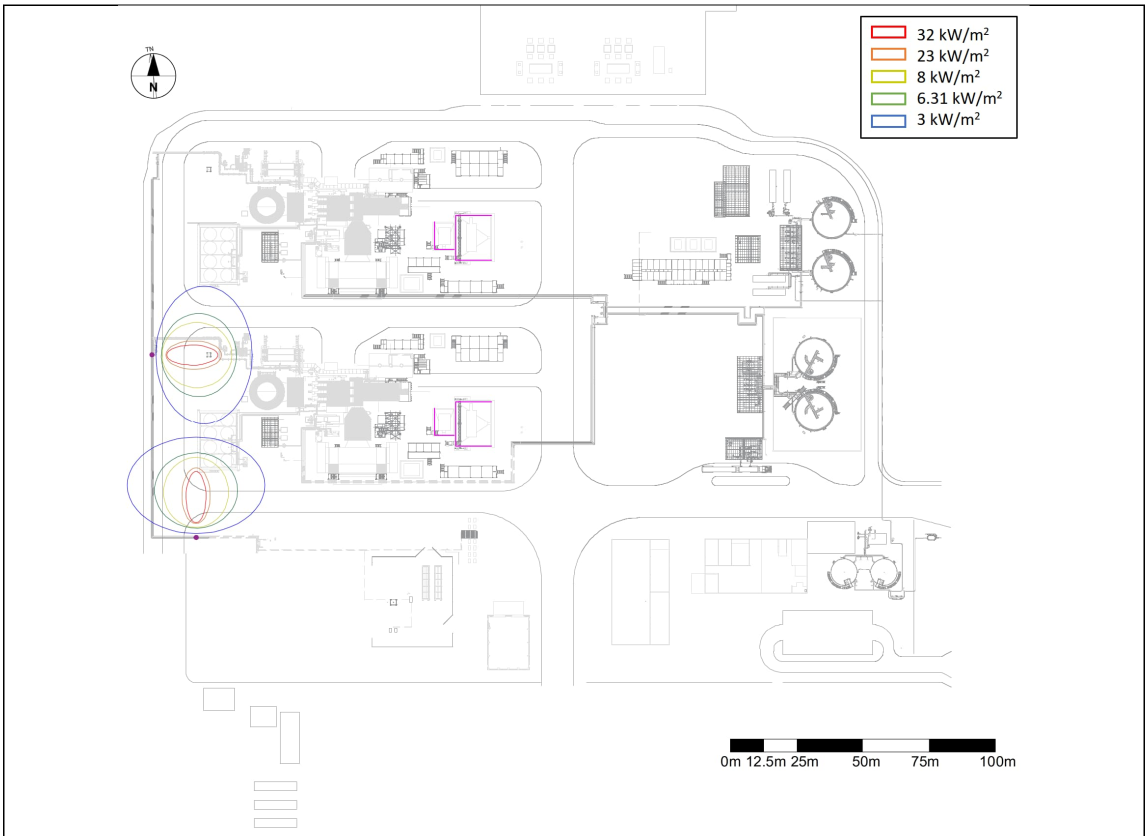
Major Incident Scenario - VCE	Explosion Overpressure (Distance from centre of incident (m))			
	7 kPa	14 kPa	21 kPa	35 kPa
NG_01_04 VCE from LOC of natural gas from Fuel gas manifold (including flow metering, gas chromatograph shelter, pressure control skid and station SDV) at Zone 3	61	30	N/R	N/R
NG_02_04 VCE from LOC of natural gas from Delivery Heaters (H-3300A/B/C) at Zone 3	61	30	N/R	N/R
NG_04_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Knock Out Drum (01EKE01AT005 and 02EKE01AT005) at Zone 1/2	84	41	N/R	N/R
NG_05_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Coalescers Filters (01EKE01AT004, 01EKE02AT004 and 02EKE01AT004, 02EKE02AT004) at Zone 1/2	84	41	N/R	N/R
NG_06_04 VCE from LOC of natural gas from OCGT (Unit 1/2) - Drips Tank (01GMA01BB001 and 02GMA01BB001) at Zone 1/2	43	21	N/R	N/R
NG_09_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Flow Meter (#70) at Zone 1/2	84	41	N/R	N/R
NG_10_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Heater (#17) at Zone 1/2	84	41	N/R	N/R
NG_11_03 VCE from LOC of natural gas from OCGT (Unit 1/2) - Fuel Gas Last Chance Filter (#36) at Zone 1/2	84	41	N/R	N/R

Comparison with the base case indicates that there is a significant change in effect distance results between source strength class “5” and “6”, i.e., the effect distances are reduced by approximately half for source strength “5”. The available information on the TNO MEM method seems to imply that a source strength range between “4” to “6” would describe the situation encountered in this project (see Table 5.3 in ref.14).

Hazard Effects Isopleth Site Overlay Drawings

The figures in the following pages represent the results in the tables in the previous section as isopleths overlaid on the site plot plan to assist assessment of the facility plant and infrastructure impacted by significant incidents involving fire hazards.

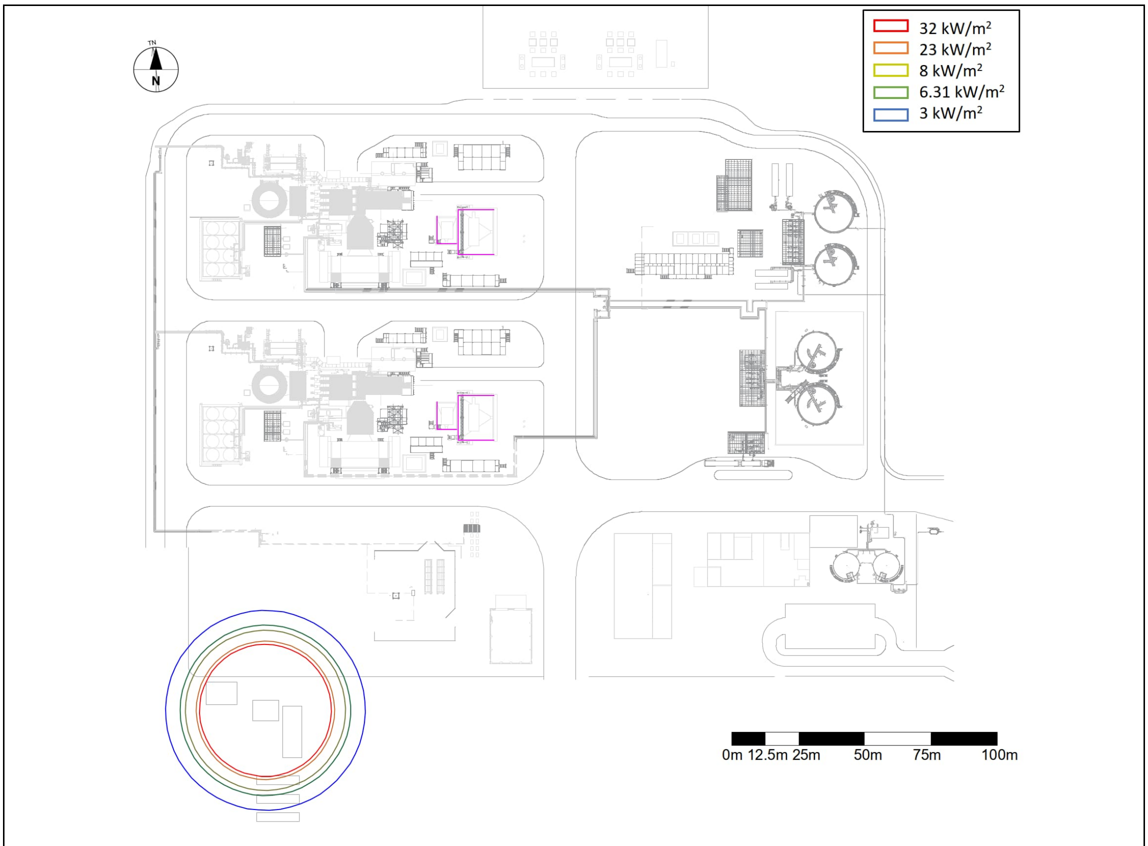
The figures showing the impact from jet fire require some preliminary explanation. A jet fire is associated with a loss of containment integrity at a point, such as a flange or broken small bore pipe branch. For an individual jet fire, the flame is long and narrow and the thermal radiation isopleths typically have the appearance show in Figure 9. The high thermal radiation levels, i.e., 23kW/m^2 and 32kW/m^2 tend to conform to the shape of the flame, as expected. Lower thermal radiation levels tend to “bulge” outward from the long axis of the flame. This is important to appreciate from the perspective of potential approach distance for fire-fighters. However, in an equipment and piping system involving numerous flanges, instrument connections and other small-bore joints, which represent potential failure and leak points it is not practical to draw every potential failure point or orientation of flame with its own isopleths. Instead, the “locus” of the possible jet fires is drawn, which results in either circles, for tightly grouped leak risks or complex shapes for more distributed leak risks.



Leak source - NG_03_01 (25mm leak) – Jet Fire

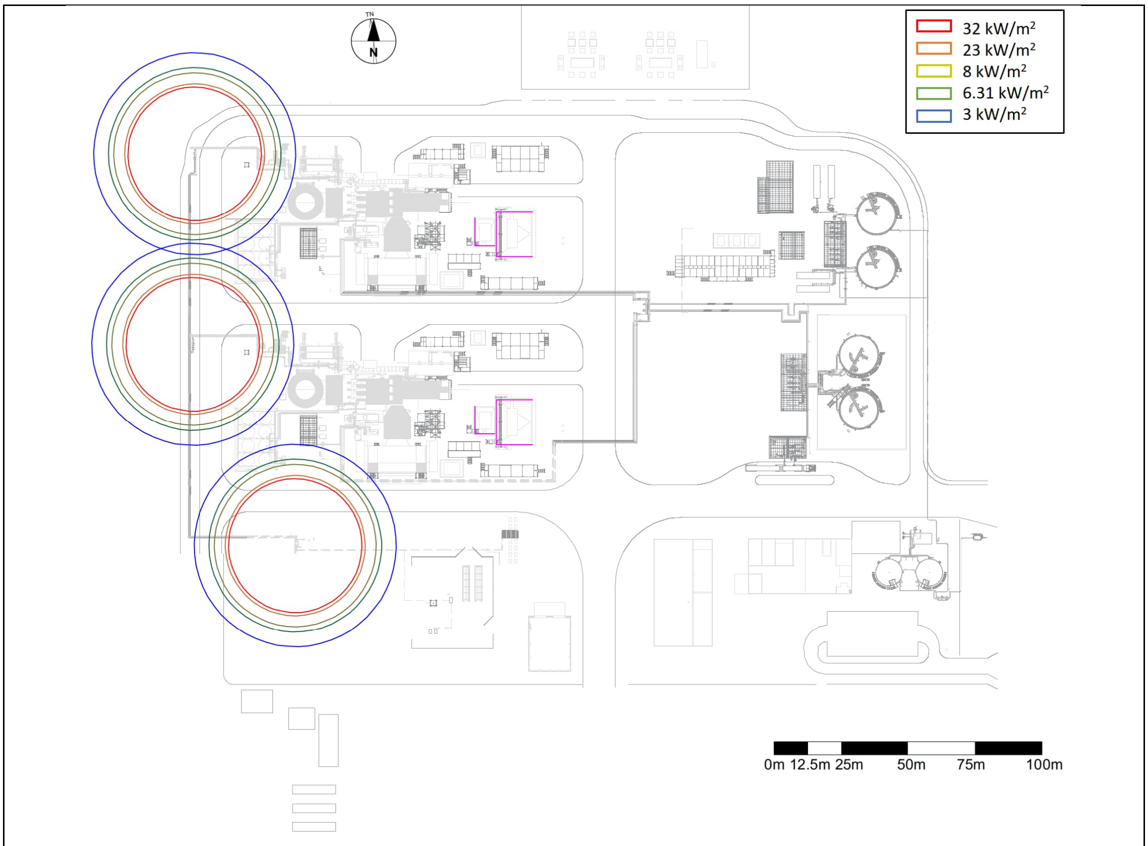
Figure 9 Sample of Jet Fire Contours from an individual 25mm leak source

Figure 10 - Jet Fires – Thermal Radiation Levels (at ground level)

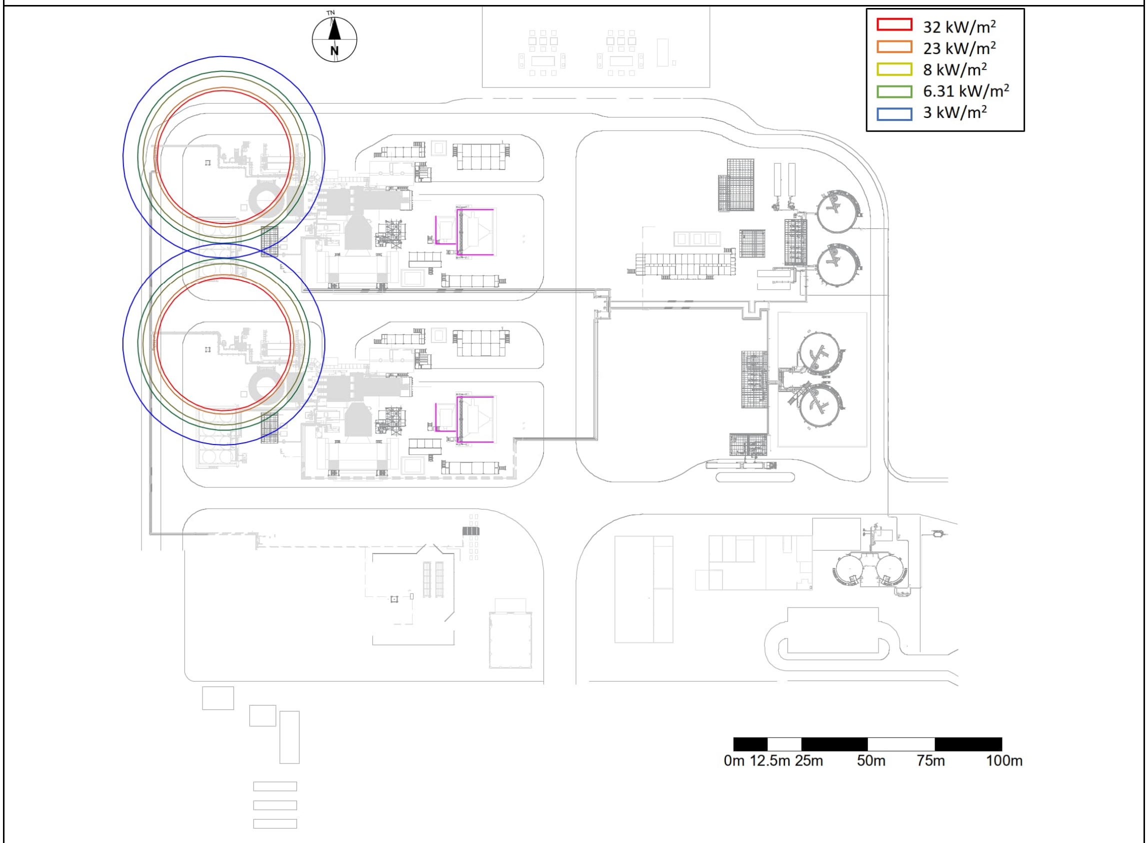


(a) NG_01_01 (25mm leak) – Jet Fire from GRS fuel gas manifold

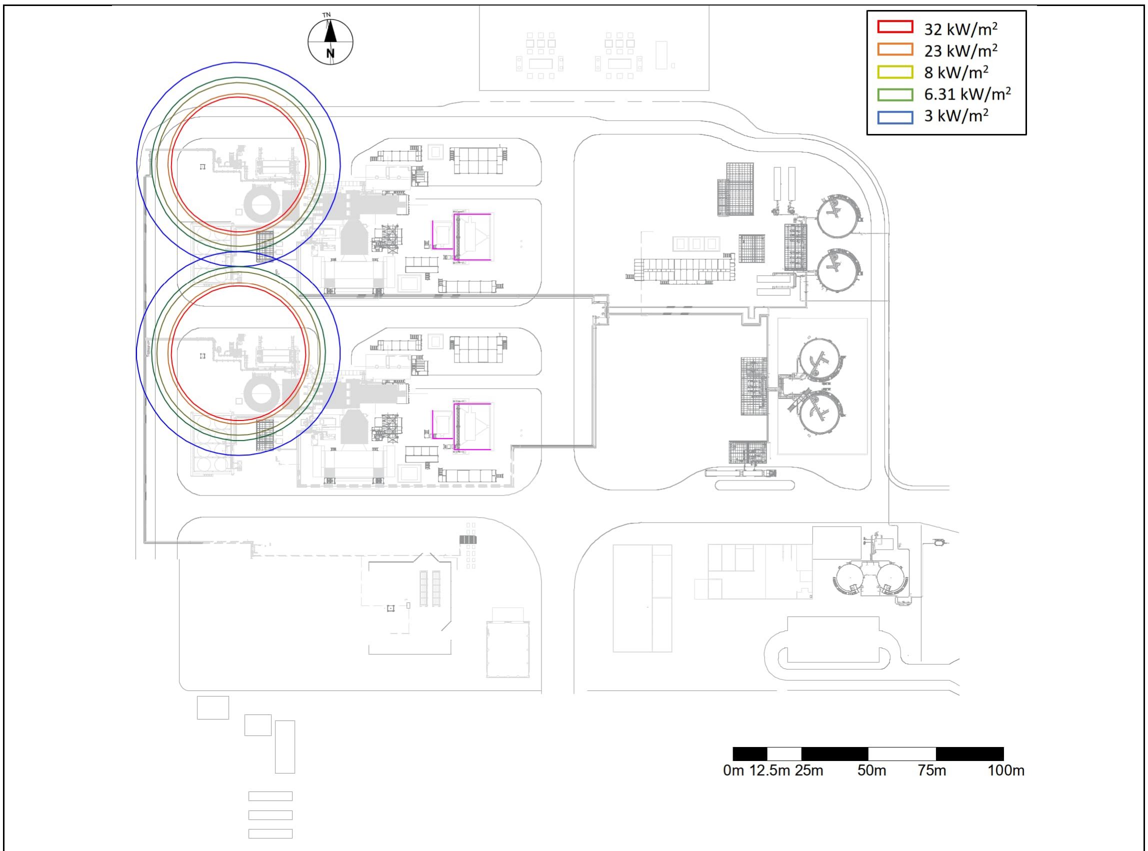
(b) NG_02_01 (25mm leak) – Jet Fire from GRS Heaters



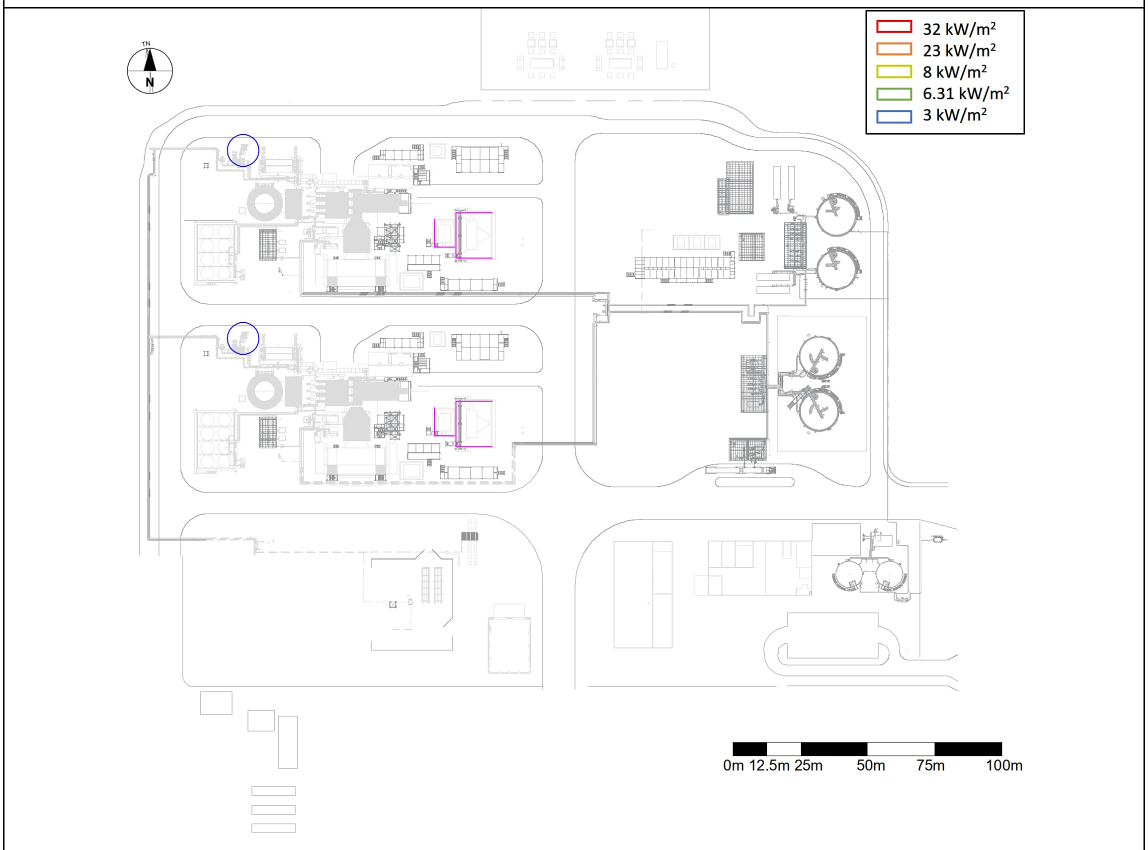
(c) NG_03_01 (25mm leak) – Jet Fire from fuel gas forwarding manifold valve sets



