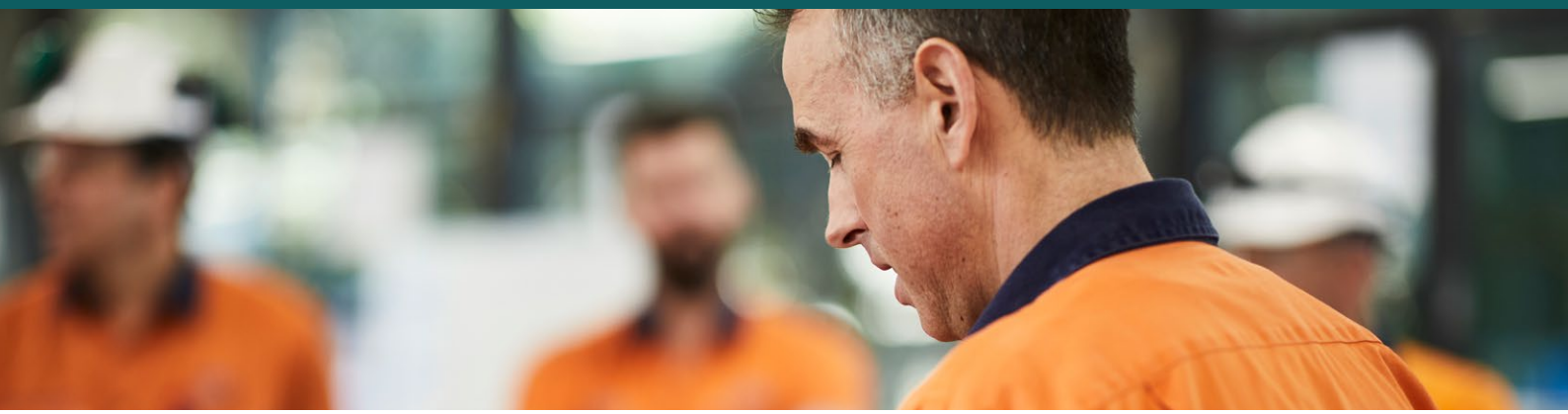
Chapter 16
Safety, hazard and risk



This chapter discusses the safety, hazard and risks associated with construction and operation of the Gas Import Jetty and Pipeline Project (the Project). This chapter is based on the process safety studies, hazard identification and risk assessment approach and processes undertaken by the Project as presented in EES Technical Report K: *Safety, hazard and risk assessments*.

16.1 Overview

Liquified natural gas (LNG) facilities, including processing plants, marine terminals and LNG shipping, have a strong industry safety record worldwide. LNG has been shipped for over 50 years in increasing quantities without a major accident resulting in the loss of LNG cargo.

Understanding the safety, hazards and risks associated with the Project is critical to ensure that systems and procedures are in place to eliminate or minimise risks to people, property and the environment.

To assess the safety, hazard and risks of the AGL Gas Import Jetty Works and the APA Pipeline Works, AGL and APA have each undertaken and will continue to undertake formal safety studies and hazard assessments. These studies include qualitative and quantitative methods. The principal studies undertaken include hazard identification workshops (HAZID), hazard and operability studies (HAZOP), a pipeline Safety Management Study (SMS) and Quantitative Risk Assessments (QRA).

In the context of these safety, hazard and risk assessments, risk is distinct from the environmental risks assessed in the other EES technical studies.

It should be noted the various safety and risk studies outlined in this chapter represent investigations conducted to date. The safety, hazard and risk studies are an iterative process that will be updated at different stages of the Project as the level of design detail and definition develops. The hazard and risk studies will be revisited when detailed designs for Project infrastructure are finalised after the EES process. Final approvals related to safety and risk will be required from relevant regulatory authorities before the Project starts operating.

The operation of the gas transmission pipeline and its construction would be subject to regulation by Energy Safe Victoria. The Gas Import Jetty Works would be regulated by Worksafe Victoria.

16.1.1 Gas Import Jetty Works safety regulations

The Gas Import Jetty Works, comprising the floating storage and regasification unit (FSRU) continuously moored at Berth 2 Crib Point Jetty, the Jetty Infrastructure and the Crib Point Receiving Facility, require various maritime and land-based approvals and will be subject to rigorous safety requirements.

AGL will address the safety aspects of the FSRU in a manner consistent with the requirements of a major hazard facility (MHF) under the Occupational Health and Safety Regulations 2017 by preparing a safety case, safety management system and emergency management plan.

While the current regulatory definition of an MHF does not include an FSRU, AGL has approached the Project in anticipation this definition may be changed in future. In that case, the FSRU operator will be required to submit a safety case to WorkSafe Victoria.

