Australia Pacific LNG Project

Volume 3: Gas Pipeline

Chapter 22: Hazard and Risk

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22.1 Introduction

22.1.1 Purpose

This chapter of the environmental impact statement (EIS) identifies the potential hazards and risks associated with the design, construction, operation, maintenance and decommissioning of the main gas transmission pipeline (the gas pipeline), and discusses measures to mitigate any of the identified potential impacts.

Coal seam gas (CSG) will be transported from the gas fields to the liquefied natural gas (LNG) facility on Curtis Island near Gladstone via a buried high pressure gas pipeline approximately 450km long. Details of the proposed gas pipeline design, route and construction methods are presented in Volume 3 Chapter 3.

This chapter is largely based on Marsh Pty Ltd's studies and technical report in Volume 5 Attachment 46. Australia Pacific LNG has also undertaken a preliminary safety management study of the gas pipeline system in accordance with Australian Standard AS 2885.1: Pipelines – Gas and liquid petroleum. A summary of the findings of the preliminary safety management study is provided in Volume 5 Attachment 49 for the gas pipeline system.

The process of identifying hazards and risks has involved the following:

- Background research on the properties and characteristics of CSG
- Review of industry experience of pipeline incidents
- Hazard identification workshops specific to the Project
- Review of risks identified within Origin's existing risk registers relevant to the Project.

Hazards were identified and a risk register prepared. The hazards, which are based on abnormal events, natural hazards or accidents are summarised in this chapter. Hazards and risks are presented in four main sections:

- Section 22.3 outlines the potentially dangerous goods and hazardous substances associated with the Project
- Section 22.4 outlines the risks to the surrounding environment, based on Marsh's technical reports. This includes a consequence analysis of hazards considered to represent significant consequences in the area of the gas pipeline
- Section 22.5 outlines the hazards and risks based on the preliminarily safety management study
- Section 22.6 outlines risks to health and safety.

The potential hazards and risks associated with the gas fields are discussed in Volume 2, and those associated with the LNG facility are discussed in Volume 4. An overall summary of the risk assessment process is presented in Volume 1 Chapter 4.

Australia Pacific LNG's key sustainability principles will be applied to the planning, design, construction, operation, maintenance and decommissioning of the gas pipeline to ensure associated hazards and risks do not aversely impact people or the environment.

Of the 12 Australia Pacific LNG sustainability principles, the following are most relevant to the gas pipeline hazard and risk component of the EIS:

- Adhering to an overriding duty to safety, ensuring operations are carried out in a safe manner and empowering employees and contractors to place safety considerations above all other priorities
- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

The ultimate objective is to design, construct and operate the gas pipeline in such a manner as to ensure a minimal impact on the surrounding environment and community, with no substantial residual risk to public amenity and ensuring the safety of those in proximity to the gas pipeline and associated facilities. The strategies outlined in this EIS will demonstrate how these sustainability principles will be addressed.

22.1.2 Scope of work

A preliminary assessment of the hazards and risks associated with the gas pipeline, from the gas processing facilities to the LNG facility on Curtis Island, has been conducted and distances to hazard end points have been estimated. This is part of an ongoing process that will see the hazards and risks assessed throughout the life of the Project. Hazard and risk assessments will be conducted for the design, construction, commissioning, operations and decommissioning stages, and these hazards and risks will also be reviewed at regular intervals throughout the life of the Project. A detailed safety management study of the gas pipeline will be conducted in the detailed design stage.

Management strategies are presented, which reduce the risks to as low as reasonably practicable, low or negligible. The broad aim of Australia Pacific LNG is to avoid risk whenever it is practical to do so.

This chapter addresses general process hazards and risks and major accident events. Hazards and risks related to air emissions including odours and greenhouse gases, dust, noise and vibration, water quality, soil including acid sulfate soil, wastes, and societal hazards and risks are included in other chapters of this EIS. The relevant chapters describe the related hazards and outline controls to reduce the risk. For example, air emissions are further discussed in Volume 3 Chapter 13.

22.1.3 Legislative framework

Queensland legislation

Volume 1 Chapter 2 provides an overview of the general regulatory framework as it applies to the entire project. While current legislation is outlined in the following sections, the Project will be undertaken in accordance with the legislative requirements in force over the course of the Project. Legislation relevant to potential hazards and risks associated with the gas pipeline is listed below. The relevance of these to the Project is then explained.

Petroleum and Gas (Production and Safety) Act

The *Petroleum and Gas (Production and Safety) Act 2004* (PAG Act) regulates petroleum and natural gas in Queensland. It aims to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry.

Petroleum activities include:

- Exploration, distillation, production, processing, refining, storage and transport of petroleum
- Distillation, production, processing, refining, storage and transport of fuel gas
- Other activities authorised under the Act for petroleum authorities.

One facet of the Act is to achieve this in a way that minimises land use conflicts and encourages responsible land use management.

The safety obligations contained in the Act apply to an operating plant as defined in the Act. Specifically, the Act mandates the application of AS 2885 (discussed below), and so this Australian Standard becomes a legislative requirement under this Act**.**

Dangerous Goods Safety Management Act

The *Dangerous Goods Safety Management Act 2001* sets out the obligations and requirements relating to the storage and handling of dangerous goods and combustible liquids, and the safe operation of major hazard facilities in Queensland. Dangerous goods are defined with reference to the 'Australian Code for the transport of dangerous goods by road and rail'.

The *Dangerous Goods Safety Management Regulation 2001* sets out specific obligations for people who manufacture, import, supply, store or handle stated dangerous goods or combustible liquids, or who supply or install equipment for storing or handling those materials.