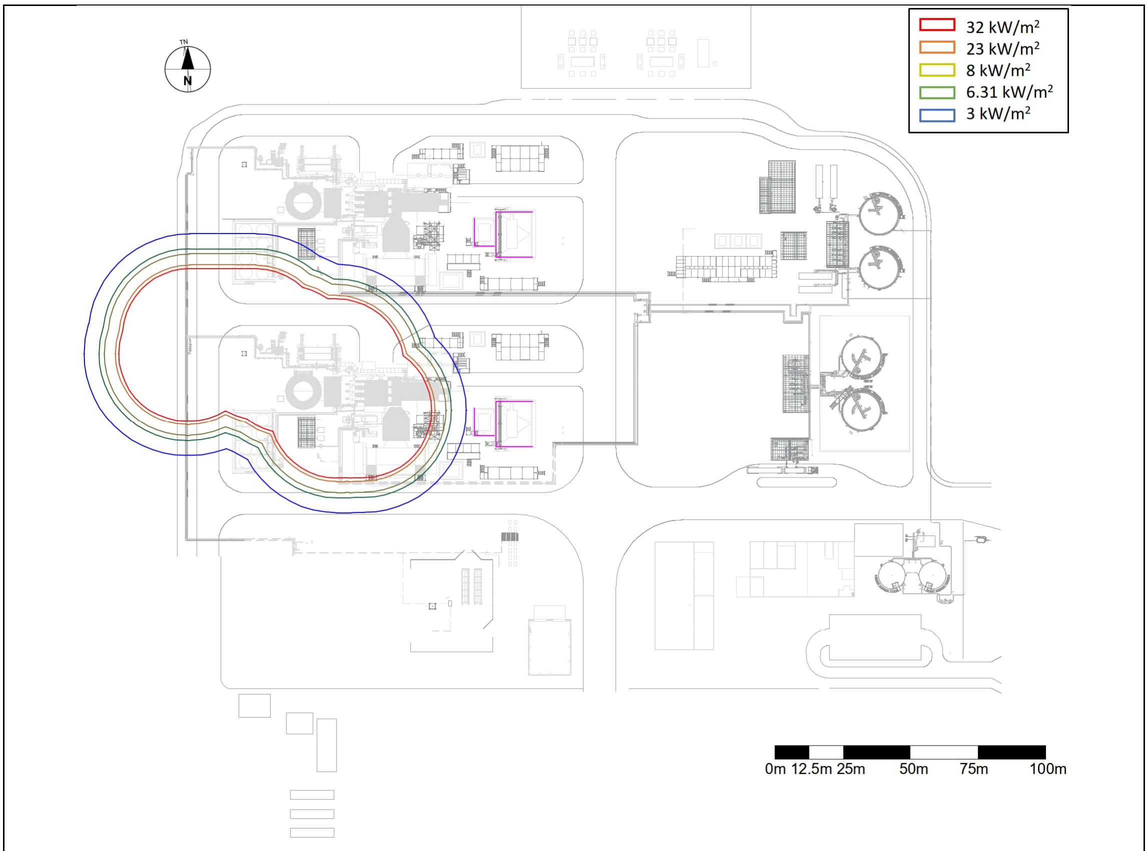
(d) NG_04_01 (25mm leak) – Jet Fire from fuel gas knock-out drums



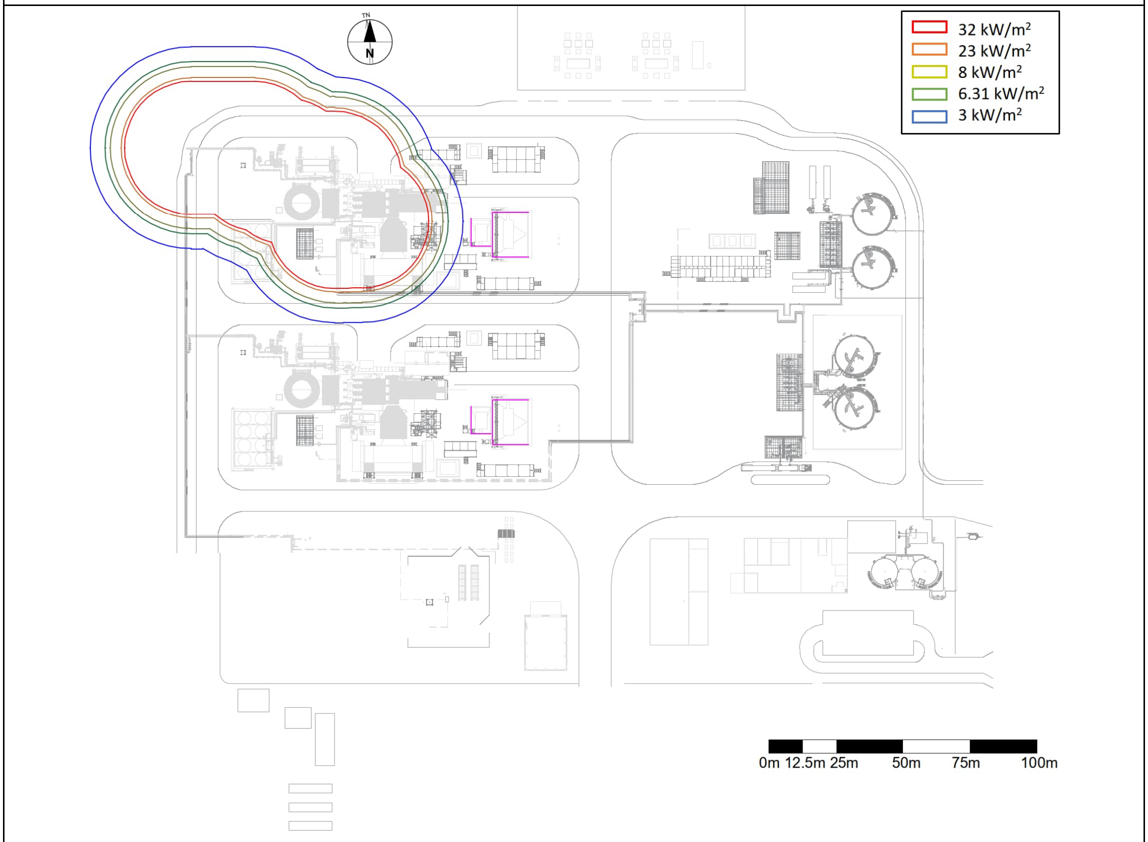
(e) NG_05_01 (25mm leak) – Jet Fire from fuel gas filter-coalescers



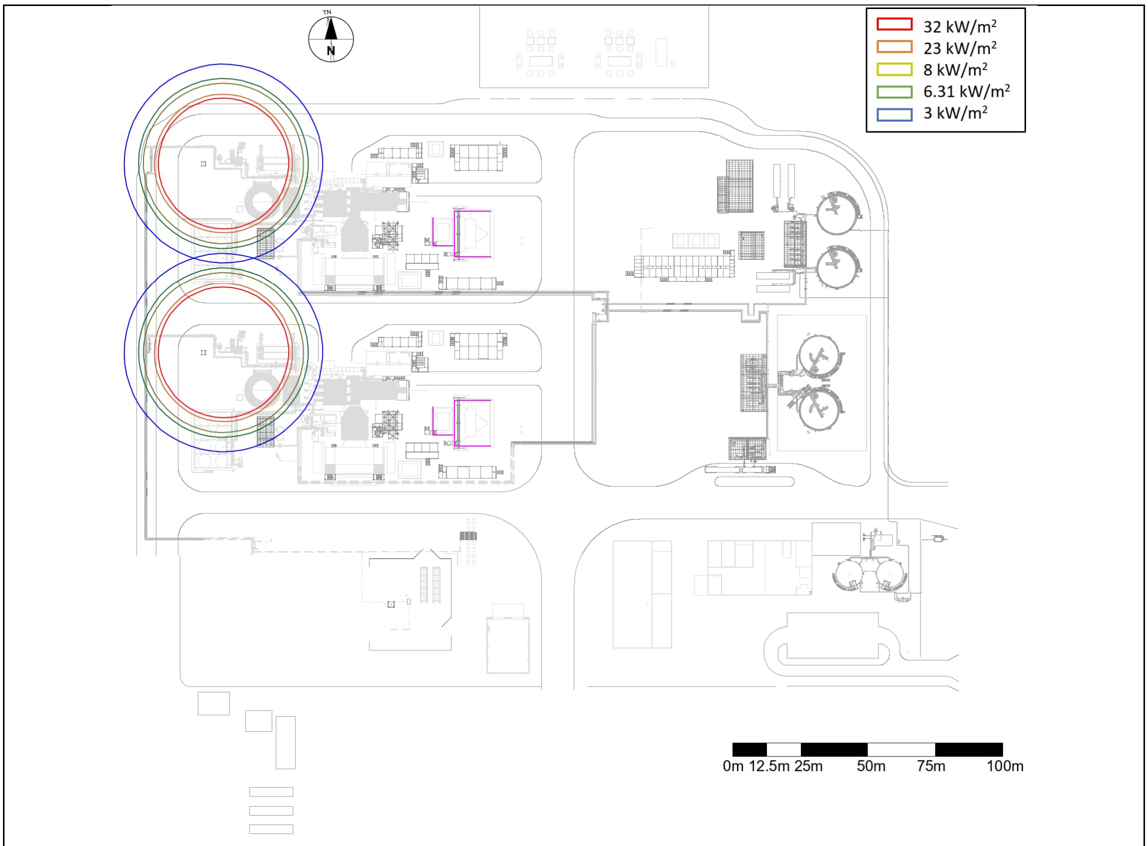
(f) NG_06_01 (25mm leak) – Jet Fire from fuel gas drips tanks



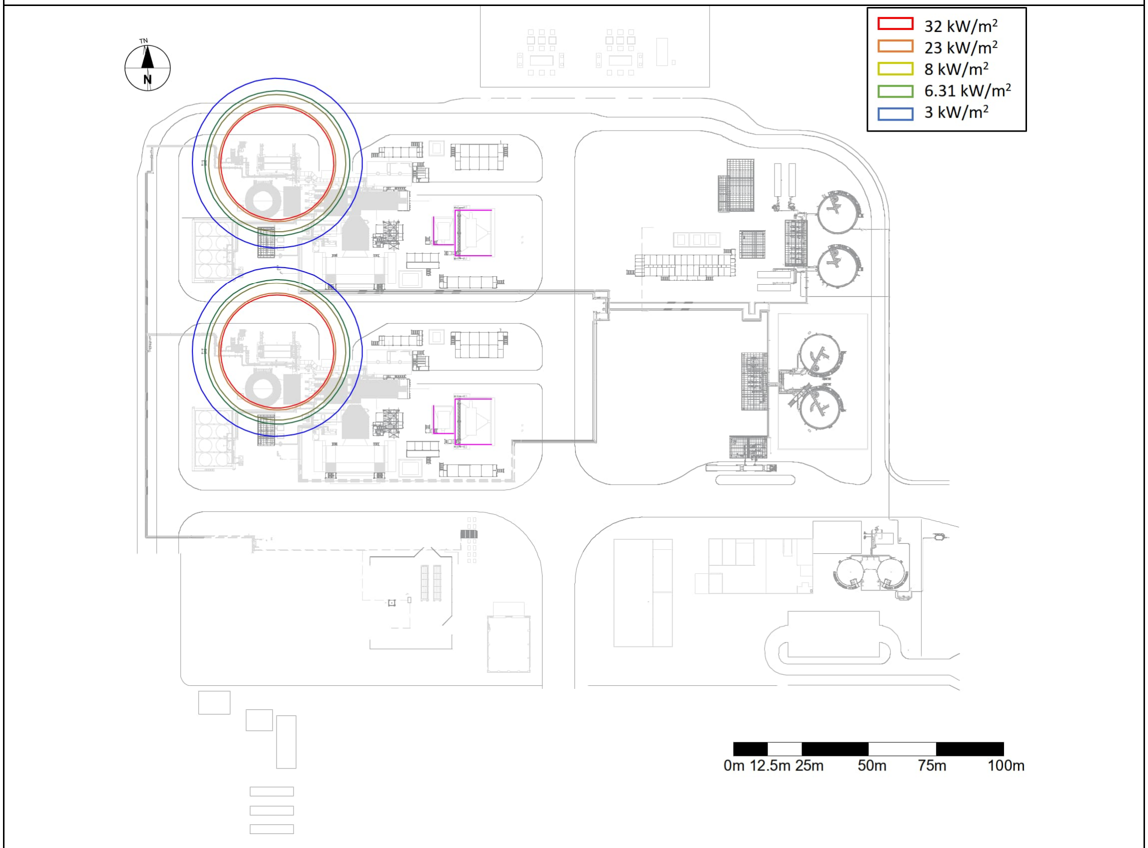
(g) NG_07_01 (25mm leak) – Jet Fire from fuel gas piping Unit 2



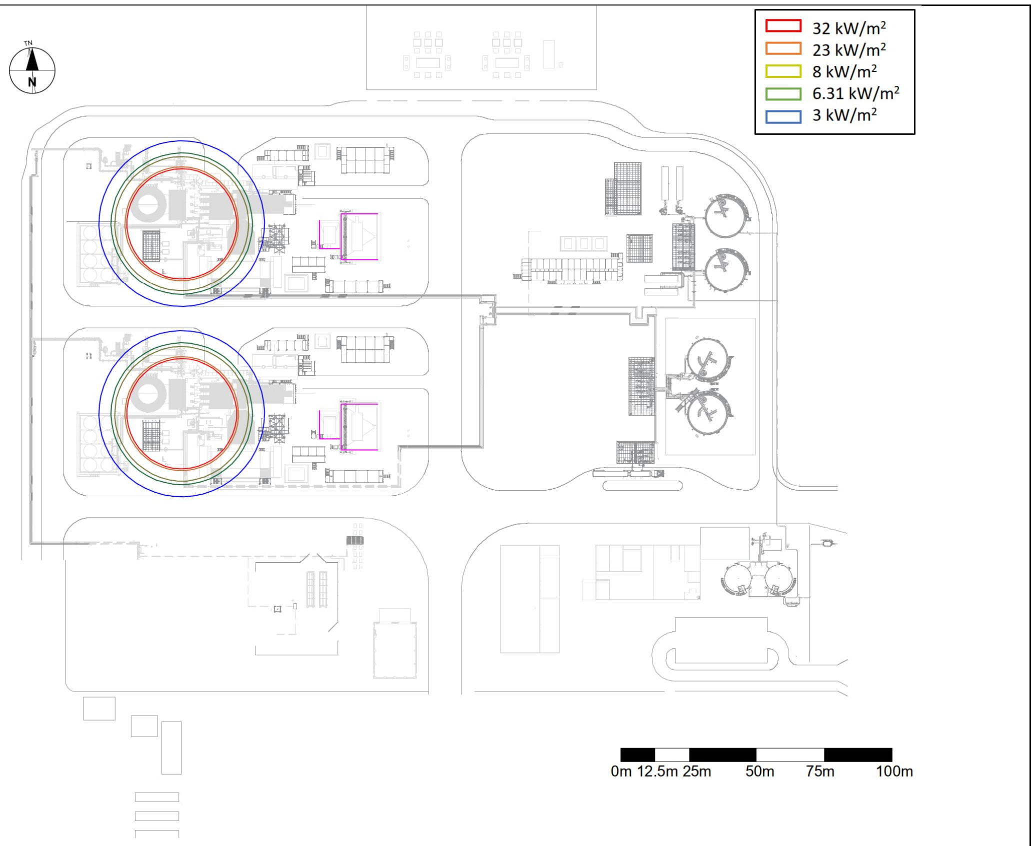
(h) NG_08_01 (25mm leak) – Jet Fire from fuel gas piping Unit 1



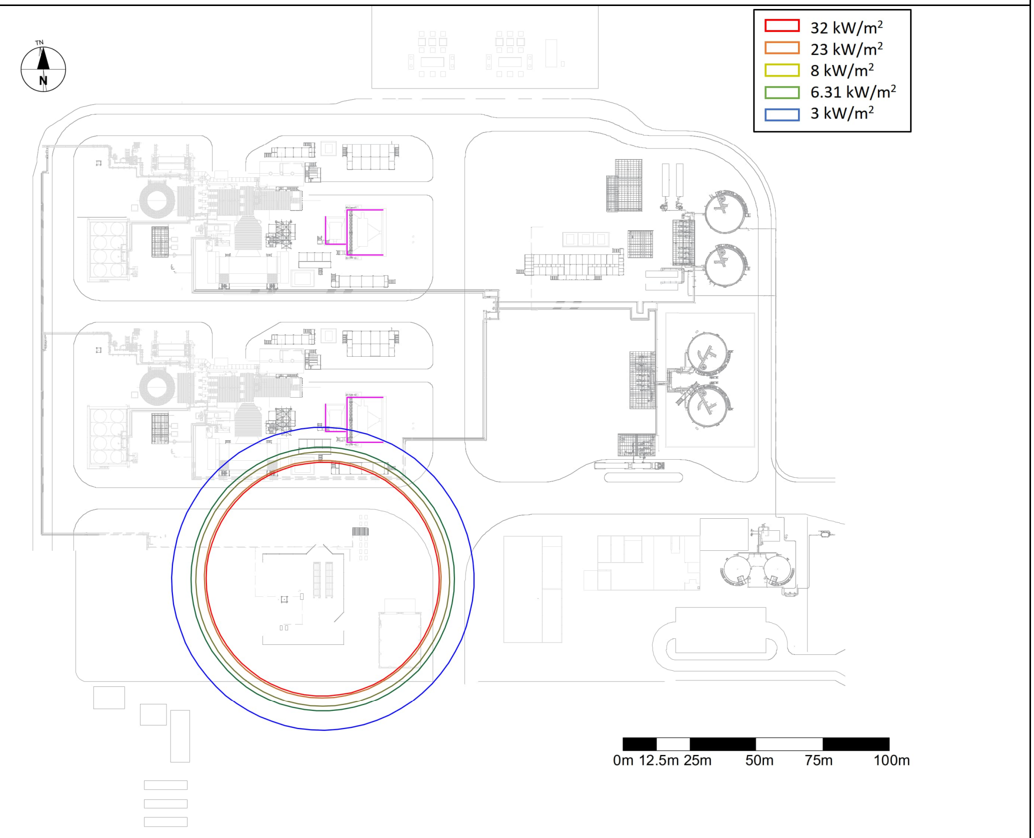
(i) NG_09_01 (25mm leak) – Jet Fire from fuel gas flowmeters (#70)



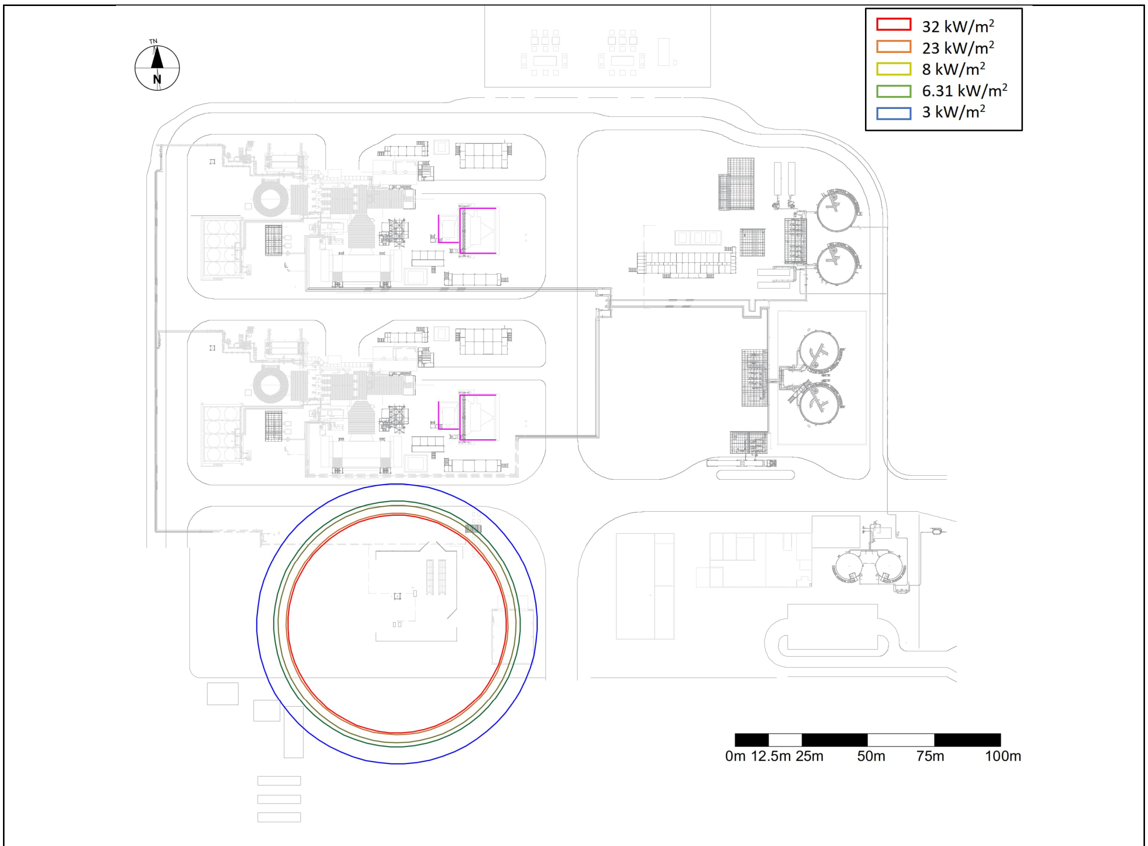
(j) NG_10_01 (25mm leak) – Jet Fire from fuel gas heaters (#17)