The operator of the Crib Point Receiving Facility and the Jetty Infrastructure (particularly the marine loading arms and gas piping mounted to the jetty) will also submit a safety case to Energy Safe Victoria.

16.1.2 Pipeline Works safety regulations

A Pipeline Licence will be required for the Pipeline Works under the *Pipelines Act 2005* (Vic) (the Pipelines Act). The Pipelines Act requires licensed pipelines to be constructed and operated safely in accordance with Australian Standard 2885: *Pipelines – Gas and liquid petroleum.*

The pipeline licensee is required to implement a range of safety measures to reduce foreseeable risks associated with operating a pipeline and to minimise, as far as is reasonably practicable, hazards and risks to the safety of the public.

A Construction Safety Management Plan and an Operational Safety Management Plan must be prepared and accepted by Energy Safe Victoria. The Pipeline Works would be constructed and operated in accordance with the approved safety management plans.

Major hazard facilities

Major hazard facilities (MHFs) are industrial sites such as oil refineries, chemical manufacturing sites, gas-processing plants, liquefied petroleum gas facilities and some warehouses and transport depots. They must be licensed and follow strict legal requirements.

What is a safety case?

To obtain a licence to operate a facility, operators are required to submit a safety case which demonstrates how the facility will be operated safely. The safety case:

- identifies the hazards and risk
- describes how the risks are controlled
- describes the safety management system in place to ensure the controls are effective and reliable.

16.2 EES evaluation objective

The scoping requirements for the EES set out the following relevant draft evaluation objectives:

> **Energy efficiency, security, affordability and safety – To provide for safe and cost-effective augmentation of Victoria's natural gas supply in the medium to longer term.**
>
> **Social, economic, amenity and land use – To minimise potential adverse social, economic, amenity and land use effects at local and regional scales.**

To assess the safety, hazard and risk of the Project, AGL and APA have undertaken several safety studies and risk assessments. These are necessary as a demonstration of adequacy that all risks are being assessed and mitigated so far as is reasonably practical to provide safe operations that meet community expectations and the regulatory requirements for the Project.

16.3 Methodology

The approach adopted for the safety, hazard and risk assessment involved the following key tasks:

- a review of relevant legislation and policy at Commonwealth, state and local level
- a review of the qualitative and quantitative safety studies completed to date, including HAZID, HAZOP, SMS and QRA studies
- consultation with regulatory bodies and key stakeholders including WorkSafe Victoria, Energy Safe Victoria and the Department of Environment, Land, Water and Planning (DELWP)
- identification of hazards and potential major incidents relevant to each element of the Project
- a risk analysis identifying the consequence and likelihood of the potential hazards to define the tolerable or acceptable levels of risk for the Project and to compare these against the estimated risk derived from QRA techniques
- development of mitigation measures in response to the safety, hazard and risk assessment.

16.3.1 Study area

The study area for the safety, hazard and risk assessment is shown in **Figure 16-1**.

For the gas pipeline, the study area encompasses the pipeline measurement length (ML), calculated at 640 metres on either side of the pipeline. The measurement length is used to classify existing and reasonably foreseeable land use adjacent to the pipeline and drives the safety design of the pipeline to mitigate threats to and from the pipeline.

The study area also includes the immediate area around the Gas Import Jetty Works facilities (FSRU, Jetty Infrastructure and Crib Point Receiving Facility) and the Pakenham Delivery Facility. The hazardous scenarios (identified through QRA and other means) and associated consequence assessments focus on specific areas of interest with respect to land use within and adjacent to the study area.

Measurement length

The measurement length (ML) is the area of consequence in the extremely unlikely event of a full loss of containment of the gas (full-bore rupture of the pipeline) plus the gas being ignited, which may cause injury after 30 seconds of exposure. The ML is calculated based on operating pressures using methods outlined in Australian Standards.