The Act and regulation are concerned with protecting against harm or injury to people or damage to property or the environment arising from an explosion, fire, harmful reaction or the evolution of flammable, corrosive or toxic vapours involving dangerous goods; or the escape, spillage or leakage of any dangerous goods. They also define the criteria by which a facility will be classified as a 'large dangerous goods location' or a 'major hazard facility'. Additional risk minimisation requirements are defined for such facilities so the necessary licenses must be obtained to operate.

However, certain parts of the Act and regulations do not apply to:

- Land that under the PAG Act is used to obtain, produce or transport petroleum
- Pipes under the PAG Act (other than pipes within the boundaries of a major hazard facility or large dangerous goods location).

Therefore, the gas pipeline is not considered a major hazard facility and will be primarily governed by the PAG Act. Major hazard facilities are administered by the Hazardous Industries and Chemicals Branch within the Department of Justice and the Attorney-General, whilst the gas fields and gas pipeline will be administered by the Queensland Mines and Energy branch of the Department of Employment, Economic Development and Innovation. The Project will obtain the necessary licenses and authorities to operate under the PAG Act.

Explosives Act

The *Explosives Act 1999* provides for the regulation of explosives, including approval to manufacture, possess, sell, store, transport or use explosives in order to ensure the safety of the community from all activities associated with explosives.

For example, if explosives are required for blasting along gas pipeline routes, a licence or approval under this Act will be required for the purchase, transportation and use of explosives.

Radiation Safety Act

The *Radiation Safety Act 1999* provides for the regulation of radioactive substances. There could be radioactive sources used for weld testing or other purposes. Australia Pacific LNG will ensure radioactive source users have the required licence and an approved radiation safety and protection plan, detailing radiation protection measures.

Workplace Health and Safety Act

The *Workplace Health and Safety Act 1995* establishes a framework for preventing or minimising workers' exposure to risks by, among other things, imposing safety obligations on certain persons and establishing benchmarks for industry through the making of regulations and codes of practice. The Act does not apply to operating plant, within the meaning of the PAG Act on land the subject of a petroleum authority under the PAG Act or petroleum tenure under the *Petroleum Act 1923*.

The *Workplace Health and Safety Act* will apply for most construction activities.

Coal Mining Safety and Health Act

The *Coal Mining Safety and Health Act* 1999 regulates the operation of coal mines, to protect the safety and health of persons at coal mines and persons who may be affected at coal mining operations. These objects are achieved by, among other things, imposing safety and health obligations on certain persons and providing for safety and health management systems.

The *Coal Mining Safety and Health Act 1999* may be relevant to the Project to the extent that any exploration, construction, extraction, processing or treatment of CSG occurs on a coal mining lease or in an area contiguous, adjoining or adjacent to a coal mining lease. With respect to this, the gas pipeline passes through the Callide Coalfields.

Fire and Rescue Service Act and Fire and Rescue Service Regulation

The *Fire and Rescue Service Act 1990* and Fire and Rescue Service Regulation 2001 requires the operator to establish effective relationships with the Queensland Fire and Rescue Service to provide for the prevention of and response to fires and certain other incidents endangering persons, property or the environment and/or for related purposes or activities.

Relevant state planning policies

Various state planning policies may be relevant to the development of the gas pipeline. The following two policies have particular relevance to the hazard and risk section of the gas pipeline element of the Project:

State Planning Policy 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide

This policy requires that developments should minimize the potential adverse impacts of flood, bushfire and landslide on people, property, economic activity and the environment. The policy has

effect when development applications are assessed, when planning schemes are made or amended and when land is designated for community infrastructure.

State Planning Policy 2/02, Planning and Managing Development Involving Acid Sulfate Soils

This policy will apply during the construction phase of the gas pipeline for the low-lying land at Gladstone, due to the potential impact on the environment. The effects of acid sulfate generation from such soil disturbance also has the potential to increase corrosion of the gas pipeline.

Whilst development of the gas pipeline is exempt from assessment under local government authority planning schemes, Australia Pacific LNG will apply the principles and objectives set out in relevant State Planning Policies to the design, construction and operation of the gas pipeline.

Relevant national and international standards

The key standards that apply to hazard and risk assessment for the Project are outlined below.

AS 2885: Pipelines - Gas and liquid petroleum

AS 2885 refers to a set of Australian Standards concerning gas and liquid petroleum pipelines which are relevant to the Project's gas pipelines. This is the primary Australian Standard to be used as a basis for the design, construction and operation of the Project's gas pipelines. Part 1 of this standard, AS 2885.1-2007: Pipelines - Gas and liquid petroleum - Design and construction, defines the requirements for the design and construction of gas pipelines.

Key requirements of AS 2885 limit the consequence and likelihood of off-site impacts and these requirements will be implemented as part of the Project, including:

- Development of a 'fracture control plan', to ensure selection of gas pipeline material which is resistant to brittle or ductile fracture
- Provide a level of resistance to penetration of the gas pipeline to reduce the likelihood of penetration and significantly reduce the likelihood of a full bore rupture
- Prevention of rupture in 'high consequence' class locations
- Maximum tolerable energy release rates – this limits the radiated heat flux generated from a fire.

Guides referred to in AS 2885.1 include SAA HB105-1998 and HIPAP 4 as outlined below.

HB 105-1998: Guide to pipeline risk assessment in accordance with AS 2885.1

This guide forms the basis for the risk assessment of pipelines in accordance with AS 2885.1.