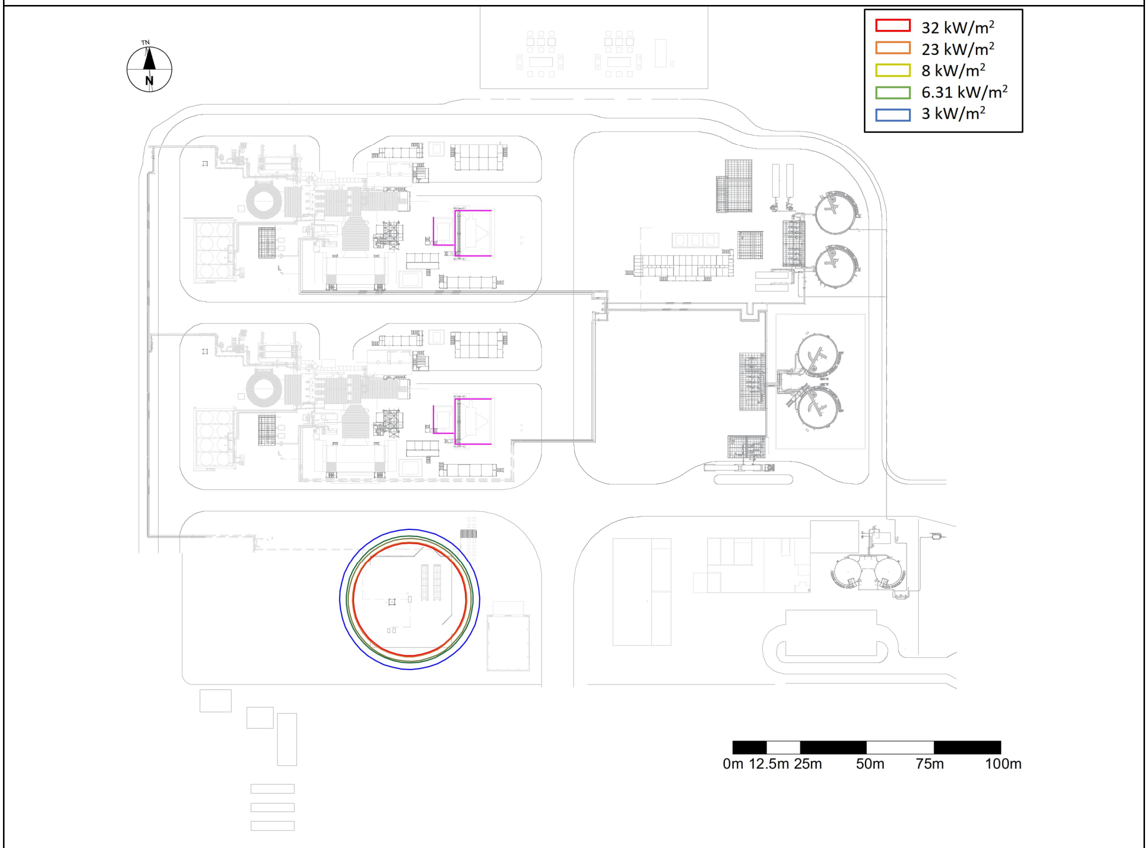
(k) NG_11_01 (25mm leak) – Jet Fire from fuel gas last chance filters (#36)



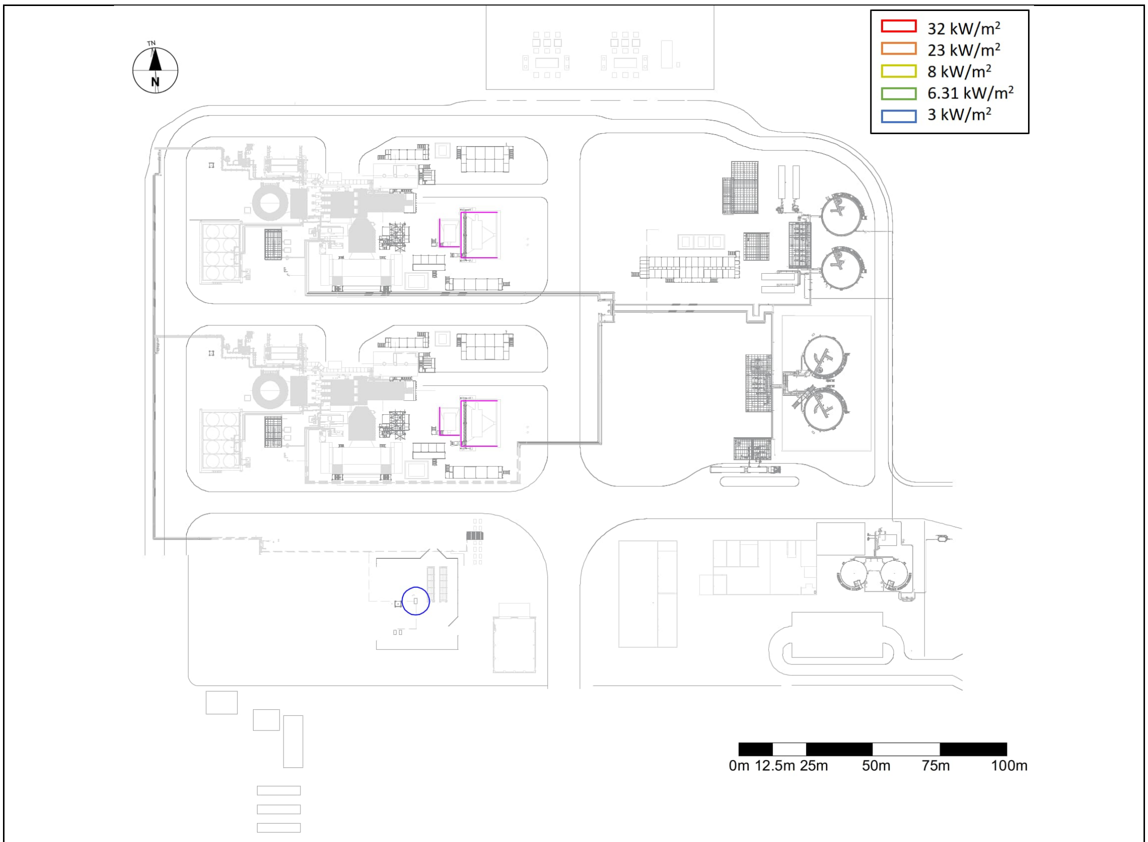
(l) HY_01_01 (25mm leak) – Jet Fire from hydrogen tube trailer



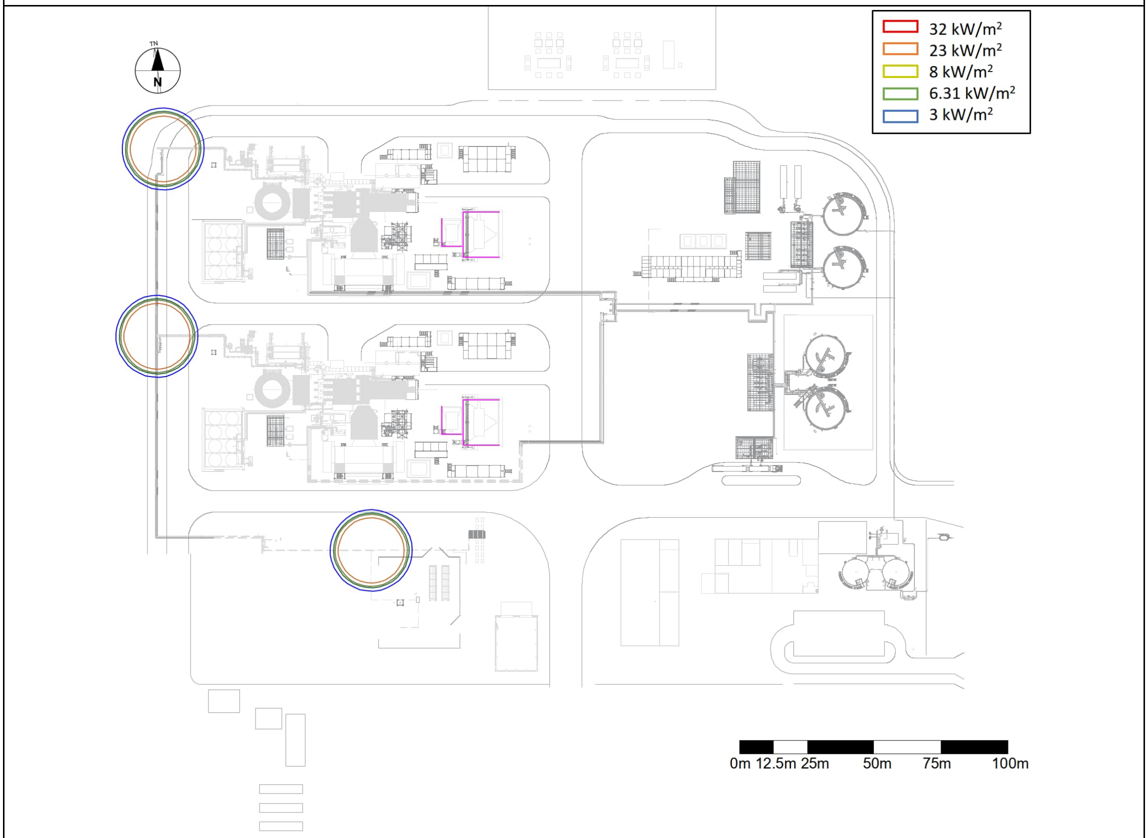
(m) HY_02_01 (25mm leak) – Jet Fire from hydrogen back-up cylinder crates



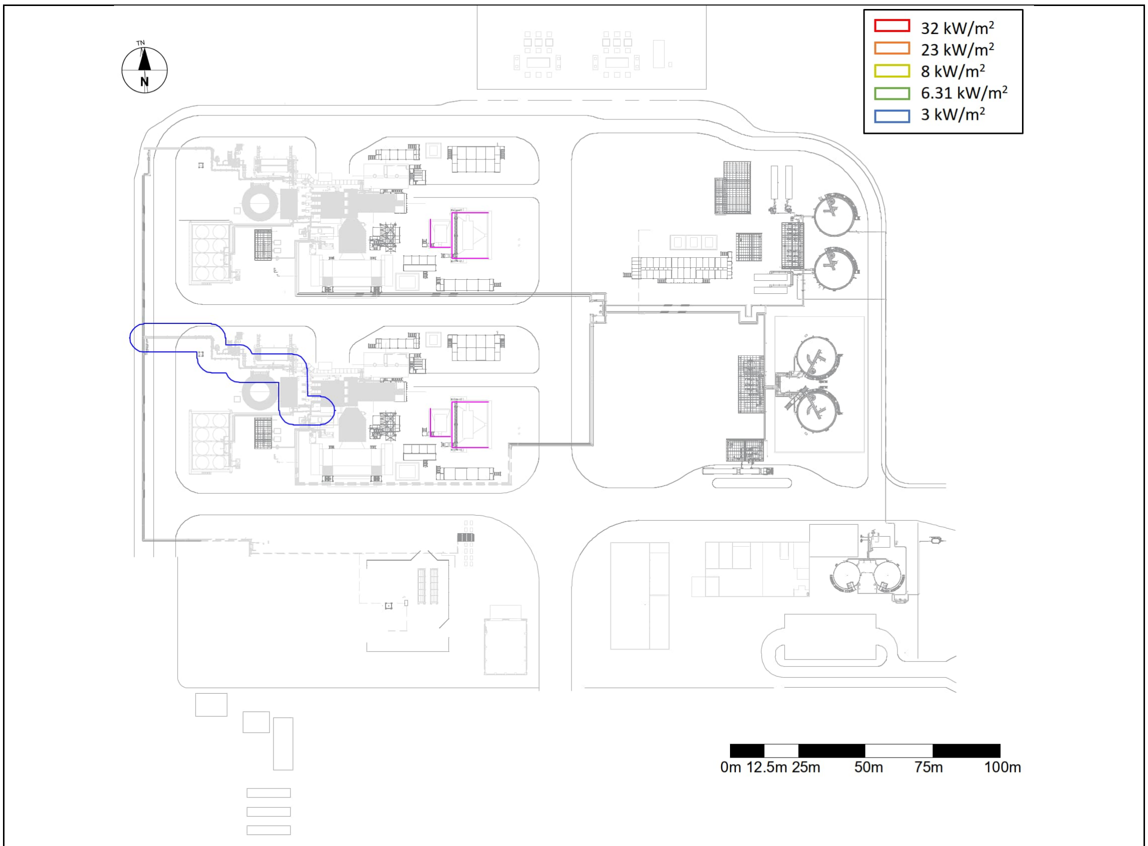
(n) HY_03_01 (10mm leak) – Jet Fire from high pressure hydrogen piping



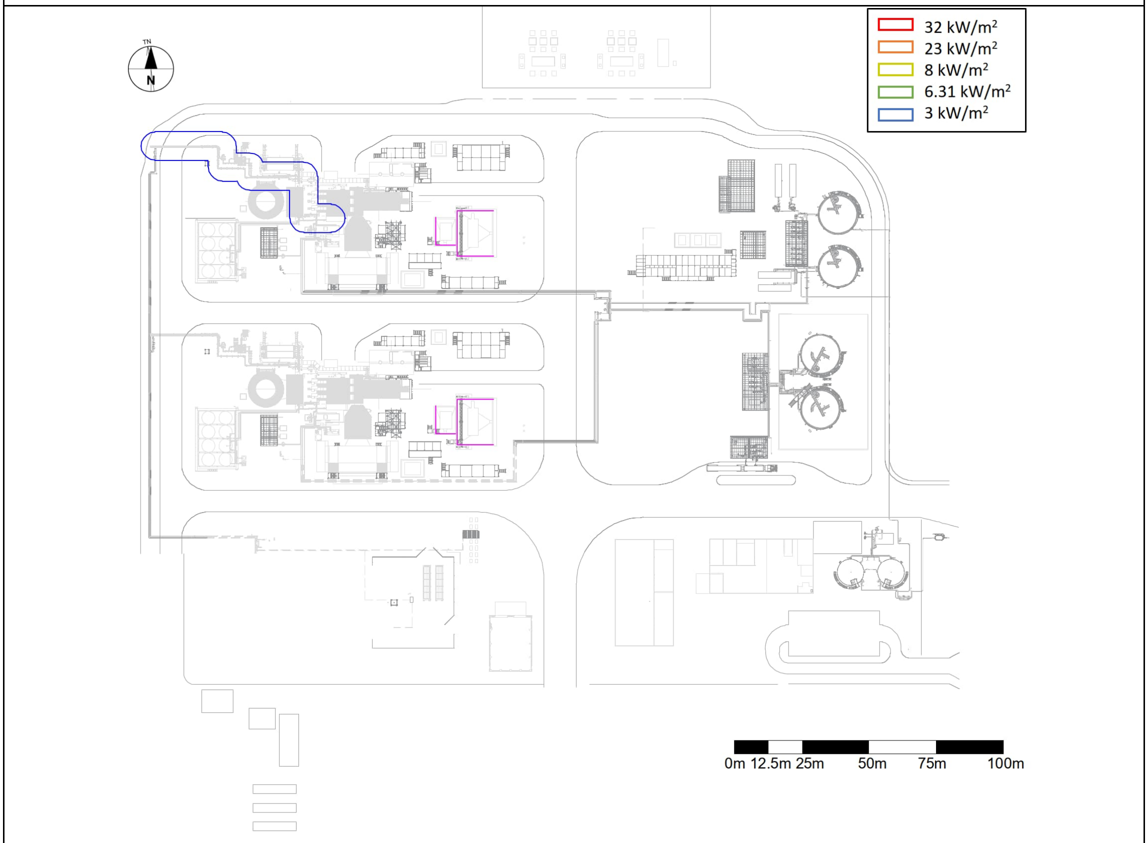
(o) HY_04_01 (10mm leak) – Jet Fire from low pressure hydrogen piping



(p) HY_05_01 (25mm leak) – Jet Fire from hydrogen forwarding manifold



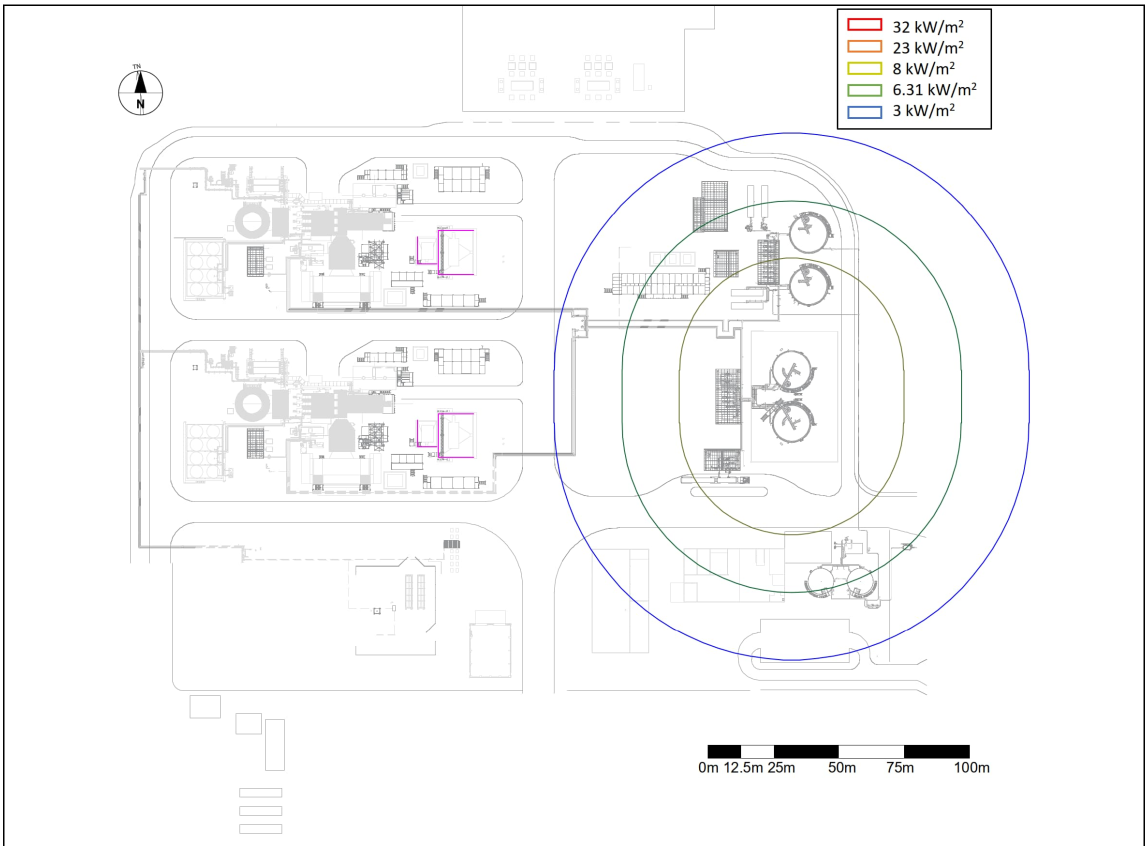
(q) HY_06_01 (10mm leak) – Jet Fire from hydrogen piping Unit 2



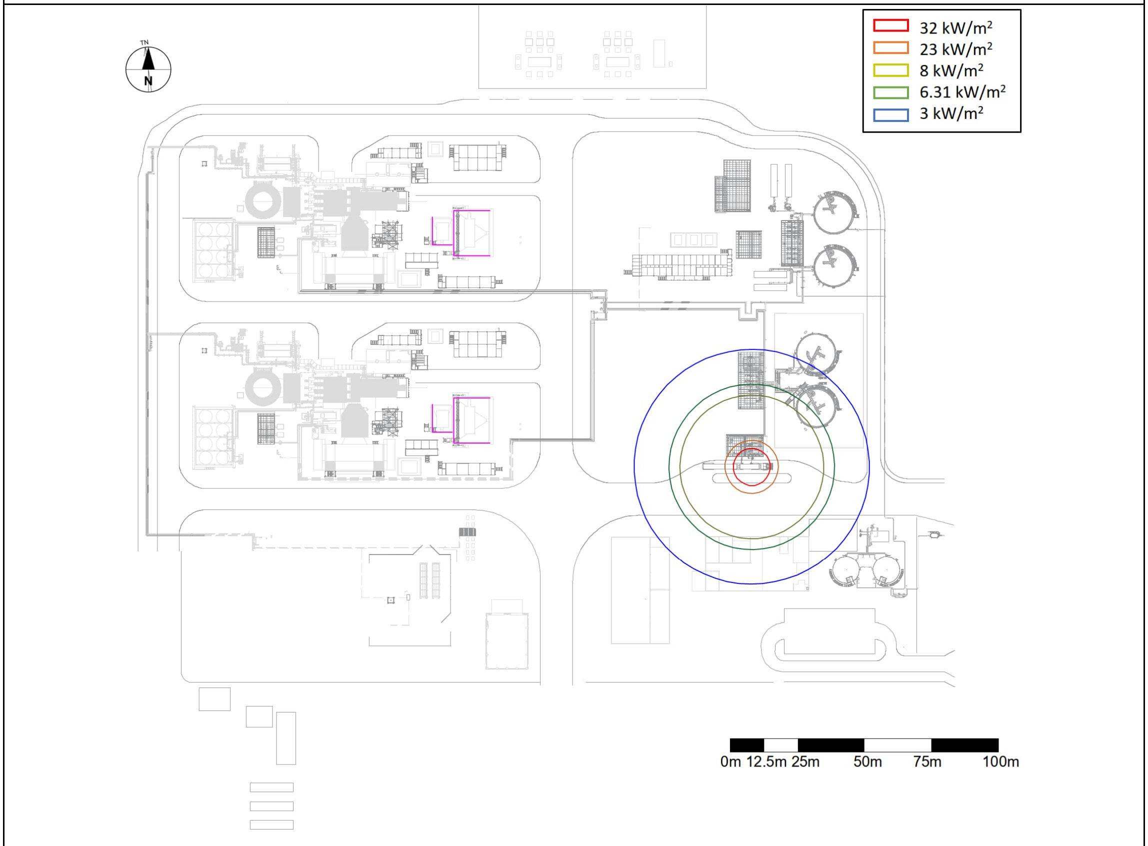
(r) HY_07_01 (10mm leak) – Jet Fire from hydrogen piping Unit 1

Figure 10 Jet Fires – Thermal Radiation Levels (at ground level)