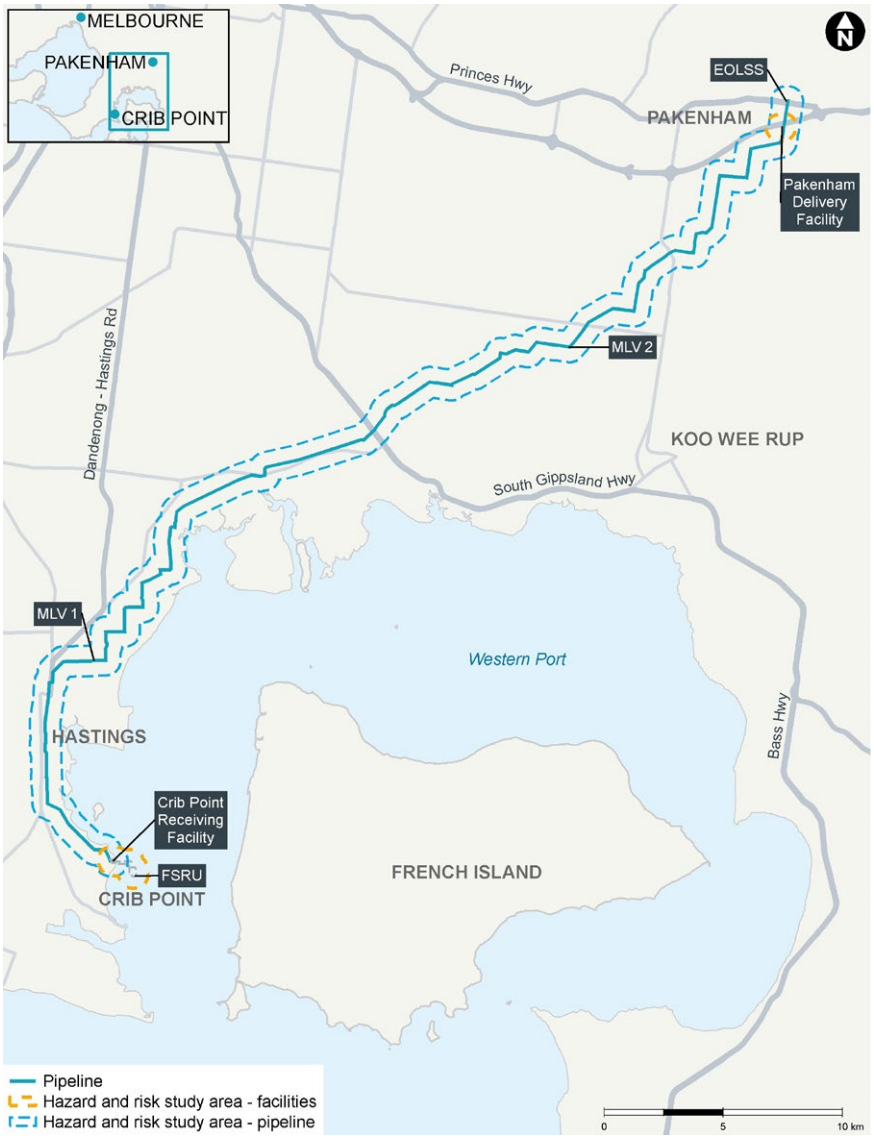


Figure 16-1:
Hazard and risk study area

16.4 Hazard identification

The operational hazards resulting from a release of flammable gas, with subsequent ignition leading to a fire or explosion, have been a primary focus of the hazard analysis, risk assessments and safety studies completed for the Project.

The operational hazards and risks and the safe handling and storage practices associated with LNG and natural gas are well established in Australia and internationally.

16.4.1 Hazardous materials

The Project would introduce the bulk storage and distribution of hazardous materials of sufficient volume to have the potential for off-site consequences. The predominant risk associated with the storage and distribution of flammable gases and liquids is an unplanned release with subsequent ignition leading to a fire or explosion.

The storage, handling and distribution of dangerous goods is subject to a Dangerous Goods licence being issued by WorkSafe Victoria under the *Dangerous Goods Act 1985* (Vic).

The primary materials stored and distributed for the Project are listed in **Table 16-1**.

Primary hazards

Flammability is the ability of a chemical to burn or ignite, causing fire or combustion.

Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures.

An **asphyxiant** is a substance that reduces or displaces the normal oxygen concentration in breathing air.

LNG would be stored on the FSRU at a very cold temperature – negative 163 degrees Celsius (-163 °C) – to keep it in liquid form. A release of LNG into atmospheric temperatures would form a gaseous vapour cloud that disperses in the atmosphere. A portion of the cloud would likely be flammable, giving rise to the possibility of ignition. In addition to the flammability risks, LNG presents a cryogenic hazard potentially causing embrittlement of steel structures with the potential for frost burns to people through direct exposure.

Natural gas has a high energy content compared with other fuel sources making it ideal for a variety of domestic and commercial applications. Natural gas is odourless, non-toxic and non-corrosive. It has a flammability range of 5 to 15 per cent by volume in air. An odorant is injected into the natural gas stream to allow the odourless natural gas to be detected by smell. The primary risk associated with the gas transmission pipeline is a loss of containment (via a leak or rupture) of high-pressure flammable gas, with subsequent ignition leading to fire and potentially explosion.

The odorant to be stored at Crib Point Receiving Facility would consist of greater than 60 per cent tetrahydrothiophene and 20 to 40 per cent tert-butyl mercaptan. Odorant is flammable. In addition, a significant release has the potential to cause general discomfort or nausea in the local community.