Risk Criteria for Land Use Safety Planning (Hazardous Industry Planning Advisory Paper no. 4)

This advisory paper, referred to as HIPAP No. 4, which is directed in the terms of reference, outlines the consequences of heat flux and overpressure, which are referred to in the 'Guide to pipeline risk assessment in accordance with AS2885.1 1998' produced by Standards Australia and in 'Guidelines for major hazard facilities C Systematic risk assessment 2008' produced by the Queensland Government. The paper and associated consultation draft 'Revised planning guidelines for hazardous development, August 2008' provide risk criteria for land uses in the vicinity of hazardous industries.

AS/NZS ISO 31000:2009: Risk management - Principles and guidelines

This Australian Standard provides a framework for evaluating potential hazards and reducing the risk of those hazards. The associated Risk Management Code of Practice 2007 and its supplements

provide information on how risk management can be achieved. This standard replaces the recently superseded AS 4360: Risk Management.

Other standards

Below is an indicative list of other major standards that will be applicable to the Project. It is recognised that there are other national standards, codes of practice, advisory standards and guidance notes of relevance that are not indicated in this list:

- AS 1170.4-2007: Structural design actions - Earthquake actions in Australia
- AS 1885.1-1990 Workplace Injury and Disease Recording Standard in the Workplace
- AS 2865-1995 Safe Working in a Confined Space (NOHSC:1009(1994))
- AS 2958 Earth Moving Machinery – Safety
- AS 3868-1991 Earth-moving machinery - Design guide for access systems
- AS 4024 Safety of machinery
- AS/NZS 4801:2001: Occupational health and safety management systems - Specification with guidance for use
- AS/NZS 60079.10.1:2009: Explosive atmospheres - Classification of areas - Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0(2008) MOD)
- AS IEC61511:2004: Functional Safety – Safety instrumented systems for the process industry sector
- National Standard for Construction Work [NOHSC: 1016 (2005)]
- National Standard for Manual Tasks (2007)
- National Standard for Occupational Noise [NOHSC: 1007 (2000)]
- National Standard for Plant [NOHSC: 1010 (1994)]
- Australian Code for the Transport of Dangerous Goods by Road and Rail, 7th Edition
- Australian Code for the Transport of Explosives by Road and Rail, 3rd Edition
- National Code of Practice for the Control of Workplace Hazardous Substances [NOHSC: 2007 (1994)]
- National Code Of Practice for Induction for Construction Work, May 2007
- National Code of Practice for the Prevention of Falls in General Construction, April 2008
- The National Code of Practice for the Prevention of Musculoskeletal Disorders from Performing Manual Tasks at Work (2007)
- National Code of Practice for the Prevention of Occupational Overuse Syndrome [NOHSC:2013(1994)]
- Mobile Crane Code of Practice 2006
- Plant Code of Practice 2005
- Risk Management Code of Practice 2007

- Traffic Management for Construction or Maintenance Work Code of Practice 2008.

22.2 Methodology

Australia Pacific LNG, through Origin Energy, has a system of risk management which uses the concepts based on AS/NZS ISO 3100:2009: Risk management - Principles and guidelines. Risk management is considered as the systematic and ongoing process of hazard identification, assessment, treatment and monitoring.

The risk management methodology used by Australia Pacific LNG in undertaking the risk assessment for the EIS stage of the Project is outlined in Volume 1 Chapter 4.

22.3 Hazard and risk assessment

Australia Pacific LNG will design the gas pipeline so that it is inherently safe. Risk assessment is considered an important part of this process. Australia Pacific LNG will use risk assessments throughout the life of the Project to capture and treat the various hazards and risks associated with its activities.

Origin has been operating gas pipelines for a number of years. This has allowed them to develop and accumulate fairly extensive risk registers for the construction, operation and decommissioning of existing gas pipelines. These provide a good initial basis for evaluating the potential hazards and risks the Project will introduce. Potential hazards range from bites from venomous snakes through to hazards from construction of, and operating and maintaining, industrial plant and equipment.

Hazards were identified through a review of Origin's existing risk registers, with a reference to initial designs and a review of related industry hazards. Scenarios were then developed to establish credible events that could conceivably impact persons, property or the environment. Where hazards were significant and quantifiable, distances to hazard end points were determined. The overall gas pipeline hazard and risk assessment and the preliminary safety management study have been completed in accordance with the requirements of the Australian Standard for gas and liquid petroleum pipelines (AS 2885).

22.3.1 CSG properties and potential hazards

Analysis of the CSG from the Walloons gas fields shows that the methane content is greater than 97%. Methane is an odourless, non-toxic and non-corrosive gas and is lighter than air above minus 110^{o}C. The lower and upper flammability limits of methane are 5% and 15% respectively. This means if the concentration of methane in air is less than 5%, the gas mixture is too dilute to burn and if it is greater than 15% there is not enough oxygen for it to burn. The auto-ignition point for methane is 580^{o}C. This is the minimum temperature required to ignite the gas in air without a spark or flame being present.

Methane is also an asphyxiant. Asphyxia begins to be significant if the oxygen concentration is reduced to below 19.5%.

Methane is compressible and a release of high pressure methane will result in localised low temperatures due to expansion cooling (Joule – Thompson effect).

22.3.2 CSG release and fire types

When CSG is released there will not necessarily be a fire. The potential outcomes are:

- Gas release without a fire
- Immediate ignition and fire
- Delayed ignition resulting in a flash fire, or vapour cloud explosion if in a confined area, and resultant jet fire.