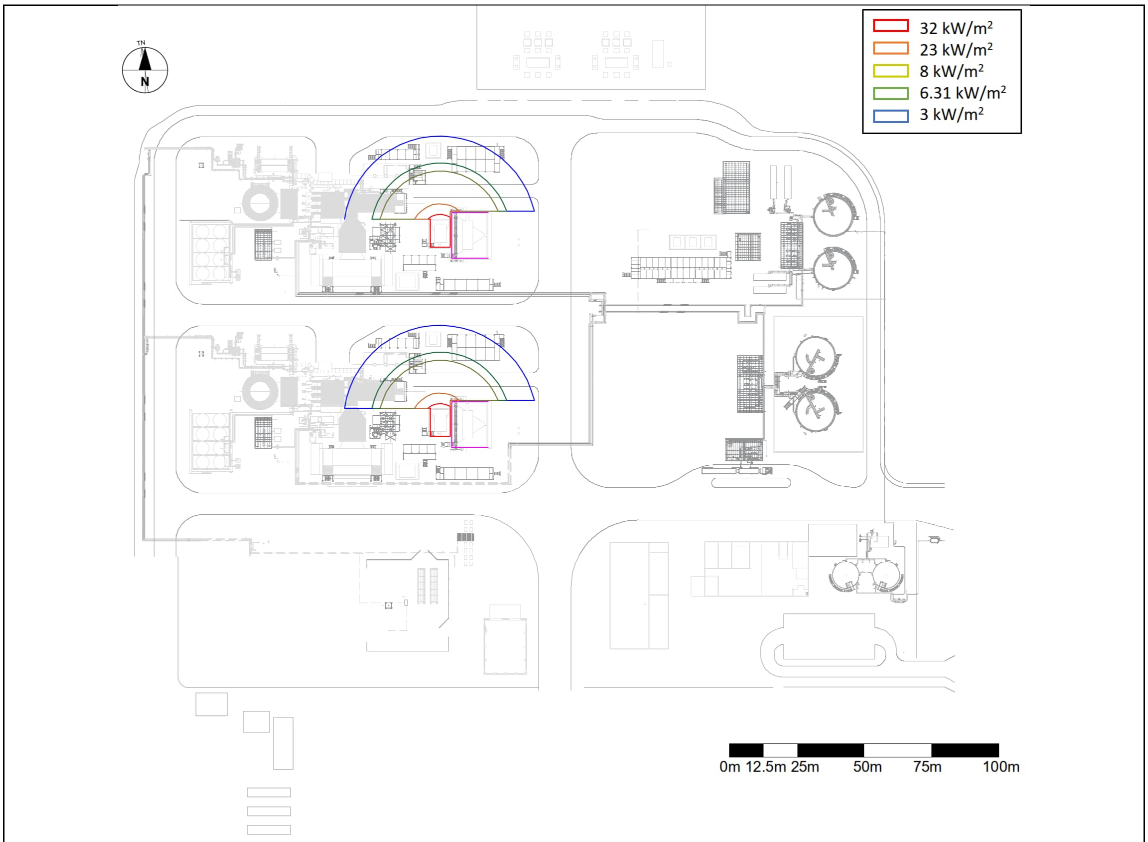
Figure 11 - Bund Fires – Thermal Radiation Levels (at ground level)



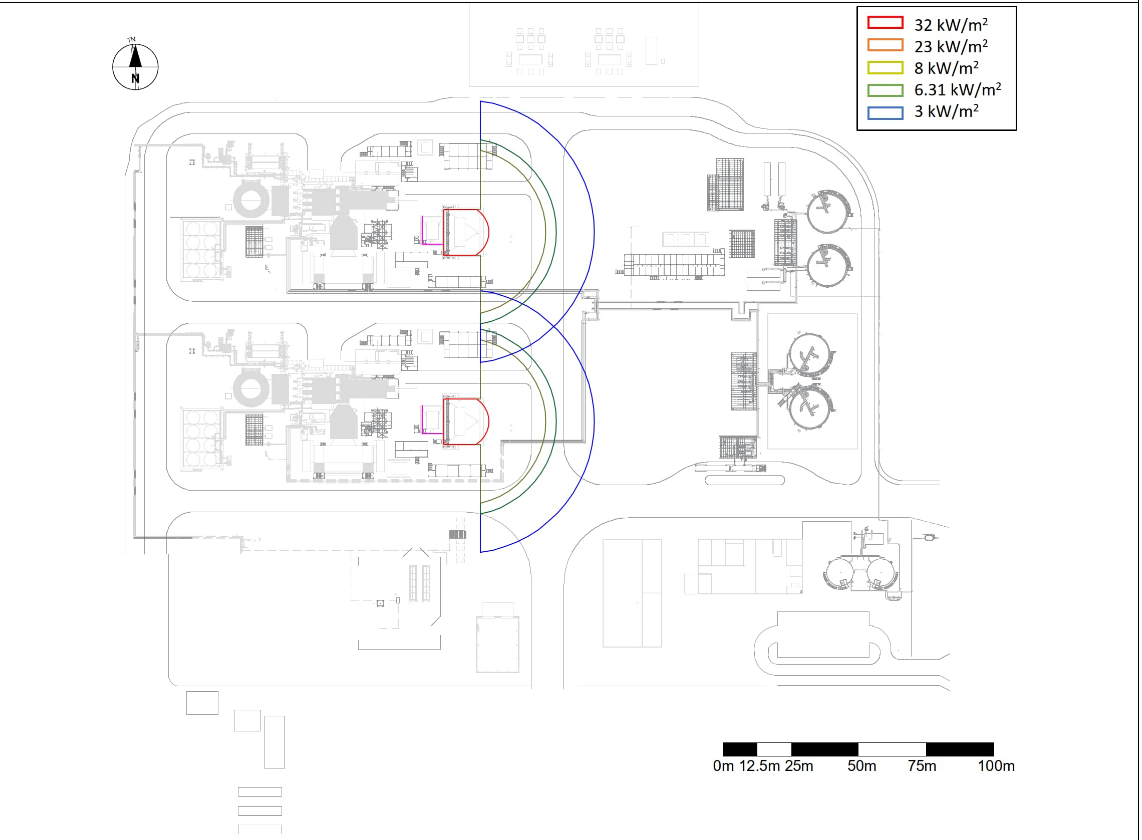
(a) DO_01_01 (Rupture) – Bund Fire in bulk fuel oil storage



(b) DO_09_01 (Rupture) – Bund Fire in fuel oil tanker bay



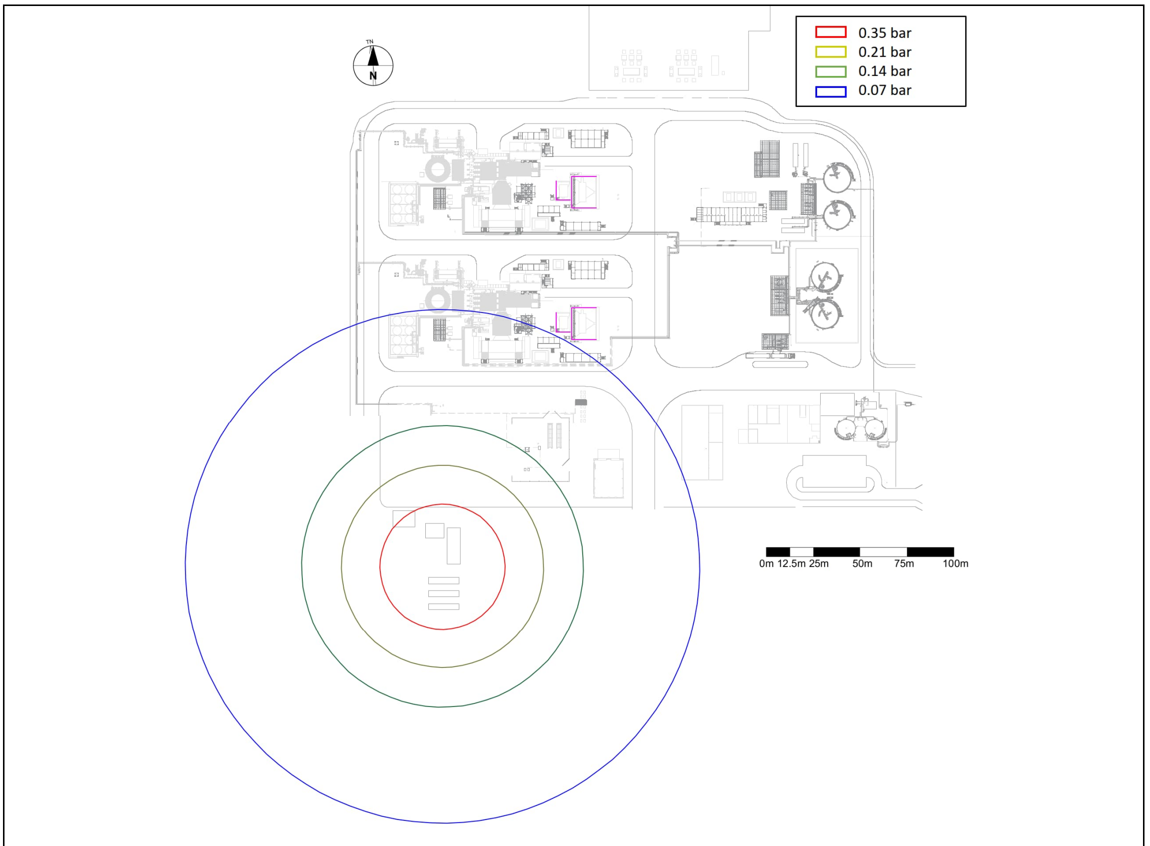
(c) TO_01_01 (Rupture) – Bund Fire (Shielded) from Unit Transformers (#121)



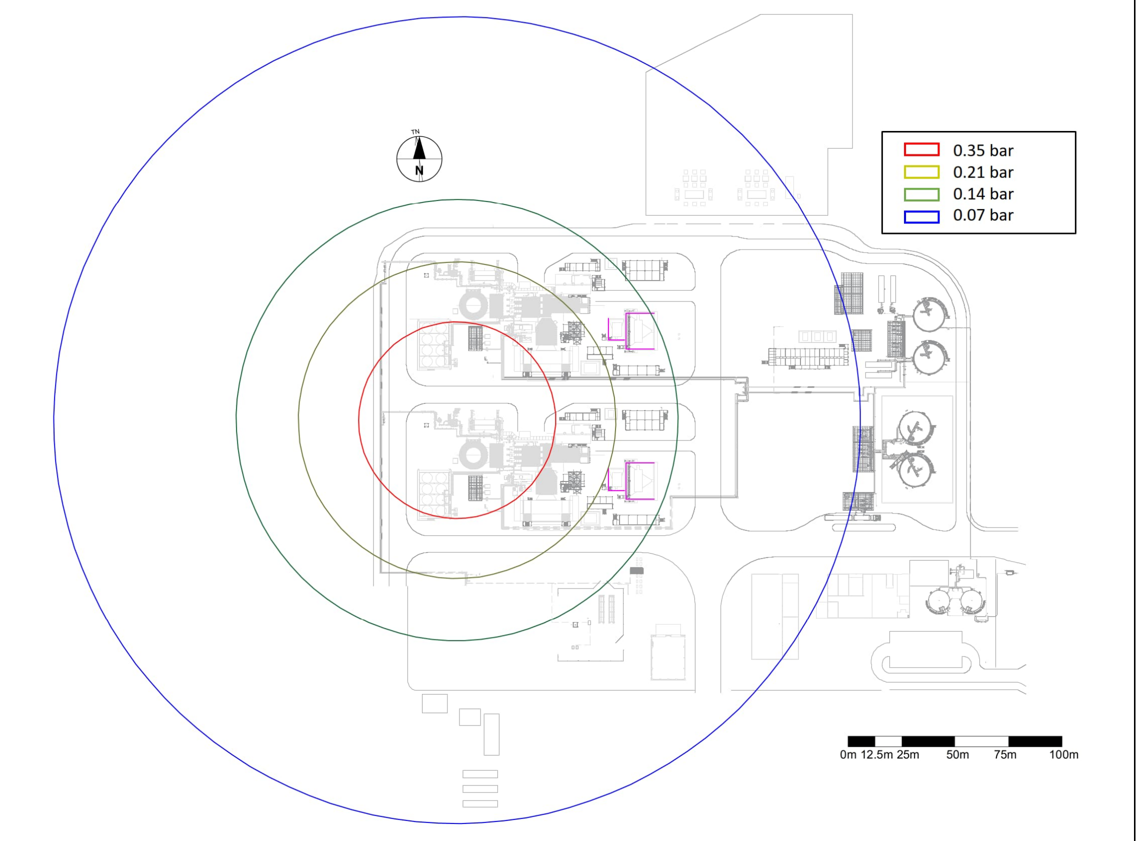
(d) TO_02_01 (Rupture) – Bund Fire (Shielded) from Generator Step-Up Transformers (#113)

Figure 11 Bund Fires – Thermal Radiation Levels (at ground level)

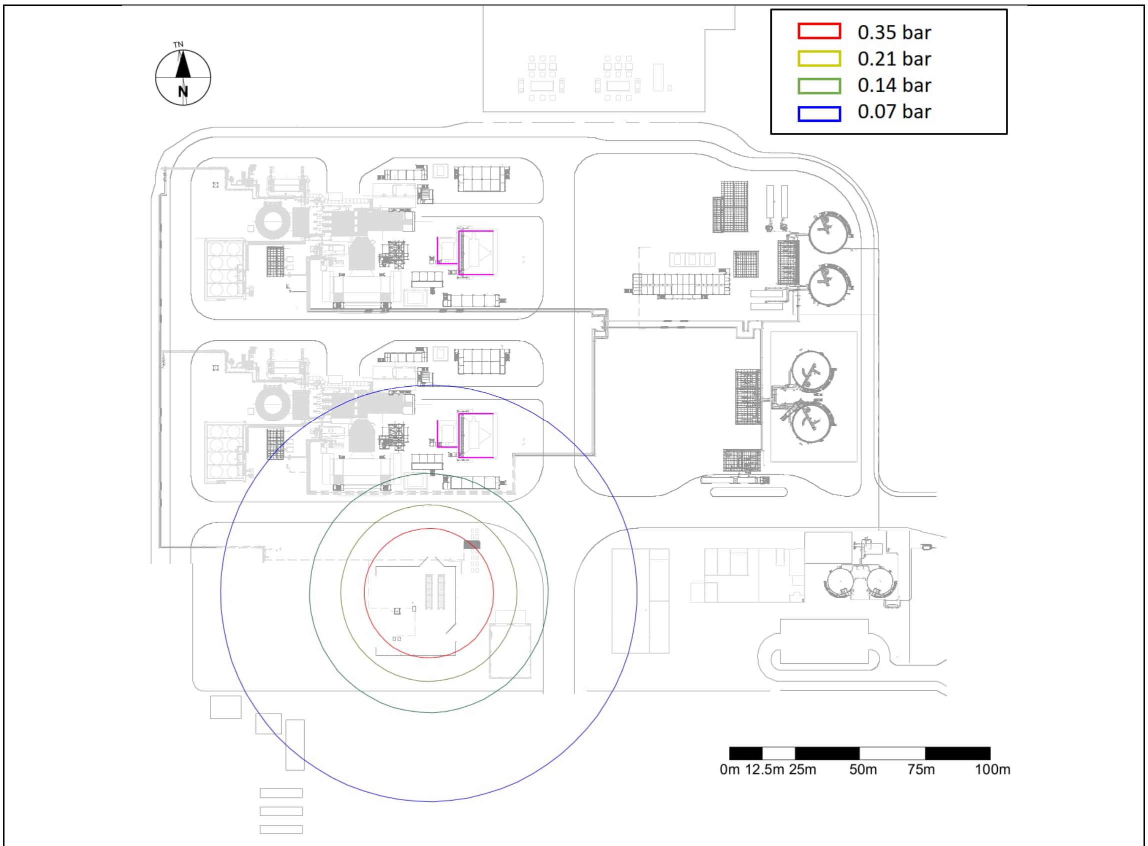
Figure 12 - Vapour Cloud Explosion – Explosion Overpressures (at ground level)



(a) NG_01_04 (Rupture) – VCE from GRS



(b) NG_04_04 (Rupture) – VCE from fuel gas filtration, metering and heating equipment Unit 2



(c) HY_01_04 (Rupture) – VCE from hydrogen storage facility

Figure 12 Vapour Cloud Explosion – Explosion Overpressures (at ground level)

Appendix F

Hazardous Material Properties

Appendix F Hazardous Material Properties

Table 24 Composition and Associated Properties of Natural Gas

Parameters	Unit	Value
Methane	mol%	90.93
Ethane	mol%	5.24
Propane	mol%	0.74
n-Butane	mol%	0.04
i-Butane	mol%	0.03
n-Pentane	mol%	0.01
i-Pentane	mol%	0.01
Hexane	mol%	0.01
Heptane	mol%	0.02
Octane	mol%	-
Nitrogen (N_2)	mol%	0.87
Carbon Dioxide (CO_2)	mol%	2.10
Hydrogen (H_2)	mol%	-
Molecular Weight	g/mol	17.74
Specific Gravity	-	0.6126
Higher Heating Value	MJ/Sm^3	38.71
Wobbe Index	MJ/Sm^3	49.45

Note: Typical Longford gas composition (Rich LNG) taken from the APA Gas Supply Specification is adopted.

Appendix G

Fire Protection of Buildings

Appendix G Fire Protection of Buildings

Table 25 Fire Protection of Buildings – Summary

Building	Function	Preliminary BCA Building Class	Occupancy	Size	Construction	Ventilation	Fire Hazards	Fire Systems	Additional Information
Control & Administration Building	Building to house control room, administration offices, meeting room, personnel facilities.	Office – Class 5 Bushfire Attack Level = 0	Not permanently manned, occupied as required, predominately day shift occupancy. For the purpose of the BCA D1.13 the building population is determined to be not more than 18 occupants.	Single Storey. Building has a rise in storeys of one. Floor area = 723m²	Type C fire resistance and stability construction Comms Rooms 1 & 2, Control Room 120/120/120 FRL	Mechanically ventilated Air conditioned	Electrical Cooking facilities (Lunch Area) Arson	Fire systems exceed requirements for BCA compliance to address business criticality. *Detection & alarm* Smoke detectors, heat detectors and Manual Call Points (MCPs), which will trigger the Building Occupant Warning System (BOWS). *Fire Protection* Automatic fire sprinklers which will trigger the Building Occupant Warning System (BOWS). Gaseous suppression systems for Comms Room 1 & 2. *Fire Fighting* First response portable fire extinguishers and fire hose reels. Fire hydrants located externally, minimum of 10m from the building.	Fire Indicator Panel networked to the site Main Fire Indictor Panel. Graphics display within the Control Room. Standalone building greater than 3m from adjacent buildings (fire-source features) for BCA requirements. Being remote from fire source features no particular fire resistance levels are required to the external walls/columns. Secured site and building.
Workshop & Storage Building	Building to house facilities for maintenance/repairs of site equipment.	Class 8 Bushfire Attack Level = 0	Not permanently manned, occupied as required, predominately day shift occupancy. For the purpose of the BCA D1.13 the building population is determined as 5 occupants.	Single Storey. Building has a rise in storeys of one. Floor area = 827m²	Type C fire resistance and stability construction	Mechanically & Naturally ventilated Air conditioned	Electrical Welding Arson	Fire systems exceed requirements for BCA compliance to address business criticality. *Detection & alarm* Smoke detectors, heat detectors and Manual Call Points (MCPs), which will trigger the Building Occupant Warning System (BOWS). *Fire Protection* Automatic fire sprinklers which will trigger the Building Occupant Warning System (BOWS). *Fire Fighting* First response portable fire extinguishers and fire hose reels. Fire hydrants located externally, minimum of 10m from the building.	Fire Indicator Panel networked to the site Main Fire Indictor Panel. Standalone building greater than 3m from adjacent buildings (fire-source features) for BCA requirements. Being remote from fire source features no particular fire resistance levels are required to the external walls/columns. Secured site and building.

Building	Function	Preliminary BCA Building Class	Occupancy	Size	Construction	Ventilation	Fire Hazards	Fire Systems	Additional Information
Chemical Store	Shelter for storage of chemicals.	Class 7b Bushfire Attack Level = 0	Not permanently manned; occupied as required. For the purpose of the BCA D1.13 the building population is determined as not more than 10 occupants.	Single Storey. Building has a rise in storeys of one. Floor area = 330m²	Type C fire resistance and stability construction	Naturally ventilated	Flammable & Combustible liquids – containerised storage Forklift & Delivery Vehicles Electrical Arson	Fire systems exceed requirements for BCA compliance to address business criticality. *Detection & alarm* Heat detectors and Manual Call Points (MCPs), which will trigger the Building Occupant Warning System (BOWS). *Fire Fighting* First response portable fire extinguishers and fire hose reels. Fire hydrants located externally, minimum of 10m from the building.	Fire Indicator Panel networked to the site Main Fire Indictor Panel. Standalone building greater than 3m from adjacent buildings (fire-source features) for BCA requirements. Being remote from fire source features no particular fire resistance levels are required to the external walls/columns. Secured site and building.
Fire Pump Room	Building to house the fire pumps and Fire Control Centre (FCC).	Class 8	Not normally occupied.	Single Storey. Building has a rise in storeys of one. Floor area = 130m²	Type C fire resistance and stability construction	Naturally ventilated	Combustible liquid – Diesel fuel Electrical Bushfire Arson	Fire systems comply with BCA requirements. *Detection & alarm* Smoke detectors (within the FCC) and Manual Call Points (MCPs), which will trigger the Building Occupant Warning System (BOWS). *Fire Protection* Automatic fire sprinklers which will trigger the Building Occupant Warning System (BOWS). *Fire Fighting* First response portable fire extinguishers. Fire hydrants located externally, minimum of 10m from the building.	Main Fire Indictor Panel and Main Emergency Warning Panel within FCC, including Graphics display. Standalone building greater than 3m from adjacent buildings (fire-source features) for BCA requirements. Being remote from fire source features no particular fire resistance levels are required to the external walls/columns. Secured site and building.
Electrical Equipment Rooms	Building to house electrical equipment for site.	Class 8 Bushfire Attack Level = 12.5 (Zone 1 & 3)	Not normally occupied.	Single Storey. Building has a rise in storeys of one. Floor area = varies	Non-combustible construction	Mechanically ventilated Air conditioned	Electrical Bushfire Arson	Fire systems exceed requirements for BCA compliance to address business criticality. *Detection & alarm* Smoke detectors, MASD detection and Manual Call Points, which will trigger the Building Occupant Warning System (BOWS). *Fire Protection*	Fire Indicator Panel networked to the site Main Fire Indictor Panel. Secured site and building.