Liquid nitrogen would be stored at Crib Point Receiving Facility at temperatures of approximately negative 196 °C and would be used to dilute the natural gas to meet specifications where required. Liquid nitrogen is non-flammable and odourless. Like LNG, liquid nitrogen presents a cryogenic hazard to steel structures and frost burns to people if spilled.

When cryogenic liquids like LNG or liquid nitrogen form a gas, the gas is very cold and usually heavier than air. This cold, heavy gas does not disperse very well and can accumulate near the ground and act as an asphyxiant by displacing oxygen in air, especially in confined spaces.

Table 16-1: Primary hazardous materials

Material	Hazard	Storage capacity	Location	Works area
Liquefied natural gas (LNG)	Flammability Cryogenic	170,000 cubic metres (m^3)	FSRU cargo	Gas Import Jetty Works
Natural gas	Flammability	1,764 kilo standard cubic meters (kscm) in storage (approximately 1,800 tonnes contained in process and pipeline)	Pipeline/Gas piping and marine loading arms/Crib Point Receiving Facility/ Pakenham Delivery Facility	Pipeline Works/ Gas Import Jetty Works
Odorant	Flammability	40 m^3	Crib Point Receiving Facility	Gas Import Jetty Works
Liquid nitrogen	Cryogenic Asphyxiant	3,000 tonnes (~3717 m^3)	Crib Point Receiving Facility	Gas Import Jetty Works

16.4.2 Major hazards and risks

A large uncontrolled release of gas or liquid gas and ignition can lead to a high consequence safety incident with potential for thermal radiation due to jet, pool or flash fires and blast overpressure effects from a potential explosion of a gas cloud. The predominant hazards include:

- jet fires resulting from the ignition of a continuous release gas producing a long, stable, high temperature flame
- flash fires occurring when a cloud of gas is ignited, resulting in a flame travelling through the cloud
- pool fires which may occur above an LNG or odorant spill as the liquid evaporates after a flash fire
- vapour cloud explosion occurring when a large cloud of gas is ignited – vapour cloud explosions associated with lighter-than-air gases (such as natural gas) generally require confinement (such as in a building or enclosure) for the cloud to accumulate
- rapid phase transition resulting from the release of LNG over water where the LNG vaporises violently leading to an explosion.

Ignition of a gas or liquid release can produce a jet or pool fire resulting in damage to unprotected plant and equipment and personnel hazards from thermal radiation exposure. The risk of fatality or injury from exposure to a jet or pool fire comes via the level of heat radiation in kilowatts per square metre (kW/m^2) and the duration of exposure.

In addition to the release of gas or liquid gas, there is a risk of spills and ignition from potential liquid hydrocarbon sources, including diesel fuel associated with the firewater pumps on the jetty, gasoline or diesel associated with vehicles and hydraulic fluid associated with the operation of the marine loading arms (MLAs) on the jetty. Unlike petrol which is highly flammable, diesel fuel is a combustible liquid with a flashpoint above 60ºC. This relatively high flashpoint means that insufficient vapour is produced under ambient conditions and so is unlikely to ignite, other than as an escalation event (such as being triggered by another event). Likewise, hydraulic fluid is assumed to be combustible, making ignition highly unlikely. Spills on the jetty would be contained as described in **Section 16.6.1** of this chapter.

16.4.3 Construction hazards

During construction, the public and the workforce would be exposed to hazards routinely experienced in the construction of major infrastructure. Hazards would include, but not be limited to:

- unauthorised public access to construction sites
- modified road access and crossings, and vehicle movements on public roads and at site access points
- working in the vicinity of moving equipment and vehicles
- working at heights
- falling objects from elevated workers or crane assisted lifts
- exposure to electrical hazards
- excavation hazards
- hazards associated with welding activities, such as fumes
- noise and dust
- confined spaces
- working overwater during Jetty Infrastructure installation and construction.

For example, major structural elements for the Jetty Infrastructure, including the MLAs, fire towers and fire pumps would be delivered to a local port and unloaded directly onto a material barge for transportation to the jetty. These activities would introduce lifting hazards, falling object hazards and the hazard of collision between material barges and either the jetty or passing ships. Scaffolding structures would be installed on the jetty to provide access to relevant work areas, although these would present a risk of falling objects, collapse risk for scaffolding and introduce working at heights and overwater hazards for workers.

Some sections of the pipeline would be constructed via open trench cut and cover method. This would create the risk of trench collapse, entry to confined spaces, engulfment and the risk of injury from mechanical plant.

Construction areas and laydown yards would be adequately segregated and secured preventing access to the public. Construction of the Project would be undertaken in accordance with a Safety Management Plan to control hazards to the public and manage worker safety.