Note that boiling liquid expanding vapour explosion and pool fires are not considered in this section of the EIS, as there will not be any liquefied CSG or other liquefied hydrocarbons in the gas pipeline element of the Project.

A gas release will not result in a fire if the gas is not exposed to an ignition source.

If an ignition source is present near the release point a fire could occur. If a release of CSG occurs at low pressure and low velocity, any resultant fire would resemble standard combustion. A methane flame is typically quite difficult to see in daylight conditions. A release of CSG ignited and under pressure would result in a 'jet fire'. A jet fire has the shape of a cone.

If a gas release does not ignite immediately, a gas cloud may form which could find an ignition source distant from the point of release. A flash fire or vapour cloud explosion may occur under these circumstances. A flash fire is the term for a slow deflagration of a premixed, truly unconfined, unobstructed gas cloud producing negligible overpressure. Thermal effects are the main hazard.

A vapour cloud explosion is an explosion occurring with the release of a large quantity of flammable gas, which ignites following the formation of a cloud or plume of pre-mixed fuel and air. For a vapour cloud to explode, there is a minimum and maximum ratio of fuel vapour to air within which ignition can occur. This range is 5 to 15% for methane. It is unlikely that there would be enough confined gas in a cloud in the given ratios in a confined space for a vapour cloud explosion to occur. For gas that could ignite, it has a greater prospect of combustion via a flash fire mechanism, which generally does not create a damaging pressure wave and thus a vapour cloud explosion is unlikely to occur.

22.3.3 Hazardous substances

CSG is itself considered a hazardous substance. CSG, consisting predominantly of methane, is a flammable gas and asphyxiant as described in Section 22.3.1. Other potentially hazardous substances are described below.

Before CSG is transmitted through the pipeline and during decommissioning, the gas pipeline may potentially be purged with nitrogen. Nitrogen is a colourless, odourless and tasteless gas that comprises approximately 78% of the Earth's atmosphere. There have been a number of fatalities in Australia, Canada and the United States from accidental nitrogen asphyxiation in the mining industry. Only reputable and experienced nitrogen purging contractors will be utilised. Enclosed spaces will be minimised, leaks will be monitored and remedial action taken, during commissioning and decommissioning to ensure this risk does not eventuate.

Typical material used for gas pipeline construction consists of:

- Line pipe – steel
- Consumables (welding rods, grinding discs, and so on)
- External coating and field joint coating materials
- Sand bags or polystyrene foam blocks
- Slag or garnet for sand blasting pipes

- Markers, post and signs
- Fuels and lubricants
- Fencing.

There will be no substantial use or storage of hazardous substances related to gas pipeline operations and there is unlikely to be a substantial use or storage of hazardous substances during construction. Fuels and lubricants will be used as a part of vehicle transport and equipment maintenance and are unlikely to be stored near the gas pipelines.

Any chemicals, including fuels and lubricants, are likely to be in smaller quantities, and will be managed using material safety data sheets and dangerous goods guidelines.

22.4 Gas pipeline hazards and risks

The major hazards identified for the gas pipeline are presented in the following sections. For each risk, the potential hazard, the possible causes, the foreseeable consequences and key controls are presented in tables. These tables are based on numerous risk workshops conducted during the EIS studies, which included relevant experts and experienced personnel.

There is some overlap between the risks for the gas fields (Volume 2) and gas pipeline (Volume 3). Potential hazards and risks are described for the drilling, construction, operation and decommissioning phases within the following areas:

- Plant and equipment – gas pipeline
- Natural hazards
- Vehicles and traffic.

The gas pipeline is considered to begin at the pig launcher at the beginning of the pipeline, which includes the Woleebee and Condabri lateral pipelines, and is considered to end at the pig receiver where it joins Australia Pacific LNG's proposed LNG facility near Laird Point. The gas pipeline consists of three sections which are summarised in Table 22.1.

The high pressure gas pipeline network from the outlet of each gas processing facility to the start of the laterals is at essentially the same pressure and presents similar hazards to the gas pipeline, which is the subject of this volume of the EIS. For further information about the hazards and risks of this pipeline network refer to Volume 2 Chapter 22.

Table 22.1 Proposed gas pipeline diameters and lengths

Section	Nominal diameter of pipe (inches)	Length of pipeline (km)
Main pipeline	42	362
Condabri lateral	36	44
Woleebee lateral	30	38

The construction of the gas pipeline will include establishment of temporary accommodation facilities and laydown areas. Vehicle transport to and from the accommodation facilities, pipelines, major towns, airports and rail stations will be required. Vehicles, such as light vehicles, excavators, trenching machines and diggers will be utilised for gas pipeline construction. The gas pipeline will be underground with the pipeline surfacing at 'scraper stations' along the route. The gas pipeline will

cross several roads, whose amenity will be maintained during the construction and operation phases of the Project, these include Warrego Highway, Eidsvold to Theodore Road and Dawson Highway.

The gas pipeline will be constructed by trenching, boring under roads, and horizontal directional drilling (HDD). Intermittent scraper stations allow the insertion and retrieval of devices known as 'pigs' to internally clean and inspect the pipe. Australia Pacific LNG proposes to use 'intelligent pigs', which collect various forms of data, such as pipeline wall thickness and profile. A supervisory, control and data acquisition system will be installed and used to monitor and control the gas flows. The gas pipeline will be patrolled both aerially and on the ground. The pipes will have an external coating and impressed current cathodic protection to reduce the risk of corrosion. The pipes will be welded and non-destructive testing will be undertaken on the welds to check the weld integrity.