Building	Function	Preliminary BCA Building Class	Occupancy	Size	Construction	Ventilation	Fire Hazards	Fire Systems	Additional Information
								Automatic fire sprinklers below the raised platforms which will trigger the Building Occupant Warning System (BOWS). Gaseous suppression systems within electrical rooms which will trigger the Building Occupant Warning System (BOWS). *Fire Fighting* First response portable fire extinguishers. Fire hose reels located externally adjacent to exit doors/exit stairs. Fire hydrants located externally, minimum of 10m from the building.	

Appendix H

Bushfire Hazard and Asset Protection Zone

Hunter Power Project

Bushfire Assessment Report

Rev 0

13 April 2021

Hunter Power Project

Project No:	IS354500
Document Title:	Bushfire Assessment Report
Document No.:	Hunter Power Project
Revision:	Rev 0
Date:	13 April 2021
Client Name:	Snowy Hydro
Project Manager:	Karl Ivanusic
Author:	C Clifton, T McCaig
File Name:	IS354500_Hunter Power EIS_Bushfire_Final_20210416

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	13/04/2021	Issue for EIS	T McCaig, C Clifton	C Clifton	A Stephens, T Colman, M Luger	K Ivanusic

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Abbreviations

Term	Definition
APZ	Asset Protection Zone: an area located between bushfire prone vegetation and dwellings or other valued assets
AWS	Automated Weather Station
BAL	Bushfire Attack Level: radiant heat exposure from bushfire
BFMC	Bush Fire Management Committee: Hunter BFMC is the committee applicable to the Proposal
BFRMP	Bush Fire Risk Management Plan: plan developed by Hunter BFMC for strategic management of bushfire risk in Cessnock and Maitland local government areas
BPL	Bushfire prone land: land designated as supporting bushfire prone vegetation as defined by RFS (2015)
CMIP	Coupled Model Intercomparison Project of the Intergovernmental Panel on Climate Change (IPCC)
EIS	Environmental Impact Statement
FDR	Fire Danger Rating
FFDI	Forest Fire Danger Index
NBWS	National Bushfire Warning System
PBP	Planning for Bushfire Protection (NSW RFS, 2019a)
PCT	Plant Community Type
RCP	Representative Concentration Pathway: scenario representing addition radiant heat retained in atmosphere as a result of a defined future trajectory for greenhouse gas emissions
RFS	NSW Rural Fire Service
SEARs	Secretary's Environment Assessment Requirements
SFAZ	Strategic Fire Advantage Zone: an area (typically) located around valued assets whose bushfire fuels are managed to moderate fire behaviour and reduce bushfire risk
TOBAN	Total fire ban

Executive summary

Overview

Snowy Hydro Limited (Snowy Hydro) proposes to construct and operate a gas fired power station near Kurri Kurri, NSW ('the Proposal') on the site of the former Kurri Kurri aluminium smelter owned by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro Aluminium). The Proposal would have a capacity of up to approximately 750 MW, which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel as a back-up fuel. It is proposed to operate as a "peak load" generation facility that supplies electricity at short notice when there is a requirement in the National Electricity Market.

Snowy Hydro is currently seeking approval for the Proposal from the NSW Minister for Planning and Public Spaces, under the NSW *Environmental Planning and Assessment Act 1979*. Draft Secretary's Environmental Assessment Requirements (SEARs) were issued for the Proposal on 5 February 2021. This report responds to a requirement under the SEARs to assess bushfire risks for the Proposal in accordance with the NSW Rural Fire Service (RFS) guidance document, *Planning for Bushfire Protection 2019*.

Existing conditions

The Proposal Site is located approximately three km north of the town of Kurri Kurri, in the small suburb of Loxford, NSW within the Cessnock City Council local government area. The Proposal Site is almost completely devoid of native vegetation cover. Native vegetation is only present on the proposed electrical switchyard, stormwater basin and the Asset Protection Zone areas of the Proposal Site. The remnant vegetation within the proposed electrical switchyard area is classified as high or moderate bushfire risk. The land along the northern and western edges of the Proposal Site is located in buffer areas for nearby bushfire prone vegetation. The remainder of the Proposal Site is not classified as bushfire prone.

The Proposal Site experiences a warm temperate climate with warm and relatively wet summers and cooler and drier winters. Although the climate is relatively mild, days with maximum temperatures exceeding 40°C occur occasionally between the months of October and March, inclusive. The mild climate typically moderates fire weather conditions. The bushfire season generally runs between October and March, but may commence several months earlier under dry conditions. Highly elevated fire weather conditions may occur during this period, particularly on days with north-westerly or westerly winds, high temperatures and low humidity. Days with severe fire danger ratings or greater occur about eight times each year, on average. The frequency of such days is projected to increase in response to projected climate change over the operating life of the Proposal.

Fire is a regular feature of the landscape in which the Proposal is located. Two relatively large fires have burnt to the boundary of the former Kurri Kurri aluminium smelter within the last 20 years (the most recent in 2016-17).

Landscape bushfire risks in the Proposal's environs arise mainly from the large patch of bushfire prone vegetation (Coastal Swamp Oak Forest vegetation community) located to its north and west. Two main bushfire risk scenarios have been identified:

- *Scenario one:* A fire ignites in or burns into the native vegetation areas to north-west of the Proposal Site on a day of elevated fire danger, with strong north-westerly to westerly winds. Under such conditions, embers and smoke would carry towards/into the Proposal Site, and infrastructure and any persons present would be exposed to radiant heat from the fire burning in native vegetation. This scenario describes circumstances where bushfires would pose the greatest risk to the Proposal and personnel operating there.
- *Scenario two:* Electrical equipment failure or hot works result in fire ignition at the Proposal Site. Fire escapes into native vegetation to the west or north-west and then spreads under moderated fire weather conditions influenced by relatively humid southerly or easterly winds. While this scenario is considered to be unlikely, it provides the most plausible situation for a fire igniting due to activities conducted at the Proposal Site to escape into the surrounding landscape.

Should native vegetation in the vicinity of the Proposal Site be ignited in a bushfire, it could expose the generation and/or switchyard infrastructure of the Proposal to radiant heat, embers and smoke. The level of exposure to bushfire attack, referred to as the bushfire attack level (BAL), varies with distance from the vegetation. With the exception of the proposed switchyard and some other land in the north-east of the Proposal Site, most areas would be exposed to low levels (less than 12.5 W/m^2) of radiant heat in the event of a bushfire in nearby native vegetation.

Bushfire protection measures

Bushfire protection measures have been identified for construction and operational phases of the Proposal, based on guidance from *Planning for Bushfire Protection* (PBP). Adoption of the measures described here is expected to reduce, to an acceptable level, both the risk of bushfire ignition by construction and/or operation of the assets and the risk that bushfires in the landscape pose to the assets.

The main bushfire protection measures that have application to construction and operation of the Proposal are:

- *SFAZ:* areas of relatively high bushfire risk native vegetation to the north and west of the Proposal Site are managed by RFS under the Hunter Bush Fire Risk Management Plan as strategic fire advantage zones (SFAZ). Bushfire fuel hazard in these areas is actively maintained to reduce bushfire risk, as well as radiant heat and ember attack exposure. With reduced bushfire fuel hazard, the behaviour of any fire that becomes established is likely to be moderated.
- *APZ:* which provides a buffer zone between a bushfire hazard and buildings or other structures. Asset Protection Zones (APZs) are managed to minimise fuel loads and reduce radiant heat levels, flame, ember and smoke attack. They help to provide a space for firefighters and other emergency services personnel responding to a fire event and reduce opportunities for any fire igniting on site to escape to surrounding areas. A 10 m wide APZ is proposed to be established and maintained along the boundaries of the Proposal Site adjacent to woody vegetation.
- *Vegetation removal:* all vegetation (including grasses) is to be removed from the proposed switchyard to reduce opportunities for a fire entering the Proposal Site and for a fire being ignited by electrical infrastructure (e.g. explosive failure of transformer, arcing from a conductor) escaping from the Proposal Site. Woody vegetation is to be removed from the proposed APZ. The remainder of the Proposal Site is already largely free of vegetation and will be maintained that way.
- *Location of sensitive infrastructure:* buildings and other infrastructure with sensitivity to radiant heat exposure would be placed in areas within the site that would be exposed to less than a moderate bushfire attack level of BAL-19[1].
- *Hazardous materials:* it may be necessary during some construction stages to store diesel fuel and other potentially flammable materials on the Proposal Site. Furthermore, the Proposal includes the construction of two large diesel storage tanks to support operation if gas is unavailable. Storage of diesel and any other hazardous materials will follow environmental protection guidance and be located at parts of the Proposal Site with moderate radiant heat exposure (<BAL-19) in the event of a bushfire. Since the entire Proposal Site could be subject to ember attack, storage areas for any hazardous materials would be free of vegetation or any other combustible materials that could contribute to a fire ignition.
- *Access roads:* safe operational access is provided to and within the Proposal Site for emergency services personnel. Access roads will also provide for safe egress from the site by personnel in case of a bushfire or other emergency.
- *Fire water supply:* access to water for fire suppression and/or protection of structures or equipment located on the Proposal Site would be provided.

[1] BAL-19 corresponds to a radiant heat exposure of approximately 19 W/m^2

Hot works controls would be put in place during construction to reduce the risk of fire ignition posed by activities that produce sparks or involve heat sources. On any declared total fire ban (TOBAN) days during construction, any hot works would only be undertaken with prior approval from the RFS.

Emergency and evacuation planning typically forms part of bushfire protection measures. Emergency responses to bushfire would be addressed with other hazards as part of the operator's and construction contractor's site emergency management plans.

Potential environmental impacts of proposed bushfire protection measures

Potential environmental impacts of the proposed bushfire protection measures are largely confined to the clearing of native vegetation within parts of the Proposal Site and the proposed APZ (area of native vegetation to be cleared in the APZ would be approximately 0.39 ha) and the potential for erosion and sedimentation associated with construction of the proposed APZ access track.

1. Introduction

1.1 Proposal description

Snowy Hydro Limited (Snowy Hydro) ('the Proponent') proposes to develop a gas fired power station near Kurri Kurri, NSW ('the Proposal'). Snowy Hydro is seeking approval from the NSW Minister for Planning and Public Spaces under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Proposal.

The Proposal involves the construction and operation of a power station and electrical switchyard, together with other associated infrastructure. The power station would have a capacity of up to approximately 750 megawatts (MW), which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel fuel as back-up as required.

The Proposal would operate as a "peak load" generation facility supplying electricity at short notice when there is a requirement in the National Electricity Market. The major supporting infrastructure that is part of the Proposal would be a 132 kV electrical switchyard located within the Proposal Site. The Proposal would connect into existing 132 kV electricity transmission infrastructure located adjacent to the proposed switchyard. A new gas lateral pipeline and gas receiving station will also be required. This would be developed by a third party and subject to a separate environmental assessment and planning approval.

Other ancillary elements of the Proposal include:

- Storage tanks and other water management infrastructure
- Fire water storage and firefighting equipment such as hydrants and pumps
- Maintenance laydown areas
- Diesel fuel storage tank(s) and truck unloading facilities
- Stormwater basin
- Site access roads and car parking
- Office/administration, amenities, workshop/storage areas.

Construction activities are proposed to commence early 2022 and the Proposal is intended to be operational by the end of 2023. Further description of the Proposal is provided in Chapter 2 of the Environmental Impact Statement.

The Proposal Site forms part of the decommissioned Kurri Kurri aluminium smelter site which is owned by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro Aluminium). The Hydro Aluminium facility ceased operation in late 2012 and was permanently closed in 2014. Demolition and site remediation works on the Proposal Site are ongoing but are to be completed prior to construction of the Proposal.

The Kurri Kurri aluminium smelter site has been extensively remediated, with most of the above ground structures having been demolished, asbestos removed, and waste materials recycled. Stage 2 demolition works are currently underway and involve demolition of below ground infrastructure amongst other works.

On 16 December 2020 the Proposal was declared critical State significant infrastructure (SSI), and therefore is subject to assessment under Division 5-2 of the *Environmental Planning and Assessment Act 1979 Act* (EP&A Act).

1.2 Location

The Proposal Site is located at Loxford in the Hunter Valley region of New South Wales. It is approximately three km north of the town of Kurri Kurri, approximately 30 km west of Newcastle CBD and 125 km north of Sydney. The Proposal Site is located within the Cessnock City Council local government area (LGA) (see Figure 1.1).

1.3 Purpose of this report

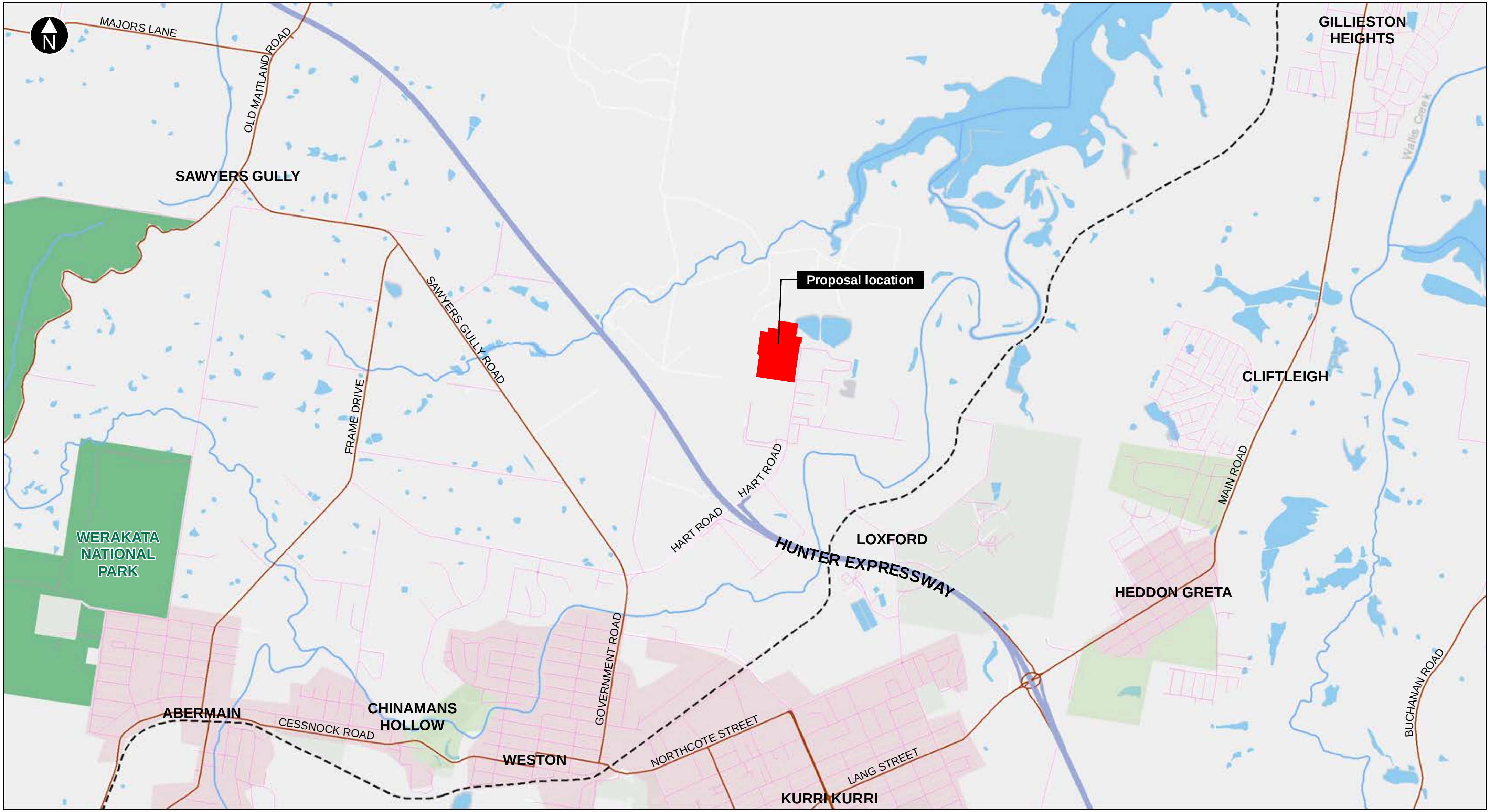
This technical report, the *Bushfire Assessment Report*, has been prepared in accordance with the draft Secretary's Environmental Assessment Requirements (SEARs) issued for the Proposal on 5 February 2021 by the Secretary of the NSW Department of Planning Industry and Environment.

The SEARs relevant to this bushfire risk assessment are presented in Table 1.1. This report contains the response to the bushfire component of the hazards and risks SEARs.

Table 1.1: Secretary's environmental assessment requirements – hazards and risks

SEARs	
Hazards and Risk	An assessment of bushfire risks in accordance with *Planning for Bushfire Protection 2019* (NSW RFS, 2019a)

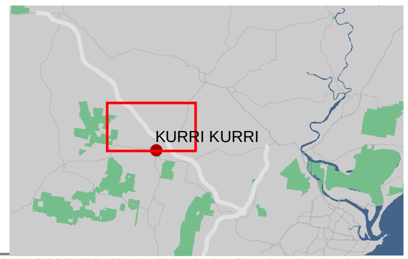
This report has been developed following guidance from the NSW Rural Fire Service (RFS), particularly *Planning for Bush Fire Protection* (PBP; RFS, 2019a). To the extent that they are applicable to the Proposal, the report also follows bushfire safety guidance developed by and for NSW electricity network operators.



Proposal location
National Parks and Wildlife Services estate / reserve
Recreation areas
Urban areas
Waterbodies
Motorway
Main roads
Roads
Railway

0 1 2 km

1:40,000 at A4
Coordinate System: GDA2020 MGA Zone 56



Data sources:
Jacobs
NSW Spatial Services

Figure 1-1 Proposal location (regional)

snowy hydro renewable energy Jacobs

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2. Legislative and policy requirements

Legislation applicable to the bushfire management of this Proposal is outlined in this section.

2.1 NSW legislation

2.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) restricts the granting of development consent on bushfire-prone land (BPL) unless the proposed development conforms with the requirements of *Planning for Bushfire Protection* (NSW RFS, 2019a; see section 2.2). Critical state significant infrastructure (such as this Proposal) does not require development consent under Part 4 of the Act and therefore is not subject to this requirement. However, the SEARs issued for this Proposal require an assessment of bushfire risk in accordance with Planning for Bushfire Protection.

Local government area Bush Fire Management Committees (BFMCs) maintain and update maps of BPL in their regions.

2.1.2 Rural Fires Act 1997

The objectives of the *Rural Fires Act 1997* are to prevent bushfires and protect people, built assets and natural assets from fire damage. The Act provides for the designation of Neighbourhood Safer Places, where people may find shelter from a bushfire. It also provides for the designation and maintenance of fire trails.

The Act states that it is the duty of public authorities, landowners, and occupiers to take all notified and practical steps to prevent bushfire ignition and minimise spread on their land. Trees that are reasonably necessary for protection of threatened species may be retained in fire breaks. Permits are required to light fires for bushfire fuel hazard reduction or to clear fire breaks. The Act reiterates that certain instruments under the EP&A Act, *National Parks and Wildlife Act 1974, Local Government Act 1993, Biodiversity Conservation Act 2016* and the *Local Land Services Act 2013* do not apply when responding to fire emergencies.

The Act declares the bushfire danger period to run from October to March (inclusive), which can be modified by the NSW Rural Fire Service (RFS). Total fire bans (TOBANs) may be issued by the Minister in the interests of public safety.

2.1.3 Work Health and Safety Act 2011

The Commonwealth *Work Health and Safety Act 2011* (and state-based legislation, the NSW *Work Health and Safety Act 2011*) provides a national framework for protection of the health and safety of people at work, and those who may be affected by such work. Under the Act, persons conducting a business or undertaking have the primary responsibility to ensure (so far as reasonably practicable) the safety of workers, and the general public, at a workplace. This includes ensuring, so far as reasonably practicable, the safety of workers and the general public from bushfire-related risks during construction works for the Proposal and its operation.

2.2 NSW guidelines

2.2.1 Planning for Bush Fire Protection

The SEARs (as per Table 1.1) mandate that this bushfire assessment follows *Planning for Bushfire Protection 2019* (NSW Rural Fire Service, 2019) (PBP). PBP seeks to provide for human safety (including of fire responders) during bushfire events and to minimise the effects of bushfires on property; while considering development potential, site characteristics and environmental protection. Achievement of these objectives is underpinned by several principles:

- Control the types of development permissible in bushfire prone areas
- Minimise the impact of radiant heat and direct flame contact by separating development from bushfire hazards
- Minimise the vulnerability of buildings to ignition and fire spread from flames, radiation and embers
- Enable appropriate access and egress for the public and firefighters
- Provide adequate water supplies for bushfire suppression operations
- Focus on property preparedness, including emergency planning and property maintenance requirements
- Facilitate the maintenance of APZs, fire trails, access for firefighting and on-site equipment for fire suppression.

2.2.2 Guide for Bush Fire Prone Land Mapping

The identification of Bushfire prone land (BPL) in NSW is required under the EP&A Act, including a requirement for and guidance for the preparation of a bush fire prone land map identifying vegetation within LGAs that has the potential to support a bush fire. The bush fire prone land map is the trigger for the consideration of bush fire protection measures for new development (*Planning for Bush Fire Protection* (RFS, 2019) and Australian Standard 3959-2009 – *Construction of buildings in bush fire prone areas*). Guidance for identification and mapping of BPL is provided in the *Guide for Bush Fire Prone Land Mapping* (NSW Rural Fire Service, 2015).

The *Guide for Bush Fire Prone Land Mapping*, in conjunction with *Planning for Bush Fire Protection*, is designed to identify if an area can support a bushfire or is subject to bushfire attack based on the presence and type of vegetation fuel sources. It is the responsibility of local government area/rural fire district-based BFMCs. BPL mapping is typically published by the respective BFMC and the maps and metadata are developed according to guidance provided by NSW RFS (2015). BPL mapping for the state is available from the NSW Government data portal, www.data.nsw.gov.au.