16.5 Quantitative Risk Assessment results

The QRA process focuses on the effects of a potential major incident and those atypical events with the potential to have impacts outside the boundaries of the Project, such as a fire or explosion. The output from the QRA is a set of risk numbers that estimate the likelihood of a specified level of harm at a specified location, providing Location Specific Individual Risk (LSIR) contours.

The objective of the QRA is to systematically address the likelihood and consequence of all potential hydrocarbon-related risks for the Project to determine if the risks are tolerable in accordance with established risk criteria and to make recommendations for risk reduction measures if the resulting risk levels exceed the tolerable risk criteria. The generally accepted industry criteria for tolerable risk is defined in the New South Wales *Hazardous Industry Planning Advisory Paper No.4* (HIPAP4).

In the case of fatality, the HIPAP4 criteria differentiates between the various types of land use, recognising the need to protect more vulnerable members of the community. The fatality risk criteria considered tolerable for specific land uses adopted from HIPAP4 is shown in **Table 16-2**.

Accredited registrar and international classification society, DNV GL, conducted a preliminary QRA for hazards and risks associated with the Gas Import Jetty Works at Crib Point including but not limited to:

- all modes of the FSRU operation
- marine operations (approach and mooring) for the FSRU, LNG carrier and United Petroleum tankers
- gas operations on the Crib Point Jetty including gas send out from the FSRU, MLAs and ship to ship transfer
- Crib Point Receiving Facility operations
- interactions (simultaneous operations) with external factors such United Petroleum unloading activities and operations of the pumping station.

The initial QRA results for the Gas Import Jetty Works show that the fatality risk, property damage and propagation risk (that is, the escalation of an incident to neighbouring facilities) likelihood is within the generally accepted industry criteria for tolerable risk as defined by HIPAP4. This means the Gas Import Jetty Works do not present an unacceptable risk to adjacent land uses nor are they considered a disproportionate risk to these land users.

Based on the initial QRA results for the Gas Import Jetty Works and the HIPAP4 criteria shown in **Table 16-2**, the following observations are made with regards to specific areas of interest:

- at Woolleys Beach Reserve, and the closest point at which the public can get near to the Gas Import Jetty Works on land, the HIPAP 4 criteria for open spaces is met
- the risk at the Victorian Maritime Centre meets the risk criteria of not exceeding five in a million years likelihood of fatality for commercial developments
- there are no residential areas or sensitive land uses (hospitals, schools, child-care facilities, old age facilities) within the LSIR contours.

For the Pipeline Works, a QRA was carried out for hazards and risks associated with all modes of operation for the Pakenham Delivery Facility including but not limited to gas receipt, gas treatment and transmission to the Victorian Transmission System.

The risk results for the Pakenham Delivery Facility indicate the risk levels are below the tolerable risk criterion for industrial land use according to HIPAP4. The areas of interest with respect to off-site risk in the vicinity of the Pakenham Delivery Facility (residential areas to the east and north-east, the Pakenham East rail depot and freeway) meet their respective levels of tolerable risk according to HIPAP4 land uses. This means the Pakenham Delivery Facility does not represent an unacceptable risk to adjacent land uses nor is it considered a disproportionate risk to these land users.

Table 16-2: NSW Hazardous Industry Planning Advisory Paper No.4 (HIPAP4) tolerance criteria

Land use	Risk of fatality (per million years) tolerance criteria	Risk of fatality (per annum) tolerance criteria
Hospitals, schools, child-care facilities, old age housing	0.5	5E-07
Residential, hotels, motels, tourist resorts	1	1E-06
Commercial developments, retail centres, offices, entertainment spaces	5	5E-06
Sporting complexes and active open spaces	10	1E-05
Industrial	50	5E-05

16.6 Safety in design and operation

This section describes key aspects of the design and operation of the Gas Import Jetty Works and Pipeline Works in regard to safety. Threats identified in the pipeline Safety Management Study (SMS) and responses in the design of the Pipeline Works to reduce risks to as low as reasonably practicable are noted in **Section 16.6.2** below. A detailed description of the Project is provided in **Chapter 4** *Project description*.

The Project would include numerous safety systems each responsible for the monitoring, control and shutdown of the gas export process in the event of an emergency. Due to the interconnectivity of the respective facilities, each operator would have the ability to close shutdown valves within other operator facilities. An overview of the Project safety systems is provided below with more detail found in EES Technical Report K: *Safety, hazard and risk assessments*.

16.6.1 Gas Import Jetty Works

The FSRU would be moored at Berth 2 of Crib Point Jetty within the Port of Hastings on the western side of Western Port. The Port of Hastings is under the authority of the Port of Hastings Development Authority (PoHDA) and the Victorian Regional Channels Authority (VRCA). PoHDA and the VRCA would have a key role in regulating the safe movement of the FSRU, safety at berth for the FSRU and for the arrival and departure of LNG carriers in Port, and the transfer and delivery of LNG from and between these vessels. The FSRU and visiting LNG carriers would be required to meet the requirements of the port and maritime regulations.