22.4.1 Plant and equipment

Gas pipeline design and whole of life safety management

Many of the potential hazards and risks in the construction and operation of the gas pipeline will be taken into consideration in the design of the gas pipeline. The design features will prevent many of the potential hazards from occurring or reduce the damage that could occur.

The design and construction of the gas transmission system will be based on AS 2885, which covers the gas pipeline itself and associated equipment, such as compressor and meter stations. The objectives and fundamental principles of the standard include:

- Safety of the general public and pipeline personnel
- Protection of the environment
- Security of supply.

To comply with AS 2885:

- Australia Pacific LNG will be responsible for the safety of the gas pipeline.
- All threats to a gas pipeline will be identified and either controlled or the associated risks will be evaluated and managed to an acceptable level
- The gas pipeline will be designed and constructed to have sufficient strength, ductility and toughness to withstand all design loads to which it may be subjected during construction, testing and operation. The design will be reviewed, assessed and approved
- Before the gas pipeline is placed into operation, it will be inspected and tested to prove its integrity
- The integrity and safe operation of the gas pipeline will be maintained in accordance with an approved safety and operating plan
- Where changes occur in or to a gas pipeline or its surroundings, which alter the design basis or affect the original integrity, appropriate steps will be taken to assess the changes and where necessary implement modifications to maintain safe operation of the gas pipeline.
- At the end of its system design life, the gas pipeline will be abandoned unless an approved engineering investigation determines that its continued operation is safe
- Before a gas pipeline is abandoned, an abandonment plan will be developed and approved.

Australia Pacific LNG will develop and maintain a safety management plan incorporating a whole of life safety management approach, which will include risk management, safety management studies, construction safety management plans, safety and operating plans, safety audits and reviews as indicated in which will meet AS 2885 and PAG Act requirements.

In accordance with AS 2885, the principal gas pipeline safety design requirements are determined according to different location classifications, which are based on the nature and population density of adjacent land uses. Minimum standards are specified for protection of the gas pipeline against failure, and for limitation of the potential consequences of a failure at these different location classifications. The standard also requires that the gas pipeline be designed to limit the maximum credible release for certain location types. The gas pipeline design will comply with the maximum credible release requirements outlined in AS 2885 in any given location. For example, the maximum credible release rate will be limited to 10 gigajoules per second when the gas pipeline is in a location considered residential, industrial or sensitive. This is described in Table 22.2.

Table 22.2 Maximum credible release requirements

Location class	Maximum credible release rate (gigajoules per second)
Residential	
Industrial	10
Sensitive (e.g. hospitals, aged care, schools)	
High density residential	1

Figure 22.1 from AS 2885 shows a whole-of-life gas pipeline safety management approach. Australia Pacific LNG will use this approach and manage each part of the life of the gas pipeline from preliminary design to abandonment. The stated studies, management and safety plans will be developed at each stage over the life of the gas pipeline.