BPL assessments are based on allocation of the vegetation present into one of four categories, as follows:

- *Category 1:* which includes areas of forest, woodland, heath, forested wetland and timber plantation. Highest risk category.
- *Category 2:* rainforests and “lower risk vegetation parcels”. These parcels contain remnant vegetation that is limited in its connectivity to larger areas and land parcels with land management practices that actively reduce bushfire risk (and are subject to a bushfire plan or similar). Category 2 vegetation has lower bushfire risk than category 1 and 3 vegetation.
- *Category 3:* which includes grasslands, freshwater wetlands, semi-arid woodlands, alpine complex and arid shrublands. Moderate risk category.
- *Exclusion:* Areas of vegetation less than 1 ha and greater than 100 m separation from category 1, 2 or 3 vegetation; small patches or strips of remnant vegetation; managed grasslands; agricultural cropland; gardens; and mangroves are not mapped as bushfire prone.

BPL is defined as land with category 1, 2 or 3 vegetation and land within 100 m of category 1 or within 30 m of category 2 or 3 vegetation. BPL mapping for the Proposal Site is discussed further in Section 3.1.

3. Bushfire risk factors

3.1 Regional context

The Proposal Site is located approximately three km north of the town of Kurri Kurri in a small suburb called Loxford, within the Cessnock City Council local government area. It is situated approximately 30 km west of Newcastle CBD and 125 km north of Sydney. The Proposal Site was previously occupied by the Kurri Kurri aluminium smelter.

Except for two small areas within the proposed location of the electrical switchyard, the entire Proposal Site has been cleared of native vegetation. Parts of the proposed electrical switchyard (Figure 3.1) includes land that is currently classified as high and moderate bushfire risk (BPL categories 1 and 3, respectively). The northern and western edges of the Proposal Site are located within buffer areas for category 1 and 3 vegetation, with the remainder of the Proposal Site not classified as bushfire prone.

Landscape bushfire risks to the Proposal arise mainly from the large patch of bushfire prone vegetation (Coastal Swamp Oak Forest vegetation community) located to its north and west. Smaller fragments of this vegetation community are also located to the east of the Proposal Site.

3.2 Current bushfire management arrangements

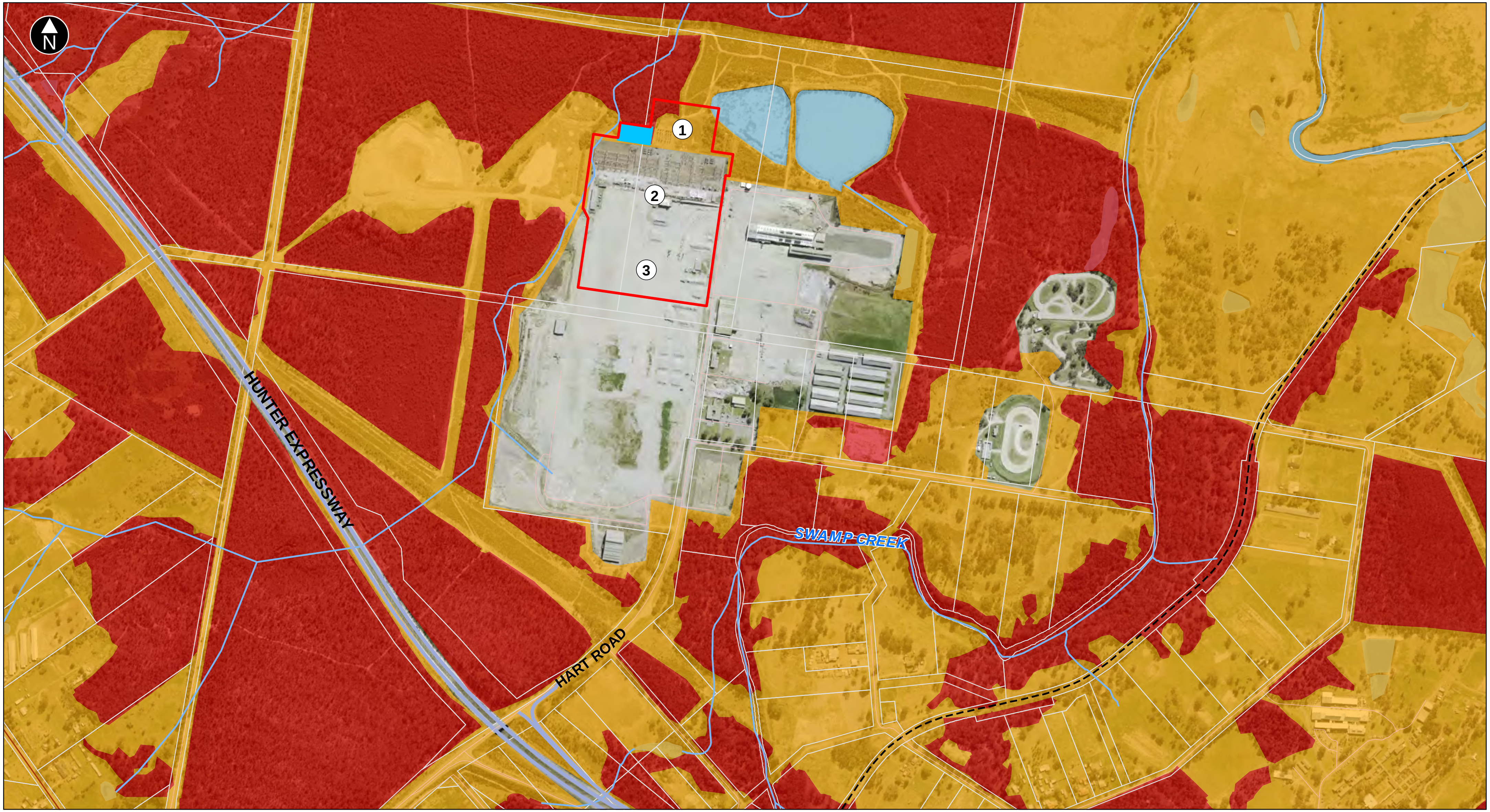
Bushfire management arrangements for the region in which the Proposal is located are described in the Hunter BFMC's Bush Fire Risk Management Plan (BFRMP; Hunter BFMC, 2009) for Cessnock and Maitland local government areas. The Plan seeks to:

- Reduce the number of human-induced bushfire ignitions that cause damage to life, property and the environment
- Manage fuel to reduce the rate of spread and intensity of bushfires, while minimising environmental/ ecological impacts
- Reduce the community's vulnerability to bushfires by improving its preparedness
- Effectively contain fires with a potential to cause damage to life, property and the environment.

The Hunter BFRMP identified the former Kurri Kurri aluminium smelter (within which the Proposal is located) as a priority 1C (extreme risk) area and specified several risk mitigation strategies, including hazard reduction and property planning. The former Kurri Kurri aluminium smelter site is set within an APZ and is surrounded by a Strategic Fire Advantage Zone (SFAZ) that extends over the surrounding native vegetation and grassland.

APZ are intended to protect human life, property and highly valued public assets and values and are developed to enable the safe use of direct attack suppression strategies. SFAZ seek to provide strategic areas that will reduce the speed and intensity of bushfires, reduce the potential for spot fire development and contain fires within management boundaries. They are managed to provide for parallel and/or indirect suppression strategies under elevated fire weather conditions. Bushfire fuel hazard within the SFAZ is intended to be maintained below high (Hunter BFMC, 2009).

The wider surrounding area around the Proposal Site is relatively well-served by fire response services. The nearest Fire and Rescue NSW station is located at Lang Lang St, Kurri Kurri, approximately four km to the south of the Proposal Site. NSW RFS have a control centre at East Maitland, approximately eight km from the Proposal Site and at Cameron Park, 20 km from the Proposal Site.

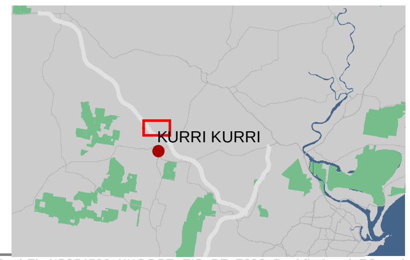


Proposal site
Detention basin
Motorway
Main roads
Roads
Railway
Waterbodies
Cadastre
Category 1: High bushfire risk
Category 3: Moderate bushfire risk

1 Proposed Switchyard Area
2 Proposed Plant Area
3 Proposed Buffer Area

0 250 500 m

1:12,000 at A4
Coordinate System: GDA2020 MGA Zone 56



Data sources:
Jacobs 2020
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 3-1 Bushfire prone land mapping

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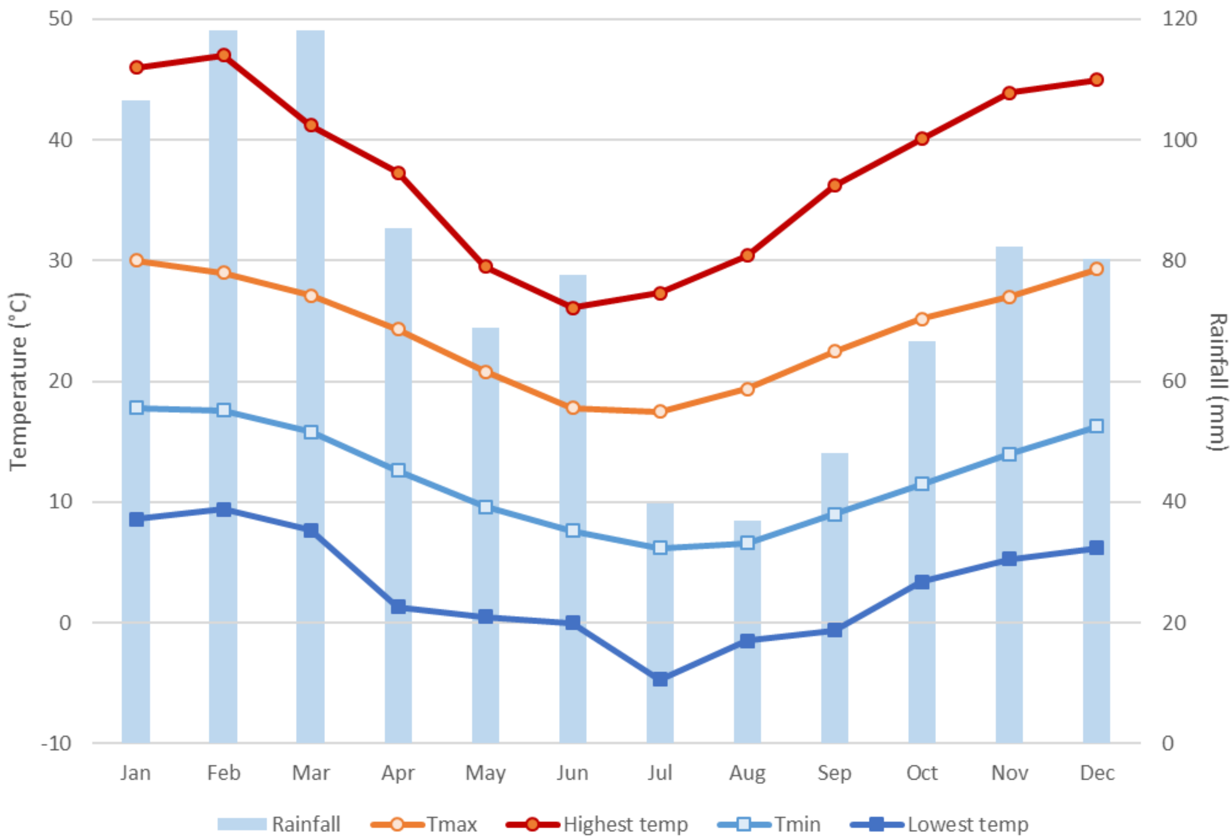
snowy hydro renewable energy
Jacobs

3.3 Bushfire weather

3.3.1 Historical bushfire weather

The Proposal Site experiences a warm temperate climate. Summers are warm and relatively wet and winters are cooler and relatively dry (Figure 3.2). Average daily maximum temperatures range between 18°C in July and 30°C in January[2]. Temperatures in excess of 40°C have been recorded in the months between October and March. The hottest recorded temperature is 47.0°C (February 2017). Average minimum temperatures range between 6.2°C in July and 17.8°C in January. Freezing conditions have been recorded between June and September, with the lowest recorded temperature being -4.7°C (July 1970).

The estimated average annual rainfall is 931 mm. Annual rainfall (1967-2020) has ranged between 483 mm (1980) and 1350 mm (1988). The highest recorded daily rainfall total is 243 mm (April 2015). Over 60 per cent of the yearly rainfall occurs during the warm season months of October-March.



Data from: Bureau of Meteorology station 061250 Paterson (Tocal AWS). Records 1967-2020.

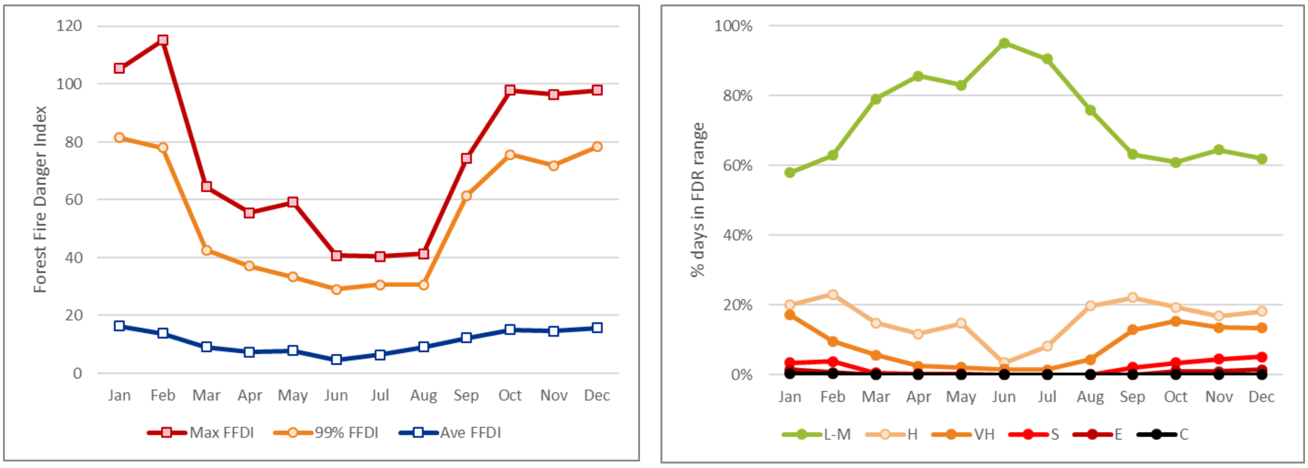
Figure 3.2: Average monthly rainfall, average daily maximum (Tmax) and minimum (Tmin) temperatures, maximum (Highest temp) and minimum (Lowest temp) recorded temperatures.

Average monthly fire danger ratings (FDR) are in the low to moderate range between March and September (Forest Fire Danger Index (FFDI) ≤12) and high throughout the remainder of the year (Figure 3.3). Days of very high FDR or greater (FFDI ≥25) may occur in any month. Days with catastrophic fire danger (FFDI>100) have been recorded in January and February (only once in each month). Days in the extreme fire danger range (FFDI 75-100) have been recorded in each month between October and February.

[2] Meteorological records are based on Bureau of Meteorology station 061250 Paterson (Tocal AWS) for the period 1967-2020. This weather station is located approximately 23 km from Kurri Kurri. Meteorological stations at Cessnock and Maitland are closer than Paterson, but have shorter lengths of record, particularly for temperature.

Total Fire Bans (TOBANs) are declared by the NSW RFS. During TOBANs, potential human sources of ignition are prohibited or restricted to reduce the risk of bushfires igniting during or (rarely) immediately preceding a period of dangerous fire weather. FDR on TOBAN days is typically very high or greater.

The bushfire season generally runs between October and March (Hunter BFMC, 2009). Days with north-westerly winds, high daytime temperatures and low humidity are most commonly associated with dangerous fire weather conditions in Hunter BFMC region. Dry lightning storms are common in the mountains in the west of the region during the bushfire season.



a) Monthly values of maximum FFDI, 99th percentile of daily maximum FFDI and average daily FFDI.

b) Percentage of days with maximum daily FFDI in each fire danger rating scale (low-moderate: L-M; high: H; very high: VH; severe: S; extreme: E; catastrophic: C)

Figure 3.3: Estimated forest fire danger index (FFDI) and fire danger rating (FDR) values for Paterson (Tocal AWS; 061250), based on records for 2004-2019.

3.3.2 Climate change projections for bushfire

The Proposal is anticipated to have a service life of approximately 30 years (but could be extended) and should therefore be resilient to fire weather and other climatic conditions in the 2050s. Climate projections indicate bushfire weather in the region is very likely to become harsher over the coming decades (Dowdy *et al.*, 2015).

Climate projections for 2050 were generated for the Proposal Site, based on the mean model results for all CMIP5[3] models with projections for wind speed, relative humidity, daily rainfall and maximum temperature for RCP8.5[4] (high emissions scenario); as made available through SimCLIM[5]. Change factors to 2050 for each of these weather parameters were applied to the 2003-2019 data for BoM station 061250 (Paterson – Tocal AWS), as (humidity and windspeed) data for the standard baseline (1986-2005) were not available for this location.

3 CMIP5: Coupled Model Intercomparison Project Phase 5. This refers to the collaborative framework resulting in a collection of models for climate change. They were used in the International Panel on Climate Change's (IPCC's) Fifth Assessment Report. CMIP5 is the most recent phase of the CMIP project at the time of writing.

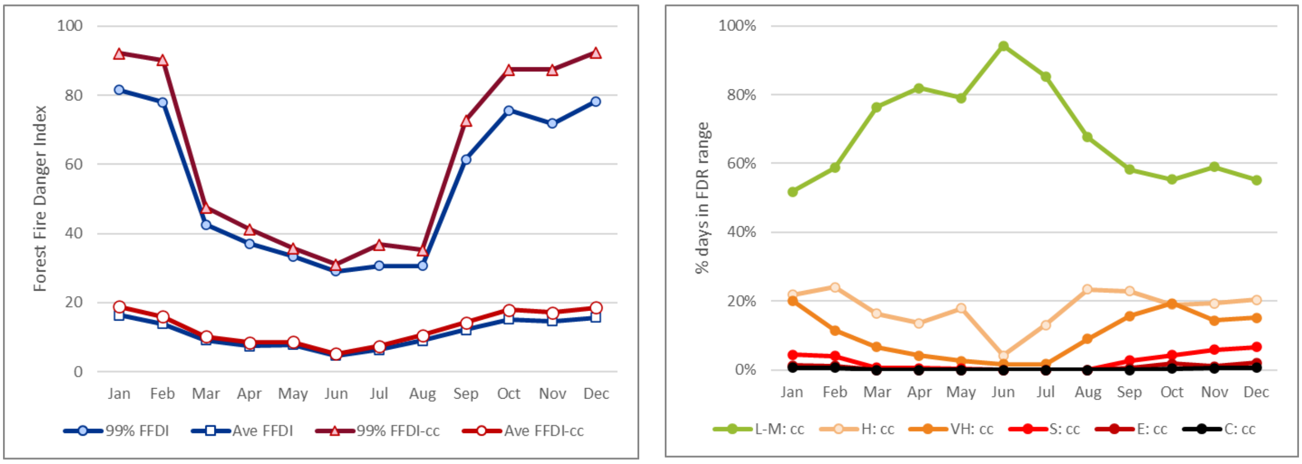
4 Population and economic growth, technological change including reliance on fossil fuels, and political and social changes will all have substantial effects on greenhouse gas emissions and accumulation in the atmosphere. To account for this uncertainty, the Intergovernmental Panel on Climate Change (IPCC) developed four Representative Concentration Pathways (RCPs) to illustrate four different scenarios for global human activity and development over the coming century, and the resulting effect on global climate. The four RCPs are distillations of a large volume of future scenarios discussed in the scientific literature, chosen by a multi-disciplinary team of experts to form the basis of the Fifth Assessment Report (IPCC, 2014). RCP8.5 represents a scenario in which emissions continue to rise rapidly through most of the century. This is driven by continued population and economic growth, without a transition to low-carbon technologies (business as usual).

5 https://www. https://www.climsystems.com/

Climate models suggest that the main projected changes in climate for the region under the RCP8.5 scenario are for:

- Increased temperature: temperatures are projected to increase throughout the year, with annual average maximum temperatures approximately 1.7°C warmer by 2050
- Decreased cool season rainfall: summer rainfall is projected to increase slightly, and cool season rainfall is projected to decline slightly. With warmer conditions, bushfire fuel availability is expected to be slightly greater at the commencement of the fire danger period than is currently the case
- Decreased relative humidity: changes in relative humidity can be expected due to increased temperatures and small changes in the seasonality of rainfall. Relative humidity is projected to decrease through most of the year, particularly during spring
- Small changes to wind: average wind speeds are projected to increase slightly through much of the fire season.

Combined, these projections indicate that bushfire weather will become harsher. Average FDR is projected to increase slightly (Figure 3.4, Table 3.1). Days with dangerous fire weather conditions are projected to become more frequent and occur through more months of the year. Days with severe FDR are projected to occur between September and May by about 2050 under the high emissions RCP8.5 scenario. Catastrophic fire weather conditions could occur between October and February, compared with only January and February historically.



a) Monthly values of 99th percentile of daily maximum FFDI and average daily FFDI – historically (blue) and projected for 2050 under RCP8.5 (red).

b) Percentage of days with maximum daily FFDI in each FDR scale (low-moderate: L-M; high: H; very high: VH; severe: S; extreme: E; catastrophic: C) projected for 2050 under RCP8.5

Figure 3.4: Estimated forest fire danger index (FFDI) and fire danger rating (FDR) values for Paterson (Tocal AWS; 061250), based on records for 2004-2019 and climate change projections for 2050 RCP8.5.