The FSRU is an existing ocean-going vessel designed and constructed to recognised international standards and assigned a Class notation (classification) under the DNV GL Classification system. The DNV GL Classification system has gained worldwide recognition as a demonstration that an adequate level of safety and quality has been implemented in the design, construction, operation and maintenance of the asset. Compliance with its Classification requirements would be verified by DNV GL through a system of periodic surveys during the Project's operation. The operation of the FSRU would be undertaken by an experienced third-party operator.

The FSRU is a double-hulled vessel with a number of passive and active safety systems. Mooring the FSRU at the jetty provides additional separation from nearby communities.

The Jetty Infrastructure at Berth 2 would include MLAs, gas piping, a fire protection system and an electrical substation. Berth 2 would be enlarged and structurally refurbished by PoHDA to make it fit for use. Gas and fire detection would be provided on Berth 2 and the jetty.

DNV GL Classification

DNV GL is an international accredited registrar and classification society headquartered in Norway. As a classification society, DNV GL sets standards for ships and offshore structures that comprise safety, reliability and environmental requirements for vessels.

The MLAs would connect the FSRU to the gas piping mounted on the jetty to transfer the gas from the FSRU to the Crib Point Receiving Facility on land. Each MLA would be fitted with a quick connect/disconnect isolation in the event the connection was broken. The gas piping could be isolated at two locations: on the shore at an isolation valve in the receiving facility, and at emergency shut down valves located downstream of each MLA on Berth 2.

Primary firefighting for liquid spill fires on the jetty would be by portable foam carts and extinguishers. If a fire could not be fought with portable foam carts or extinguishers, fire water could be supplied to provide cooling to equipment until the fire self-extinguishes. The design includes diesel-driven fire pumps which use seawater, and three oscillating fire water monitors on individual towers with sufficient range to reach the whole pierhead and the required area of the FSRU hull.

Foam use on the jetty would be minimised as far as practicable to avoid environmental spill of firefighting foam. All deck areas of Berth 2 would have bunding/kerbing to contain spills and firefighting consumables to an extent that is practicable.

The diesel-driven firewater pumps and their associated fuel storage tanks located on the berth would be provided with a spill tray for containment of small fuel releases. The diesel storage tank would be double walled, reducing the potential for significant releases and removing the requirement for full bunding (retaining walls), as permitted by AS1940 – *The storage and handling of flammable and combustible liquids*. Any hydraulic fluid leaks from the Jetty Infrastructure would be within the bunding and kerbing for collection into the jetty sump.

The Crib Point Receiving Facility would include an odorant system to inject mercaptan into the gas to assist in detection of natural gas in the event of a leak. The odorant package has been through a hazard and operability review with the vendor and the resultant actions incorporated into the design, including bunding of the odorant storage area and storing Mercaptan Odorant Neutraliser on site to neutralise a large loss of odorant. The odorant plant would be complete with standalone safety interlocks and emergency shutdowns.

16.6.2 Pipeline Works

The Pipeline Works would be designed in accordance with Australian Standard/New Zealand Standard AS/NZS 2885.1 *Pipelines – gas and liquid petroleum*. The pipeline would be protected against corrosion by an external coating with secondary corrosion protection utilising an impressed cathodic protection system.

Threats identified along the pipeline alignment and facilities include:

- external interference
- corrosion
- natural events
- faults in design
- faults in construction
- intentional and wilful damage.

The identified threats were used to determine pipeline protection measures, hazard prevention, failure analysis and risk evaluation for credible threats. A total of 212 potential threats were identified in the SMS of which one of the 98 credible threats was evaluated as presenting an intermediate risk, with the rest presenting a low or negligible risk or not requiring further assessment. The threat defined as being an intermediate risk was the risk of the pipeline being punctured by vertical auger boring (drilling) to install new power poles.

Further evaluation of the potential damage caused to the pipeline by third-party drilling was undertaken in a formal As Low As Reasonably Practicable (ALARP) assessment to apply additional control measures. The assessment came up with additional controls including:

- additional marker posts for the pipeline in areas of high potential risk and where power poles are located within 10 metres of the pipeline
- liaison activities targeting telecommunication, large developers and excavation companies
- additional protective slabbing, greater than normal APA standards, whenever the pipeline is laid within three metres of an existing power pole.

The SMS uses land use classifications to inform direct threats to the pipeline and the consequence of a pipeline failure to adjacent existing and reasonably foreseeable future land uses. An outcome of this consideration of threat/consequence/likelihood is for the risk of a pipeline rupturing to be designed out to ALARP.