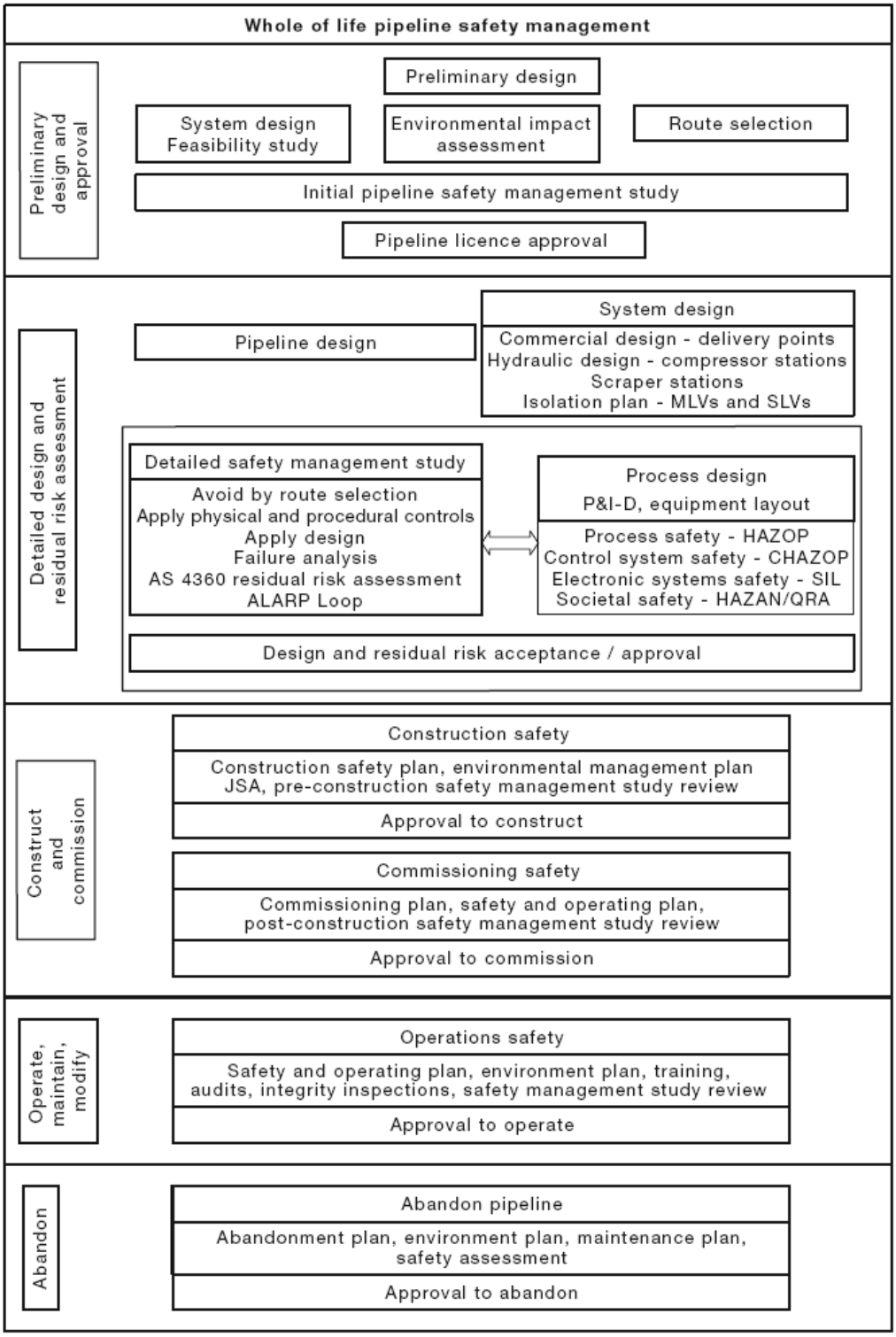

Figure 22.1 Whole of life gas pipeline safety management (AS 2885.1)

Gas pipeline construction

The majority of the gas pipeline will be constructed by open-cut trenching and backfill. Thrust boring will be used to cross roads, railways and other infrastructure and HDD will be used to for the marine crossing of The Narrows at Port Curtis. The potential risks that may arise during the construction phase and which could impact the wider community are outlined in Table 22.3.

Health and safety risks to workers onsite, such as risks associated with manual handling and falling pipe, are further outlined in Section 22.6.

Australia Pacific LNG will employ reputable contractors for the construction of the gas pipeline, and will work with them to develop construction procedures for the entire operation. This will include areas that will need to be barricaded, vehicle management plans, assessment of the location and height of powerlines and design of the gas pipeline.

Table 22.3 Potential gas pipeline construction hazards

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Damage to infrastructure during construction	Excavation Use of explosives Vehicle impact	Interruption to community or business Injury or death	Identification of infrastructure Surveys Controlled use of explosives by trained and licensed contractors Vehicle management plan Reputable pipeline construction contractors Construction safety management plans	Low
Person, fauna or vehicle falling into open excavations or trenches	Unexpected open excavations	Damage to vehicles Injury or fatality Loss of fauna	Boring of pipeline at road crossings Construction safety management plan Environmental management plan Barricades Identification	Low
Overhead electrical transmission power line damaged	Boring and trenching operations Pipeline construction equipment operated by or transported under power lines and interfering/ making contact with live lines Mechanical impact	Interruption to power Electrocution and /or fatality	Standard operating procedures for boring and trenching Gas pipeline route Height of transmission powerlines Potential use of isolation devices	Low
Damage to data cables	Excavation Use of explosives	Loss of service Electrocution and/or fatality	Standard operating procedures for explosives Dial before you dig (or use explosives)	Low

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Uncontrolled detonation of explosives	Fire or spark as an ignition source leading to detonation Misfire Premature detonation Overcharge Radar in close proximity (airport)	Fatality or serious injury Potential rupture of adjacent gas pipeline Explosion	Qualified explosives operator Exclusion zone and radio silence or shielded fuses whilst undertaking explosive operations	Low
Accommodation fire	Electrical fault Naked flame Hot oil Source of fuel and ignition Kitchen fire	Loss of infrastructure Injury or death	Smoke detectors installed and operational Fire fighting equipment installed and operational Emergency response procedures Ongoing education and training of persons	Low
Infrastructure collapse	Design failure Deliberate damage or sabotage Maintenance oversight	Equipment damage Damaged pipeline Fatality or injury	Infrastructure designed to standards Hazard and risk identification throughout the project Liaison with authorities Emergency response procedures Standard operating procedure for explosives Exclusion of persons from construction sites	Low
Exposure to radiation	Radioactive sources used for instrumentation e.g. x-ray for pipeline integrity Time near source and distance from source Radiation source is dropped or lost	Radiation sickness	Non-destructive testing personnel are licensed according to the *Radiation Safety Act 1999* Reputable weld testing service acquired	Negligible

Gas pipeline operation and maintenance

Some of the potential hazards involved in the operation and maintenance of the gas pipeline are outlined in Table 22.4. Australia Pacific LNG will undertake maintenance and conduct inspections for the commissioning, operation and decommissioning of the gas pipeline to prevent such risks. Procedures will include the steps for normal operation, pigging, corrosion, isolation and repairs. Specific procedures will be developed for emergency situations. Prior to commissioning, a full commissioning plan and a safety and operating plan will be developed, and maintenance and inspections persons will be fully trained in these procedures.

Australia Pacific LNG will conduct regular training sessions and undertake regular auditing and integrity inspections. Auditing and integrity inspections will be conducted for the gas pipeline (as per AS 2885.1) and for associated infrastructure. Auditing will also include compliance with standards, operating and safety procedures. The safety plan will be regularly reviewed and updated based on feedback, which will be proactively obtained. Other controls will include:

- Traffic management
- Consultation with the local community
- Signage and identification of buried pipe
- Safety, operational, inspection and maintenance procedures
- Ongoing training and education of site personnel
- Environmental management plans.

With the implementation of these controls the risks during operations and maintenance will be negligible or low.