Table 3.1: Fire danger index, indicative fire behaviour and average occurrence at the Proposal Site

FDR	Fire behaviour guidance	Average number of days/y	
		Current	2050
Low-moderate FDI<12	There is some potential for fires and those that occur will normally stop (meteorological conditions allowing) at roads, tracks and watercourses. Fires that occur can generally be extinguished by the use of hand operated water sprays and fire beaters.	268 (74%)	251 (69%)
High FDI 12-24	Fires are capable of spreading rapidly, particularly in the absence of preventative measures and may require additional work effort to be extinguished.	58 (16%)	65 (18%)
Very high FDI 25-50	Fires are capable of spreading rapidly, with or without preventative measures. Fire containment may require significant effort and the use of earthmoving equipment and/or backburning.	30 (8%)	37 (10%)
Severe FDI 51-74	Fires are capable of being uncontrollable, unpredictable and extremely fast moving. They will NOT be contained without extensive effort on established fire lines with adequate personnel and equipment (this may include water bombing aircraft).	6.9 (1.9%)	8.9 (2.4%)
Extreme FDI 75-100		1.6 (0.4%)	2.3 (0.6%)
Catastrophic FDI>100	Fires are capable of being uncontrollable, unpredictable, and extremely fast moving, and will NOT be contained without extensive effort on very large established fire trails with extensive personnel and equipment (this will include water bombing aircraft).	0.1 (0.03%)	0.8 (0.2%)

3.4 Topography

The Proposal Site was extensively disturbed during construction of the former Kurri Kurri aluminium smelter. The site is primarily flat with an elevation of approximately 14m AHD. Land to the north and east comprises low-lying and largely flat land that supports patches of native vegetation and farming land. It includes the waterways of Swamp Creek, Black Waterholes Creek and the Swamp Creek wetlands, which drain to the Wentworth swamps and are part of the Hunter River floodplain. Land outside the Proposal Site gradually slopes (and drains) to the north-east, towards Black Waterholes Creek.

3.5 Vegetation and land uses

The Proposal Site is adjacent to bushfire prone vegetation to its north and west and (currently) includes a small area of native vegetation. Most native vegetation in the vicinity of the Proposal Site is Category 1 high bushfire risk vegetation (Figure 3.1) and comprises the vegetation communities listed in Table 3.2. Bushfire hazard is primarily provided by the Parramatta Red Gum vegetation community.

In addition to the areas of native vegetation that surround the Proposal Site, the area has rural residential, agricultural and industrial land in the vicinity. The nearest residential area is Kurri Kurri, located approximately three km south and south-west of the Proposal Site.

Transmission line corridors in the vicinity of the Proposal Site are regularly maintained to reduce the hazard posed by woody vegetation. These areas support grasses, sedges and low woody shrubs. Land to the north east of the Proposal Site (~one km away) is used for farming and supports grasses and scattered patches of remnant native vegetation.

Table 3.2: Plant community types (PCT) of the bushfire study area

PCT	Plant community type description	Keith vegetation classification
1633	Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Dry Sclerophyll Forests
1737	Typha rushland	Freshwater Wetlands

Source: Jacobs (2021) Kurri Kurri OCGT Development - Biodiversity Development Assessment Report

3.6 Fire history and ignition sources

According to the Hunter BFRMP, the main ignition sources in the landscape surrounding the Proposal Site are:

- Arson – most common around townships, roads and trails; in grassy areas (which are more accessible than forests) and during school holidays
- Escaped planned burns
- Illegal burning activities
- Arcing distribution power lines
- Motor vehicles.

The Hunter bushfire management area (Cessnock and Maitland local government areas) records, on average, approximately 200 bushfires per year. About five of these develop into major fires each year, on average. Larger and more damaging fires in the region typically travel in an easterly direction under the influence of north-westerly or westerly winds. In some circumstances, strong southerly and/or easterly wind changes may intensify fire events.

The fire history in the area surrounding the Proposal Site is shown in Figure 3.5[6]. The larger bushfires occurred in the 2002-03 and 2016-17 seasons. These burnt from the north-west towards the south-east and affected bushland and adjacent rural land areas. They burnt to the boundary of the former Kurri Kurri aluminium smelter site. The 2002-03 bushfire burned through area of the proposed switchyard at the northern end of the Proposal Site. There are also anecdotal reports of other smaller fires in the area around the Proposal Site that are not included in NSW fire history data sets.

3.7 Key bushfire risk scenarios

The key bushfire scenarios that may affect the Proposal are:

- *Scenario one:* A fire ignites in or burns into the native vegetation areas to north-west of the Proposal Site on a day of elevated fire danger, with strong north-westerly to westerly winds. Under such conditions, embers and smoke would carry towards/into the Proposal Site and infrastructure and any persons present would be exposed to radiant heat from the fire burning in native vegetation.

  This scenario describes circumstances where bushfires would pose the greatest risk to the Proposal and personnel operating there. It includes the most severe fire weather conditions and describes circumstances where a bushfire would be burning through the areas with the greatest accumulation of bushfire fuels. Under such conditions, a bushfire could burn in high bushfire risk vegetation almost to the boundary of the Proposal Site.

  This scenario reflects the two main fires depicted in Figure 3.5 and, based on these experiences, might be expected to occur once every 10-20 years, not accounting for the influence of climate change.

[6] The fire history is based on fire scar information published on data.nsw.gov,au. This data set does not necessarily capture the full extent of every fire or all of the smaller fires that have been experienced historically at a particular location.

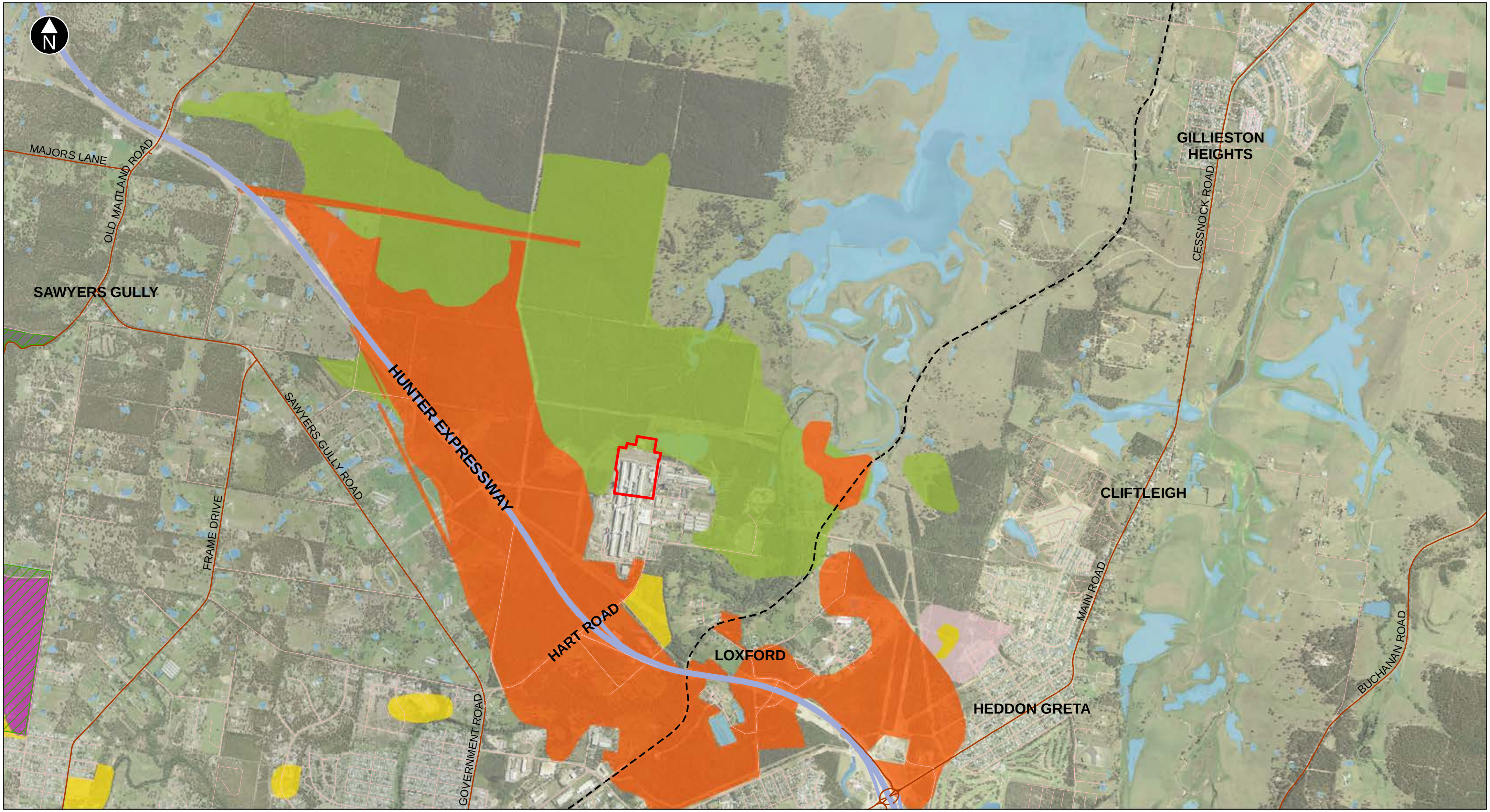
- *Scenario two:* Electrical equipment failure (most likely explosive failure of a transformer) or hot works result in fire ignition at the Proposal Site. Fire escapes into native vegetation to the west or north west and then spreads under moderated fire weather conditions influenced by relatively humid southerly or easterly winds.

  Given the anticipated separation between the Proposal and bushfire prone vegetation, this scenario is considered to be unlikely. However, it is the scenario that provides the most likely situation for a fire igniting due to activities conducted at the Proposal Site to escape into the surrounding landscape.

3.8 Bushfire attack level exposure

Should native vegetation in the vicinity of the Proposal Site be ignited in a bushfire, it would potentially expose the generation and/or switchyard infrastructure to radiant heat and embers. The level of exposure to bushfire attack (the bushfire attack level (BAL) calculated using AS3959:2018 *Construction of building in bushfire prone areas;* Standard Australia, 2018) is depicted in Figure 3.6. The BAL for the Proposal is calculated assuming a 10 m APZ. Point A is a proposed location for a standpipe for fire water supplies. The standpipe would be located on the fire access track constructed for the APZ surrounding the Proposal.

Radiant heat exposure (and ember attack) above BAL-19 is likely to threaten the integrity of conventional buildings (RFS, 2019a). The proposed switchyard area and the north-east corner of the main generation facility within the Proposal Site are the only significant areas with exposure to radiant heat at this level. Under the influence of north-westerly to westerly winds on a day with elevated fire weather conditions, much of the Proposal Site could also be exposed to ember attack generated by fire in the nearby native vegetation.



Proposal site
NPWS estate / reserve
Motorway
Main roads
Roads
Railway
Waterbodies
1995-96 Wildfire
1997-98 Wildfire
2001-02 Wildfire
2002-03 Wildfire
2006-07 Wildfire
2016-17 Wildfire

0 500 1000 m

1:40,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs 2020
NearMap 2020
NSW Spatial Services

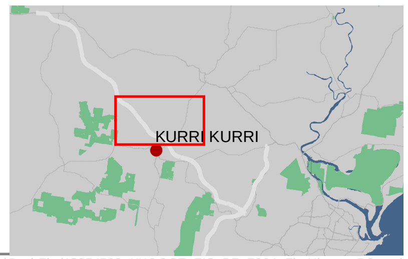


Figure 3-5 Fire history

snowyhydro renewable energy Jacobs

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Created by : AA | QA by : KI

Proposal Site	Motorway	BAL		BAL-29	① Proposed Switchyard Area		
Detention basin	Roads	Flame zone		BAL-19	② Proposed Plant Area		
Asset protection zone	Railway	BAL-40		BAL-12.5	③ Proposed Buffer Area		
	Waterbodies			Bushfire prone vegetation			
	Cadastre						

0 250 500 m

1:10,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs 2020
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 3-6 Bushfire attack level exposure from bushfire prone vegetation in the vicinity of the Proposal Site

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Created by : AA | QA by : KI

4. Bushfire protection measures

Bushfire protection measures have been developed for the construction and operational phases of the Proposal, based on guidance from PBP (RFS, 2019a). Adoption of the measures described here is expected to reduce, to an acceptable level, both the risk of bushfire ignition by construction and/or operation of the assets and the risk that bushfires in the landscape pose to the assets.

The main bushfire protection measures (mostly from PBP) that have application to construction and operation of the Proposal are:

- *SFAZ:* areas of relatively high bushfire risk native vegetation to the north and west of the Proposal Site are managed by RFS under the Hunter BRMP as strategic fire advantage zones. Bushfire fuel hazard in these areas is actively maintained (including by planned burning) to reduce bushfire risk, as well as radiant heat and ember attack exposure. With reduced bushfire fuel hazard, the behaviour of any fire that becomes established is likely to be moderated.
- *APZ:* which provide a buffer zone between a bushfire hazard and buildings or other structures. APZ are managed to minimise fuel loads and reduce radiant heat levels, flame, ember and smoke attack. They help to provide a defendable space for firefighters and other emergency services personnel responding to a fire event and reduce opportunities for any fire igniting on site to escape to surrounding areas. A 10 m wide APZ is proposed to be established and maintained along the perimeter of the Proposal Site in areas where there is an interface with bushfire prone vegetation.
- *Vegetation removal:* all vegetation (including grasses) is to be removed from the proposed switchyard to reduce opportunities for a fire entering the site and for a fire being ignited by electrical infrastructure (e.g. explosive failure of transformer, arcing from a conductor) escaping from the site. Woody vegetation is to be removed from the Proposal's proposed APZ.
- *Location of sensitive infrastructure:* buildings and other infrastructure and any hazardous material storage areas with sensitivity to radiant heat exposure will generally be placed in areas within the site that would be exposed to less than BAL-19.
- *Access roads:* which provide safe operational access to and within the Proposal Site for emergency services personnel. Access roads will also provide safe egress for site personnel in case of a bushfire or other emergency.
- *Fire water supply:* access to water for fire suppression and/or protection of structures or equipment located on the Proposal Site will be provided.

Emergency and evacuation planning typically forms part of bushfire protection measures. Emergency responses to bushfire would be addressed with other hazards as part of the operator's site emergency management plan. These bushfire protection measures should be incorporated into the Proposal's Hazard Management Plan.

4.1 Bushfire protection measures during operation

4.1.1 Strategic Fire Advantage Zone

The Hunter BFRMP (Hunter BFMC, 2009) identifies a SFAZ around the former Kurri Kurri aluminium smelter (Figure 4.1). The SFAZ includes areas of native vegetation and cleared land that surround the Proposal Site. Bushfire fuel hazard in these areas is actively maintained (by RFS) by periodic hazard reduction burning in the larger blocks of native vegetation. This is designed to moderate fire behaviour and reduce the risks posed to people and infrastructure by radiant heat and embers.

It is assumed that given the significance of the Proposal's plant to the region and state, that the SFAZ will be maintained in future iterations of the BFRMP and that the RFS will continue to undertake periodic hazard reduction burning.

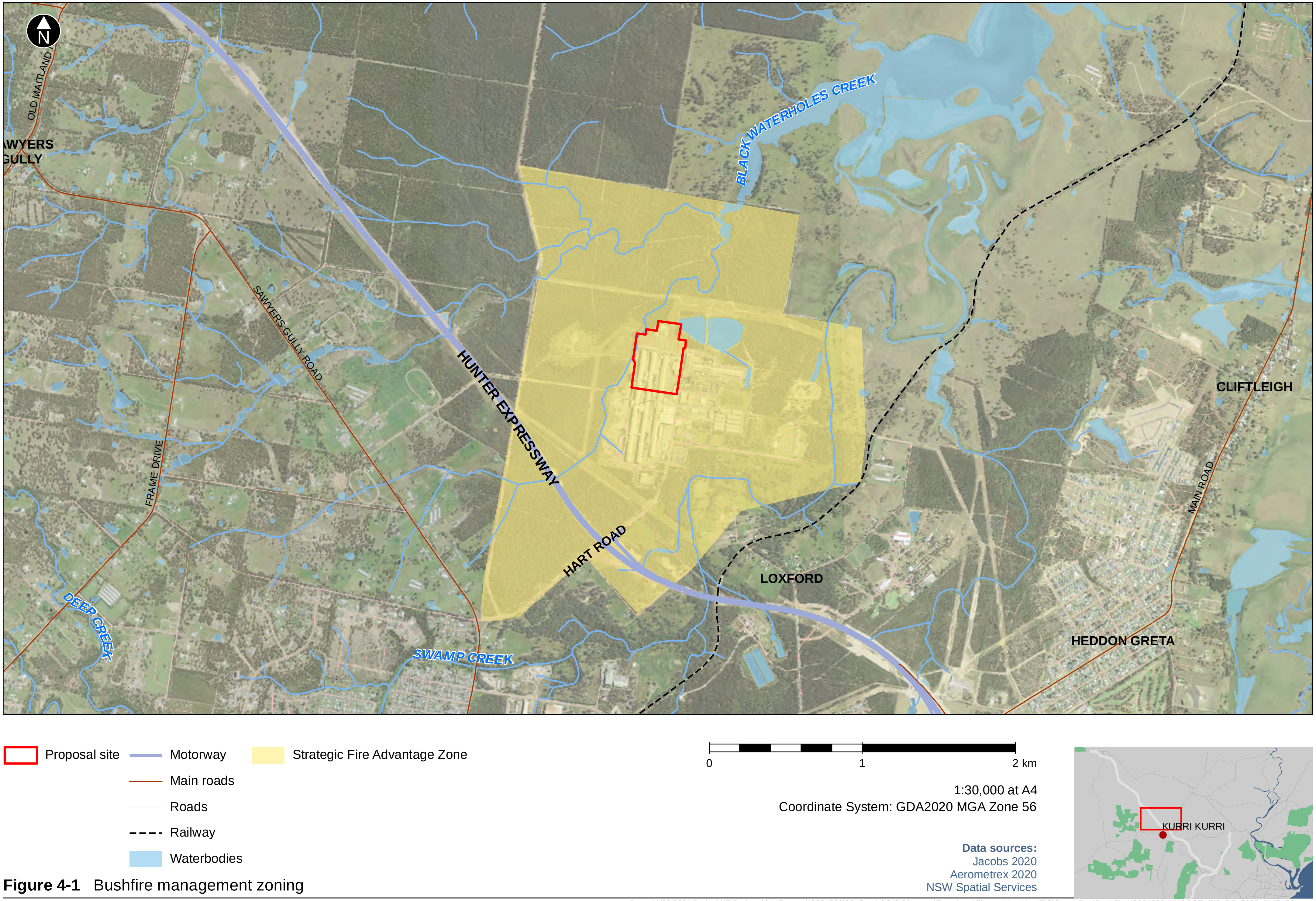


Figure 4-1 Bushfire management zoning

snowyhydro renewable energy Jacobs

4.1.2 Asset Protection Zone

APZ provide a low fuel hazard buffer between buildings (or other structures) and a bushfire hazard. They create a space to help manage the flame, radiant heat and ember exposure of the structures and any emergency service personnel or other persons in place. They typically require the removal of native overstorey vegetation and regular maintenance of the grasses, sedges or low shrubs that form the understorey.

A 10 m APZ is proposed for parts of the Proposal Site that interface with retained native vegetation, as per Figure 4.2. This is consistent with:

- *ISSC3 Guide for the management of vegetation in the vicinity of electricity assets (*Industry Safety Steering Committee [ISSC], 2016) specifications for APZ for substations/switchyards).'
- PBP 2019 specifications for renewable energy generation facilities[7].

The APZ will either not be developed or will be reduced to 2-3 m in parts of the Proposal Site that are less directly exposed to bushfire prone vegetation (see Figure 4.2).

The APZ would be cleared of native vegetation if the Proposal is approved. Only small areas of native vegetation (0.39 ha[8]) would be cleared to establish the APZ (Figure 4.2). It is proposed that an access track be constructed within part of the APZ to provide access for fire-fighting vehicles to bushfire-prone parts of the Proposal Site that currently do not have a formed track. The APZ is proposed to be constructed outside the Proposal Site's boundary fence to ensure fire response vehicles and personnel are separated from electrical infrastructure within the Proposal Site and (particularly) the electrical switchyard area.

It is recommended that all vegetation present within the APZ be kept to a maximum height of approximately 10 cm when cured and approximately 20 cm at all other times. Periodic mowing/slashing is expected to maintain this standard.

4.1.3 Vegetation removal

In addition to the removal of any trees/tall shrubs from within the APZ, vegetation would also be removed from within the Proposal Site during construction. This would comprise the clearing of a further 1.15 ha of native vegetation for construction of the Proposal and electrical safety purposes. It would reduce the risk of landscape fire spreading into the Proposal (e.g. from embers landing within it) as well as the risk of a fire igniting within it.