Most of the proposed pipeline adopts the design criteria consistent with a T1 (Residential) environment which is more conservative than the assigned land use classifications within the study area. The physical protective measures of wall thickness and depth of cover therefore exceed the requirements of AS/NZS 2885.1 for the known threats to the pipeline within the study area. The pipeline would be buried to a minimum depth of 1,200 millimetres throughout its length and deeper at rail crossings (2,000 millimetres) and watercourse crossings. The minimum depth of cover for normal excavations on land classified primarily as rural or rural residential is 750 millimetres according to AS/NZS 2885.1.

To control the potential threat from external interference due to road crossings (such as drain clearing and installation of services) by method of open cut trenching, the standard design for the pipeline would have protective slabbing from edge to edge of road easements. Protective slabbing would also be used in the vicinity of the Pakenham East rail depot, at road crossings in residential areas and near existing power poles.

APA would risk assess the exposure of the pipeline to lightning in accordance with the recommendations in AS 1768 *Lightning protection*, with any mitigation measures implemented in the design. The Pipeline Works design includes surge protection across all insulated flanges and monolithic isolation joints to prevent damage to the pipeline in the event of a lightning strike.

The pipeline would be subjected to in-line inspections to check the condition of the pipeline approximately 10 years after construction and then at a frequency determined by the first inspection.

The two mainline valve (MLV) stations provide isolatable sections of the pipeline that minimise gas volumes and allow for venting in the event of an incident leading to a release of gas. MLV1 would be operated remotely and MLV2 operated manually. Pressure would be monitored remotely at MLV1 with pressure deviation alarms indicating abnormal conditions on the pipeline.

The assumptions used in the risk evaluation process and the conclusions of the SMS would be reviewed on an ongoing basis during the pipeline's operation (at least every five years) and during routine pipeline patrols.

16.7 Emergency management and response

The approach to emergency management and response for the Project would be aligned with the Emergency Management Victoria framework. Emergency management and response would be a component of the emergency management structure implemented at Crib Point under the umbrella of the PoHDA Emergency Management Plan.

The Emergency Response Plan would set out requirements for:

- Emergency detection and shutdown systems, practices and procedures – including, for example: FSRU emergency and ship to shore systems; quick release hooks; jetty gas piping and emergency shutdown valves; shutdowns; gas and fire detection and alarms; fire detection and protection systems and fire mitigation.
- Contingency planning for responses to foreseeable incidents based on risk assessment processes and associated emergency procedures for responding to these contingencies – including, for example: oil spill response in the Port of Hastings; identification of levels of emergencies; emergency functions and organisation structure; emergency resources; reporting and notification associated with an emergency; and termination of an emergency response.
- An implementation strategy for managing the Emergency Response Plan including: training, reviews, continuous improvements; safety management systems; and critical control performance standards.
- Development and maintenance of procedures to align with the requirements of AS3745: 2010 *Planning for Emergencies in Facilities*.

16.8 Mitigation measures

The mitigation measures developed to avoid, minimise and manage potential hazards and risks are summarised in **Table 16-3**.

Surge protection

In the event of a lightning strike causing an electric current, insulated flanges and monolithic isolating joints would be surge protected.

Insulated flanges are equipped with plastic pieces that prevent the flow of an electric current between two metal surfaces, as part of the corrosion prevention system.

Monolithic isolating joints at the pipeline facilities allow for isolation of the pipeline from the facilities and provide insulation between above and below ground pipework.