Table 22.4 Potential operation and maintenance hazards

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Slow leak	Hole in gas pipeline Corrosion (corrosion escalated by acid sulfate soils)	Asphyxiation Loss of gas	See below	Negligible
Gas pipeline rupture - buried	Excavation Earthquake Corrosion Dredging through The Narrows	Jet flame fire or flash fire Injury or fatality	Selection and placement of gas pipeline easement Design standards for potential earthquake loads Gas pipeline designed to prevent full bore rupture Depth of cover Gas pipeline markers and signage Leak detection from operating parameters or other means	Low

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
			Regular pigging Remote monitoring of pressure and flow Remotely operated isolation at mid line valves Corrosion inhibitor and cathodic protection Emergency response procedures	
Gas pipeline rupture - surface	Mechanical failure of pipe / flanges / valves (such as caused by corrosion) Damage from vehicle collisions Mechanical impact Earthquake External interference Bushfire	Jet flame fire or flash fire Injury or fatality	Design standards for potential earthquake loads Gas pipeline designed to prevent full bore rupture Quality assurance of installed equipment Inspection and condition monitoring program Secured area around aboveground gas pipeline infrastructure Remote monitoring of pressure and flow Remotely operated isolation valves Emergency response procedures	Low
Rupture of adjacent gas pipeline	Use of explosives during construction Excavation or drilling Earthquake Australia Pacific LNG gas pipeline rupture Dredging	Jet flame fire or flash fire Injury or fatality	Gas pipeline survey to ensure separation distance Controlled use of explosives by trained and licensed contractors Emergency response procedures See above	Negligible
Underwater gas leak from pipeline through The Narrows	Mechanical failure Corrosion Earthquake Dredging through The Narrows	Flammable gas cloud and flash fire Impact on marine environment	Quality assurance of installed equipment Design standards for potential earthquake loads Gas pipeline designed to prevent full bore rupture Corrosion inhibitor and cathodic protection	Negligible

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
			Depth of cover Remote monitoring of pressure and flow Remotely operated isolation valves Emergency response procedures	

Decommissioning hazards

Gas pipeline decommissioning involves the pigging, flushing, filling, and plugging of each line, followed by abandonment in place. Rehabilitation of land will be undertaken where necessary, such as revegetation. Potential hazards associated with decommissioning are outlined in Table 22.5. The potential hazards involved in decommissioning will be further assessed closer to the decommissioning date, as techniques and requirements are likely to change. Initiatives will potentially include an abandonment plan, environment plan, maintenance plan and safety assessment.

Table 22.5 Potential decommissioning hazards

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Gas pipeline gas explosion during decommissioning	Unpurged gas pipeline and introduction of hot work Corrosion leakage with introduction of hot work	Explosion Injury and fatality	Decommissioning safety plan Purging of gas pipeline Assessment of corrosion Pigging before purging	Low

22.4.2 Natural hazards

Natural disasters

Potential hazards related to natural disasters are presented in Table 22.6. The likelihood of any damage in the event of a natural disaster will be significantly reduced through the design of the gas pipeline and associated equipment and facilities. Emergency response plans will be developed for at least the following scenarios and adhered to in any disaster and these will include procedures for evacuation of personnel, containment of equipment and protection of the environment. The controls that will be in place will reduce the risk to acceptable levels.

Note that climate and climate change is further discussed in Volume 3 Chapter 4 and that emergency response plans are included in Section 22.7.

Table 22.6 Potential hazards related to natural disasters

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Geology and geomorphology	Earthquake Landslide Subsidence	Gas pipeline rupture Property and equipment damage Environmental harm Injury to person	Design of gas pipeline to withstand such events Location of gas pipeline away from vulnerable areas Ongoing monitoring and inspections of gas pipeline Emergency response plans	Negligible
Storms	Wind Rain Dust	Equipment damage Injury to persons	Observe weather forecasts, warnings and updates from the Bureau of Meteorology Emergency response plans	Low
Cyclones	Seasonal and weather related	Damage to vehicles and equipment Injury or death of people	Observe weather forecasts, warnings and updates from the Bureau of Meteorology Design of equipment for storm events Emergency response plans Buried gas pipeline	Low
Floods	Excessive rain River flows	Scour and erosion (loss of vegetation and soil) Loss of gas pipeline integrity Damage to equipment and vehicles	Observe weather forecasts, warnings and updates from the Bureau of Meteorology during construction phase Emergency response plans	Negligible

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
		Health and safety risks to people Drowning	Avoiding remote locations during heavy weather Travel management Burial of gas pipeline and reinstatement of water course crossing to avoid wash away	
Lightning	Storm weather Lightning attractors	Damage to equipment or facilities Injury or death of people	Observe weather forecasts, warnings and updates from the Bureau of Meteorology Lightning protection for at risk structures Cessation of certain activities during lightning, e.g. explosive activities, standing near/under attractors Emergency response plans	Negligible
Heat wave	High temperatures Climate change	Equipment damage Heat stress or death of vulnerable persons Cancer from sun exposure	Education and training Management of persons Heat stress emergency response procedures Design of equipment and utilities for high temperatures and increased demands Use of personal protection equipment, sunscreen and shade	Negligible

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Bushfire	Friction / Dry material Sources of ignition	Damage to vehicles, equipment and facilities Injury or death of people	Observe weather forecasts, warnings and updates from the Bureau of Meteorology Observation of total fire bans for high risk days / seasons Education and training Emergency response plans Bushfire breaks (maintain clearance around gas pipeline and temporary accommodation facilities) Smoke detection at the temporary accommodation facilities Fire prevention during construction Maintain contact with and obtain advice from rural fire services	Low

Wildlife and disease vectors

Personnel will be exposed to potentially hazardous wildlife, including snakes and spiders, and disease vectors, such as, mosquitoes, rats and flies in the Project area.