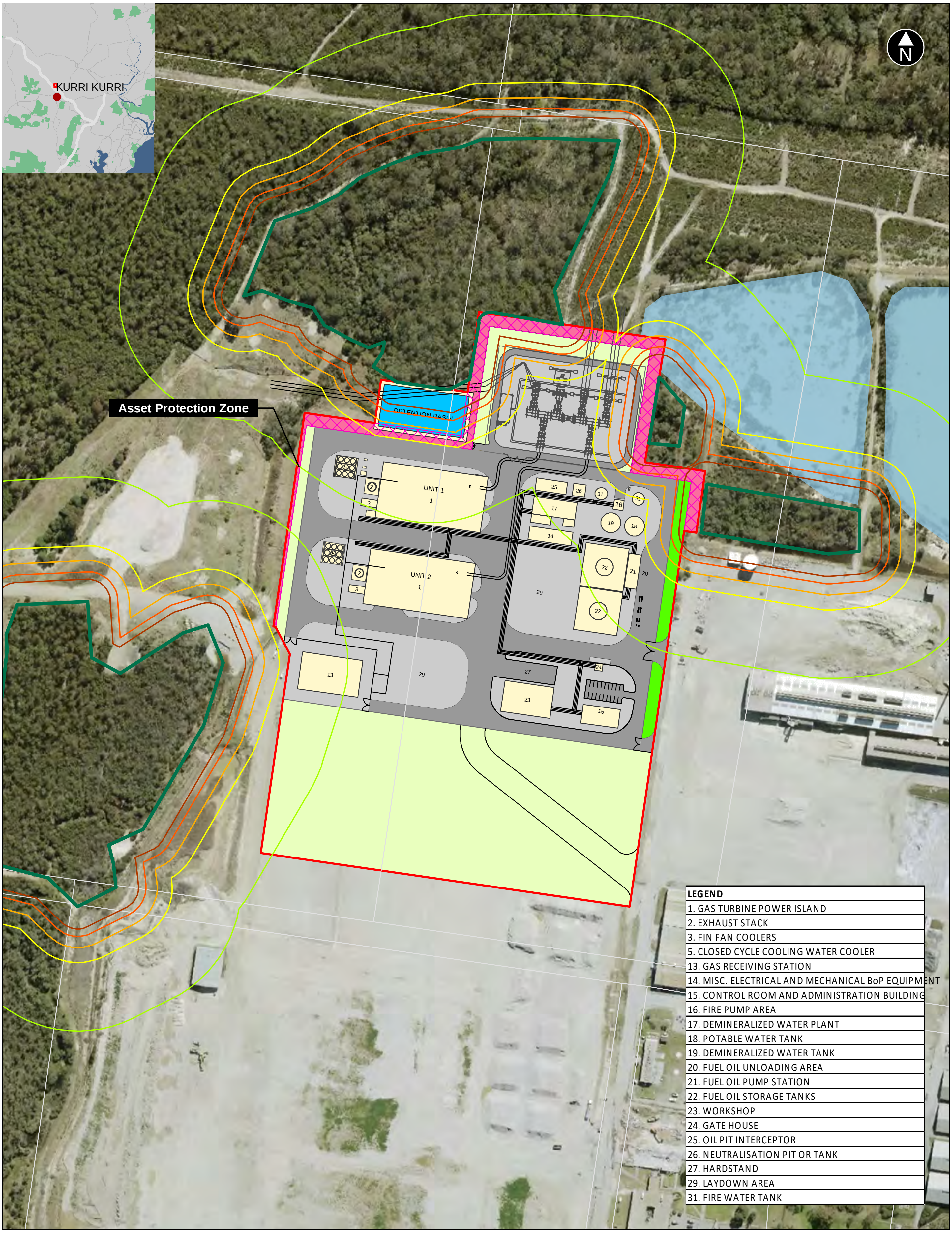
The entire area Proposal Site (with the exception of a narrow landscaping buffer adjacent to Hart Road) would be maintained free of woody vegetation. Consistent with industry practice, the plant area and switchyard area would be maintained free of all forms of vegetation. This would help to prevent embers from a landscape fire causing an ignition, and also minimise the risk of any fire from the Proposal escaping into the surrounding landscape.

4.1.4 Location of sensitive buildings and infrastructure

The majority of the Proposal Site is not expected to be exposed to radiant heat from a bushfire of more than 12.5 W/m^2 (BAL-12.5; Figure 4.2). Allowing for the proposed external APZ, a relatively small part of the Proposal Site is potentially exposed to radiant heat levels above BAL-19. More than half of the proposed switchyard area has potential radiant heat exposure of BAL-19 or more.

To mitigate the risk posed by radiant heat, any sensitive elements of the Proposal will generally be located outside areas with potential exposure exceeding BAL-19.

[7] As noted above, PBP does not specify APZ width for new gas fired (non-renewable) electrical power plants.
[8] Note that the remaining area proposed to be cleared is located within the proposed switchyard area



Proposal Site
Asset protection zone
Waterbodies

BAL
Flame zone
BAL-40
BAL-29
BAL-19
BAL-12.5

Bushfire prone vegetation

0 100 200 m

1:4,000 at A4
GDA2020 MGA Zone 56

Data sources:
Jacobs
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 4-2 Proposal layout in relation to potential bushfire attack level/radiant heat exposure

snowy hydro renewable energy
Jacobs

Date: 25/03/2021
Projects\04_Eastern\IS354500\22_Spatial\GIS\Directory\Templates\Figures\KurriKurriEIS\Specialists\BushFire\IS354500_KKOCGT_EIS_BF_F006_ProjectLayout_R2.mxd

4.1.5 Hazardous materials

The Proposal has been designed to operate using diesel fuel if gas is unavailable. It will therefore be necessary to construct diesel storage tanks on the Proposal Site. Two of these are to be constructed, as shown in Figure 4.2. These will be located in parts of the Proposal Site with potential radiant heat exposure (BAL) of 12.5-19 W/m^2. These diesel storage tanks would be constructed in line with environmental protection guidance and not have features that allow for the accumulation of embers or bushfire fuels that could ignite under ember attack.

The sensitivity of the diesel storage tanks to radiant heat exposure will be confirmed during detailed design. If the potential level of exposure is severe enough that could result in the diesel igniting or be at risk of other damage, risk mitigations will need to be deployed (e.g. potentially including sprinklers to cool the tanks in case of fire). Areas around the tanks will also be kept free of vegetation or any other combustible materials that could contribute to a fire ignition. Any fuel spills would be remediated to ensure that they cannot be a source of ignition.

4.1.6 Vehicle access

A general access/egress point for the Proposal Site is planned to be off Hart Road at the south eastern end of the Proposal Site, with the exact arrangement to be determined during the detailed design process. Hart Road connects directly to the Hunter Expressway south of the Proposal Site. Internal roads would also be developed within the Proposal Site and be available for emergency services. All internal roads and maintenance tracks would be a minimum of four metres wide and have a minimum vertical clearance of four metres.

A fire access track is to be constructed within the proposed external APZ. This would be constructed to a standard that allows use by fire response vehicles (as specified in NSW RFS fire trail standards (RFS, 2019b) for *Category 1 fire appliances*). This track would help to separate fire crews from the switchyard and its inherent electrical safety risks.

4.1.7 Water for firefighting

The former Kurri Kurri aluminium smelter site is currently serviced by potable water from Hunter Water, and there would be a connection into the Hunter Water potable water network for the Proposal Site. This would be supplemented by water storage tanks, to enable the Proposal to meet its peak water demands.

Fire water for bushfire responses would be provided via standpipes constructed at strategic locations within the Proposal Site and along the proposed APZ access track. Water would be supplied from the Hunter Water potable water system. On site water storage tanks would also be equipped with standard fittings to enable use by RFS to refill fire response vehicles in the event of failure of the potable supply. Concrete hard stands would be constructed at each water access point. These points would be clearly signposted.

4.2 Bushfire protection measures during construction

Construction activities present a different suite of risks to those for operation of the Proposal. These relate to the risks of landscape fire for construction personnel and of on-site ignitions escaping from the site into the surrounding landscape. It is anticipated that these risks would be mitigated by site characteristics and specific management actions, as follows:

- *SFAZ:* management of bushfire fuel hazard in the surrounding landscape by RFS should moderate the behaviour of a fire, should one ignite, and reduce the threat it poses to construction personnel and the construction site.

- *Site clearance:* the Proposal Site is largely a "brownfields" site, with the Proposal being developed on the site of the former Kurri Kurri aluminium smelter. With the exception of a small part of the proposed switchyard area, the Proposal Site is devoid of bushfire prone vegetation. Most of the Proposal Site would have low radiant heat exposure to any fire in nearby vegetation (see Figure 3.6) and any embers entering the Proposal Site are unlikely to find sufficient fuel for a spot fire to establish. In case of an approaching fire in the vegetation to the north and west of the Proposal Site, workers could safely retreat towards the south-east, and evacuate the Proposal Site if required.
- *Access:* In the event of a fire, emergency services would access the site via Hart Rd and through tracks used for construction activities. External access (prior to construction of the proposed APZ access track) would be via the existing formal and informal track network.
- *Fire water supply:* as noted above, the Proposal Site will have access to potable water from the Hunter Water network, and will be designed to meet the Proposal's requirements. A standpipe or connection point would be provided to enable fire response vehicles to refill.
- *Hazardous materials:* it may be necessary during some construction stages to store diesel fuel and other potentially flammable materials on the Proposal Site. Storage of such materials would follow environmental protection guidance and be located at parts of the Proposal Site with low radiant heat exposure in the event of a bushfire (i.e. outside the BAL-12.5 zone shown in Figure 3.6). Since the entire Proposal Site could be subject to ember attack, storage areas for any hazardous materials would be free of combustible materials that could contribute to a fire ignition. Any fuel spills should be remediated to ensure that they cannot be a source of ignition.
- *Hot works controls:* works that have potential to generate sparks and ignite fires will be subject to the contractor's hot works safety management procedures. Hot works will not be undertaken on TOBAN days except where permission has been given by the RFS.
- *Emergency management:* on site bushfire emergency management arrangements will be addressed through the construction contractor's site emergency management plan. Given the level of fire risk and proximity of the Proposal Site to fire services, bushfire-specific fire-fighting equipment (e.g. 4WD with slip on tank and pump) will not be necessary to be held on the Proposal Site during construction. If a fire is ignited and cannot be safely contained using fire extinguishers or other materials at hand, construction crews will dial 000 and seek emergency service assistance.

4.3 Potential environmental impacts of proposed bushfire protection measures

Potential environmental impacts of the proposed bushfire protection measures are largely confined to the clearing of native vegetation within the Proposal Site and proposed APZ and the potential for erosion and sedimentation associated with the proposed APZ access track. Clearing within the proposed switchyard area of the Proposal Site is incorporated into the initial planning for the Proposal and is also required for electrical safety. The only additional clearing that specifically results from bushfire protection measures is that for the proposed external APZ. The total estimated area of native vegetation that will be cleared for the Proposal is 1.54 ha, of which includes 0.39 ha within the proposed APZ.

5. Emergency management during construction

This section outlines the emergency management arrangements for the construction phase of the Proposal.

NSW RFS is the primary bushfire emergency response agency for any incident affecting the Proposal Site. Fire and Rescue NSW have a facility in Kurri Kurri and would respond to structure fires at the Proposal Site.

In case of a fire igniting in/around the Proposal Site:

- Personnel who are present should attempt to extinguish the fire *if safe to do so*
- Others present on site should be alerted to the presence of the fire
- Contact emergency services on 000
- Relocate personnel to a designated assembly point towards the south-east of the Proposal Site.

A Prepare-Act-Survive bushfire response plan would be prepared for the Proposal. This plan will align with the bushfire protection measures outlined in Section 5.

5.1 National bushfire warning system

Advice of bushfires igniting in the landscape surrounding the Proposal Site may be provided through the National Bushfire Warning System (NBWS) alerts. The NSW RFS uses NBWS alerts to provide information to affected areas on locations and current status of nearby bushfires, to allow people to evacuate or otherwise prepare (Figure 5.1). Information is provided through:

- Radio: alerts broadcast on the local emergency services radio station (ABC Newcastle: 1233 AM)
- Internet: NSW RFS website (www.rfs.nsw.gov.au), 'Fire Near Me' app
- Telephone: Bushfire information line 1800 NSW RFS (1800 679 737)
- Television and newspapers.

Note that some fires ignite and spread too quickly for a warning to be issued. Site personnel should be on the watch for smoke during the bushfire danger period.

5.2 Prepare-Act-Survive

A Prepare-Act-Survive bushfire response plan should be prepared by the construction contractor according to NSW RFS guidelines and the Construction Bushfire and Emergency Management Plan for the Proposal. It should include:

- Assembly point(s)
- Evacuation triggers and routes (if required)
- Neighbourhood Safer Places and Refuges of Last Resort
- Instructions for sheltering in-place, should that become necessary.

Figure 5.1: National Bushfire Warning System advice levels

Neighbourhood Safer Places are locations designated by fire authorities as having a higher likelihood of supporting human survival, should evacuation no longer be an option. It must be emphasised that anyone sheltering in a Neighbourhood Safer Place during a bushfire event may still experience extreme conditions and their safety is not guaranteed.

Designated neighbourhood safer places in the vicinity of the project are:

- Mulbring Cricket Club, Child Street Mulbring (15 minute drive south from the Proposal Site)
- Miller Park, Maitland Street East Branxton (15 minute drive north-west from the Proposal Site)
- Jeffrey Park, Congewai Street Kearsley (15 minute drive south-west from the Proposal Site)
- Branxton Oval, John Rose Avenue, Branxton (20 minute drive north-west from the Proposal Site).

6. Conclusions and recommendations

6.1 Bushfire hazard assessment

The Proposal is to be constructed on the former Kurri Kurri aluminium smelter site, approximately three km north of the town of Kurri Kurri, within the Cessnock City Council local government area. The Proposal Site is approximately 30 km west of Newcastle CBD and 125 km north of Sydney.

The immediate landscape is highly disturbed, and areas of bushfire prone native vegetation lie to the north, west and east of the Proposal Site. The Proposal Site currently includes a small area of native vegetation that is proposed to be removed to allow the development to proceed.

The separation of the Proposal Site from nearby native vegetation means that, apart from the proposed switchyard area and north-east corner of the plant area, most of the Proposal Site would only be exposed to levels of radiant heat (in the event of a bushfire) that are sufficiently low and would pose minimal risk to people, buildings or other infrastructure structure.

6.2 Bushfire risk scenarios

The bushfire season in the Hunter region generally runs from October to March, although commencement has been declared as early as August. Days of elevated fire danger are relatively infrequent, but mostly occur between December and March. Dry electrical storms and north-westerly winds are common during the fire season.

Two main bushfire risk scenarios face the Proposal and have been considered by this assessment:

- A fire igniting in the surrounding vegetation north-west of the Proposal Site on a day of elevated fire danger burns under the influence of north-westerly winds towards/through the project area. Embers and radiant heat are carried towards the site infrastructure. Two such bushfire incidents have occurred in the last 20 years.
- Electrical equipment failure, or hot works cause ignition at the Proposal Site during construction or operation. Fire spreads from the Proposal Site into surrounding vegetation to the north or west under the influence of moderate fire weather conditions with wind from the south or east.

Appropriate measures must be in place to mitigate the bushfire risks from and to the project, particularly those associated with these scenarios.

6.3 Bushfire protection measures during operation

Bushfire protection measures have been developed for operation of the Proposal that address the two main bushfire risk scenarios. These are based on the following:

- *SFAZ:* areas of relatively high bushfire risk native vegetation to the north and west of the Proposal are managed under the Hunter BRMP as strategic fire advantage zones. Bushfire fuel hazard in these areas is actively maintained (by periodic hazard reduction works) to reduce bushfire risk, as well as radiant heat and ember attack exposure. With reduced bushfire fuel hazard, the behaviour of any fire that becomes established is likely to be moderated.
- *APZ:* which provide a buffer zone between a bushfire hazard and buildings or other structures. APZ are managed to minimise fuel loads and reduce radiant heat levels, flame, ember and smoke attack. They help to provide a space for firefighters and other emergency services personnel responding to a fire event and reduce opportunities for any fire igniting on site to escape to surrounding areas. A10 m wide APZ is proposed to be established and maintained along the perimeter of the Proposal Site in areas where there is an interface with bushfire prone vegetation.

- *Vegetation removal:* all vegetation (including grasses) is to be removed from the proposed switchyard to reduce opportunities for a fire entering the site and for a fire being ignited by electrical infrastructure (e.g. explosive failure of transformer, arcing from a conductor) escaping from the site. Woody vegetation is to be removed from the proposed APZ.
- *Location of sensitive infrastructure:* buildings and other infrastructure with sensitivity to radiant heat exposure will be located in areas within the site that would be exposed to less than BAL-19.
- *Hazardous materials:* diesel storage tanks will be constructed on site to enable the Proposal to operate if gas is unavailable. The tanks will be located in areas with BAL exposure of 12.5-19 W/m^2. Given the relatively low flammability of diesel, it is not anticipated that any specific design mitigation will be required to protect the tanks from radiant heat. They will need to be constructed to avoid ember accumulation or the ignition of small fires. The need for further mitigations (e.g. fire sprinklers) will be considered during detailed design.
- *Access roads:* which provide safe operational access to and within the Proposal Site for emergency services personnel to supress a bushfire. In additional to internal site access tracks/roads, a fire access track is to be constructed within the proposed APZ.
- *Fire water supply:* adequate water is required for fire suppression and/or protection of structures or equipment located on the Proposal Site. This is to be provided by access to potable water supply and on-site water storage tanks. Access to fire water supplies is to be provided within the proposed APZ.

6.4 Bushfire protection measures during construction

While construction activities present a different suite of risks to those for operation of the Proposal, bushfire protection would be based on a similar suite of measures, as follows:

- *SFAZ:* management of bushfire fuel hazard in the surrounding landscape by RFS should moderate the behaviour of a fire, should one ignite, and reduce the threat it poses to construction personnel.
- *Site clearance:* the Proposal Site is a “brownfields” site that is largely devoid of bushfire prone vegetation. Most of the Proposal Site would have low radiant heat exposure to any fire in nearby vegetation and any embers entering the Proposal Site are unlikely to find sufficient fuel for a spot fire to establish. In case of an approaching fire in the vegetation to the north and west of the Proposal Site, workers could safely retreat towards the south-east, without necessarily needing to evacuate.
- *Access:* in the event of a fire, emergency services would access the site through tracks used for construction activities via Hart Rd. External access (prior to construction of the proposed APZ access track) would be via the existing formal and informal track network.
- *Fire water supply:* the Proposal Site would have access to potable water from Hunter Water. A standpipe or connection point will be provided to enable fire response vehicles to refill in case of fire.
- *Hazardous materials:* it is assumed that it may be necessary during some construction stages to store diesel fuel and other potentially flammable materials on site. Storage of such materials would follow environmental protection guidance and be located at parts of the site with low radiant heat exposure in the event of a bushfire. Storage areas would also be kept free of combustible materials that could be ignited by ember attack.
- *Hot works controls:* works that have potential to generate sparks and ignite fires will be subject to the contractor’s hot works safety management procedures and only be undertaken on TOBAN days with a permit from the RFS.

  Emergency management: on site bushfire emergency management arrangements will be addressed through the construction contractor’s site emergency management plan. On site bushfire fighting equipment will not be held on site during construction. If a fire is ignited and cannot be safely contained using fire extinguishers or the like, construction crews will dial 000 and seek emergency service assistance.

7. References

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Appendix I

Sample Snowy Hydro Tactical Fire Plan

Appendix I Sample Tactical Fire Plan Template

Table 26 Sample Tactical Fire Plan Template

SCENARIO: [Title and Scenario Number]		
PLANT AREA: [name]	Special requirements notes	Scenario Location Plan
FLAMMABLE OR COMBUSTIBLE MATERIAL: [name(s)]		
BRIEF PLANT AREA OPERATIONS DESCRIPTION: [description]		
SECONDARY CONTAINMENT CAPACITY: [details, if relevant]		
INCIDENT CAUSE(S):		
[description]		
CONSEQUENCE(S):	**ESTIMATED DURATION:**	**SPREAD AND ESCALATION POTENTIAL:**
[description]	[description]	[description]
DETECTION:	**ALARMS:**	**PLANT ISOLATION AND SHUTDOWN:**
[description]	[description]	[description]
EMERGENCY RESPONSE		
COMMUNICATION TO EMERGENCY SERVICES:		
[description]		
PERSONNEL SAFETY:	**EVACUATION:**	
[description]	[description]	
OPERATION OF FIRST ATTACK FIRE FIGHTING EQUIPMENT:	**OPERATION OF FIXED FIRE FIGHTING EQUIPMENT:**	**OTHER ACTIONS (EMERGENCY SERVICES):**
[description]	[description]	[description]

Appendix J

Preliminary Chemical Store Inventory

Appendix J Preliminary Chemical Store Inventory

Location	Chemicals / Materials Stored	Type of Storage	Proposed Maximum Storage Quantity	DG Class
Chemical Store Building - Inside	acetone (C3H6O)	small container	< 120 L	class 3 flammable liquids
	aerosols (propellant)	aerosol cans	< 250 L	class 2
	various lubricating oils and greases	small container	< 550 L	class 3 flammable liquids
	sulphuric acid solution (nominally 15 - 35% concentration)	dosing tank	50 L	class 8 corrosive substance (PG II)
	sodium hydroxide (caustic) (nominally 10 -25 % concentration)	dosing tank	50 L	class 8 corrosive substance (PG II)
	lubrication oil	drums	1200 L (6 drums)	class C2 combustible liquid
	control oil	drums	1200 L (6 drums)	class C2 combustible liquid
	sodium hypochlorite	small container	< 50 L HOLD	class 8 corrosive substance (PG II)
Chemical Store Building - Outside	sulphur hexafluoride	gas cylinders	50 L	class 2.2
	CEMS calibration gas - 20.9% oxygen (balance gas N2)	gas cylinders	100 L	class 2.2
	CEMS calibration gas - Carbon Monoxide (balance gas N2)	gas cylinders	100 L	class 2.2
	CEMS calibration gas - NO	gas cylinders	100 L	class 2.2
	acetylene	gas cylinders	50 L	class 2.1
	argon	gas cylinders	25 L	class 2.2

Location	Chemicals / Materials Stored	Type of Storage	Proposed Maximum Storage Quantity	DG Class
	argonshield	gas cylinders	50 L	class 2.2
	oxygen	gas cylinders	50 L	class 2.2
	stainshield	gas cylinders	50 L	class 2.2

Appendix K

Additional Damage Threshold Information

Appendix K Additional Damage Threshold Information

The following information supplements the information published in NSW HIPAP-2 [ref.5].

Table 27 TNO Empirical Data on the Effects of Explosions [ref.15][4]

Table 5. Damages to structures.

Description of Damage	P_s(kPa)
Connections between steel or aluminium ondulated plates have failed	7-14
Walls made of concrete blocks have collapsed	15-20
Brickstone walls, 20 - 30 cm, have collapsed	50
Minor damage to steel frames	8-10
Collapse of steel frames and displacement of foundation	20
Industrial steel self-framing structure collapsed	20-30
Cladding of light industry building ripped-off	30
The roof of a storage tank has collapsed	7
The supporting structure of a round storage tank has collapsed	100
Cracking in empty oil-storage tanks	20-30
Displacement of a cylindrical storage tank, failure of connecting pipes	50-100
Damage to a fractioning column	35-80
Slight deformations of a pipe-bridge	20-30
Displacement of a pipe-bridge, breakage of piping	35-40
Collapse of a pipe-bridge	40-55
Plating of cars and trucks pressed inwards	35
Breakage of wooden telephone poles	35
Loaded train carriages turned-over	50
Large trees have fallen down	20-40

[4] The primary source of the information quoted by reference 15 for this table is a study performed by Glasstone and Dolan [ref.16] for the U.S. Departments of Defense and Energy.