Table 16-3: Mitigation measures – hazard and risk

Mitigation measure ID	Mitigation measure	Works area	Project phase
MM-HR01	**Gas Import Jetty Works safety standards** The Gas Import Jetty Works will be designed, constructed and operated to meet relevant safety standards. The FSRU will be designed, operated and maintained under the purview of DNV GL. It will comply with the Rules for Classification as required to retain its Class Notation. This will include requirements for inspection, maintenance and functionality of all on-board safety systems.	Gas Import Jetty Works	Design, construction and operation
MM-HR02	**Pipeline Works safety standards** The Pipeline Works will be designed, constructed and operated in accordance with AS/NZS 2885. This will include completion of a Safety Management Study with the identification of threats and appropriate mitigation measures including increased depth of burial, heavier duty piping and protective slabs.	Pipeline Works	Design, construction and operation
MM-HR03	**Process control system and automated emergency shutdown systems** The operation of the Gas Import Works and Pipeline Works will be monitored using high integrity process automation and shutdown systems. Abnormal conditions will have alarms locally and remotely to fully attended control rooms. Out of normal conditions will result in an automatic shutdown of gas operations via closing of emergency shutdown valves. The control, monitoring and shutdown systems will be fail-safe and be designed to best industry practices with redundancy. The pipeline is also fitted with two mainline valves along its alignment to limit loss of gas in the event of a leak. MLV1 can be closed remotely.	Gas Import Jetty Works and Pipeline Works	Design and operation
MM-HR04	**Fire protection** The FSRU or LNG carrier will be provided with their own onboard fire protection and suppression systems. This is a requirement of the DNV GL class notation. Active fire protection and suppression will be provided for liquid fires and gas fires on the jetty in compliance with Australian Standards. The design fire case for Berth 2 fire systems is a jet fire in the MLA area. The required firewater cooling rate is for the ship/shore manifold area, which is defined as the MLAs and associated piping and valves as well as for FSRU hull cooling. The diesel fuel supply will be designed for six hours of firewater per pump. The current design calls for two x 100% firewater pumps. The system will be designed as a dry pipe system (i.e. no requirement for a jockey pump to maintain pressure) and be designed for saltwater service, providing an indefinite supply of water. Fire and gas detection will be provided along the gas piping on the jetty.	Gas Import Jetty Works	Design and operation
MM-HR05	**Dangerous goods** Dangerous goods, as defined by the Australian Dangerous Goods Code, and flammable and combustible liquids will be stored and handled in accordance with the *Dangerous Goods Act 1985* (Vic), Dangerous Goods (Storage and Handling) Regulations 2012, EPA Victoria publication 1698 – *Liquid storage and handling guidelines* and all relevant Australian Standards including but not limited to the requirements of: • AS1940 – *The storage and handling of flammable and combustible liquids* • AS1210 – *Pressure vessels* • AS4343 – *Pressure equipment – hazard levels* • AS3846 – *The handling and transport of dangerous cargoes in port areas* • AS2941 – *Fixed fire protection installations – pumpset systems* • AS/NZS60079 – *Explosive atmospheres.*	Gas Import Jetty Works and Pipeline Works	Construction and operation
MM-HR06	**Monitoring of chemical and fuel storage facilities** Routine visual monitoring and recording of chemicals and fuel storage facilities will occur as part of routine operational practices.	Gas Import Jetty Works and Pipeline Works	Construction and operation

Mitigation measure ID	Mitigation measure	Works area	Project phase
MM-HR07	**Emergency response plans** Emergency response plans, such as for spills, will be developed and implemented for both the construction and operations phases of the Project.	Gas Import Jetty Works and Pipeline Works	Construction and operation
MM-HR08	**Site Safety Advisor** A suitably competent person will be appointed as Site Safety Advisor during construction and will have on-site a set of the relevant safety data sheets (SDS) for hazardous and dangerous materials available at the site office.	Gas Import Jetty Works and Pipeline Works	Construction

16.9 Conclusion

AGL and APA have undertaken and will continue to undertake formal safety studies and hazard assessments for the Project components. The approach adopted for the assessment included a review of the existing conditions, a review of the existing risk assessment and safety studies undertaken to date, and the identification of potential impacts arising from a major incident during operation of the Project.

During construction members of the public and workforce would be exposed to hazards routinely experienced in the construction of major infrastructure. While the Project is not introducing any new or unique construction hazards that are not already encountered on major infrastructure projects, there are nonetheless a range of hazards that would require mitigation during construction. Construction hazards relevant to public safety would be considered as part of Health, Safety and Environment risk workshops and management plans.

The risk studies continue to be developed as detailed design of the facility progresses. Final approvals will be required from relevant authorities for the final design. The operational hazards resulting from a release of flammable gas with subsequent ignition leading to a fire or explosion were a primary focus of the hazard analysis, risk assessments and safety studies completed for the Project. The Project will require various maritime and land-based approvals and be subject to rigorous safety requirements.

The pipeline SMS identified 212 threats to the Pipeline Works, of which credible risks were further evaluated and mitigation measures incorporated into the design. The physical protective measures of wall thickness and depth of cover for the pipeline meet the most conservative land use assigned for the study area (T1 – residential), therefore exceeding the requirements of AS/NZS 2885.1 for the known threats to the pipeline.

Preliminary QRA results show that fatality risk due to a potential major incident such as a fire or explosion at the Gas Import Jetty Works and the Pakenham Delivery Facility meet their respective adopted tolerable criteria for their surrounding land uses according to HIPAP4. This means these facilities do not present an unacceptable or disproportionate risk to any of the adjacent land uses.

The hazard and risks associated with the Project have been assessed in response to the **e**nergy efficiency, security, affordability and safety; and social, economic, amenity and land use draft evaluation objectives in the EES scoping requirements. With the implementation of the identified mitigation measures and further risk assessments, potential hazardous risks during Project construction and operation to people, property and the environment would be reduced so far as is reasonably practicable.