Venomous snakes and spiders are known to inhabit the gas pipeline area. Project personnel will be alerted to the risk of snakes and the areas where they are commonly found, such as in long grass or under rocks. First aid training and treatments will be provided.

Mosquitoes are able to transmit viruses such as dengue fever or Ross River fever. Australia Pacific LNG will control mosquito breeding at any temporary ponds during construction and other water areas. The potential for malaria, which has been eradicated from Australia, and disease vectors for other exotic diseases that might be entertained as a result of migration or climate change will be further assessed, if the risks became credible.

The control of disease vectors, such as, insects and rodents is necessary for the maintenance of health and hygiene in any location. Controls are via items, such as screen doors, hygienic practices, covered waste disposal, sanitation and sewerage systems. Accommodation and office areas will be treated to minimise exposure in these environments. Controls will be monitored for effectiveness, verified by means such as audits and inspections or, where appropriate, microbiological sampling of environment and food contact surfaces will be undertaken. These controls will be regularly reviewed and adapted to reflect changed circumstances.

22.4.3 Vehicles and traffic

The potential hazard and risk aspects of road transport and traffic will be managed across the Project through the three elements of road design, vehicle design, and behaviour management of drivers and pedestrians. Potential vehicle and traffic hazards are outlined in Table 22.7. Traffic and transport impacts and their management are further outlined in Volume 3 Chapter 17.

The increase in heavy and light vehicle traffic is considered to have a high residual risk level despite the application of controls to as low as reasonably practicable and the application of controls beyond those required, such as on public roads. Due to the potential fatal consequences of a vehicle accident and the fact that the likelihood related to the background risk of a vehicle accident is high, the residual risk of a vehicle accident to persons and fauna remains high.

Australia Pacific LNG fleet vehicles and hire vehicles used by project personnel will be fitted with an in-vehicle monitoring system. Drivers will be required to comply with a corporate local transport directive, which makes journey planning mandatory.

It is difficult for Australia Pacific LNG to reduce the residual risk further as the designs of public roads and the behaviour of other road users is beyond its control. However, Australia Pacific LNG will actively engage with the relevant authorities to identify particular risks and participate in ongoing campaigns to reduce the likelihood and consequences of vehicle accidents.

Table 22.7 Potential vehicle and traffic hazards

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Increased heavy and light vehicle traffic	Transport of pipe and other materials (e.g. bedding sand, water) required to construct the gas pipeline Movement of large numbers of construction and operation staff at shift changes Addition of high volumes along previously low trafficked routes	Elevated risk of serious or fatal motor vehicle accidents Increased risk in areas outside of regular emergency services contact Increased risk of fauna injuries and deaths	Driver fatigue monitoring Enforced speed limits on project vehicles Use of buses to move people - avoid having private vehicles onsite. Restricted access to public to work areas Ongoing education and training of drivers and pedestrians in road hazards Journey management plan Vehicles fitted with in-vehicle monitoring systems Consultation with councils and Department of Transport and Main Roads regarding high risk intersections and sections of road	High
Rail and road crossings	Increased traffic at uncontrolled crossing	Injuries or fatalities Collisions and disruption of rail services	Liaison with councils and Department of Transport and Main Roads in consideration of high risk rail and road crossings Mandatory stop at railway crossings monitored by in-vehicle monitoring system	Medium
Uncontrolled detonation of explosives	Road accident Detonators attached to secondary explosives during transport	Explosion (including overpressure, debris, heat radiation and noise) Potential serious injury or fatality	Designated routes for the transportation of dangerous goods as specified in the Explosives Act and the Australian Code for the Transport of Explosives by Road and Rail Liaison with Emergency Management Queensland and the Hazardous Industries and Chemicals Branch regarding any potential handling or storage of explosives Suitably qualified explosives operator	Low

Potential hazard	Possible causes	Possible consequences	Proposed controls	Residual risk level
Diesel fire involving mobile fuel tanker	Vehicle engine fire as an ignition source to the fuel tank Naked flame Collision	Fire Environmental incident Potential injury or fatality	Suitably qualified fuel transport operator (giving consideration to vehicle maintenance, driver training and procedures) Properties of diesel (difficult to ignite) Clean up procedures as part of emergency response plan	Negligible
Marine traffic volume during construction	High volume of materials and people require transport to Curtis Island, initially from Gladstone based disembarkation (Auckland Point) Lack of regulatory staff	Increased risk of accidents and collisions Delay to operations Impact on recreational boating Environmental impact to Great Barrier Reef, e.g., from accidents and possible spillage Collision resulting in disruption to other shipping operations Potential serious injury or fatality	Speed limits for vessels through The Narrows Reputable vessel operators Communication between vessels International rules of steering Vessel traffic system Dangerous goods carried according to the International Maritime Dangerous Goods Code	Negligible
Boat strike	Fast moving vessels in areas that overlap with the habitats used by marine turtles, dugong and inshore dolphin	Death or serious injury to species of conservation significance	Speed limits for vessels in any areas identified where there is significant overlap between the transit area and dugong, marine turtles and inshore dolphin	Low

22.4.4 Cumulative risk levels to surrounding land uses

Considerable effort has been made to locate the gas pipeline away from sensitive receptors. The proposed gas pipeline route traverses primarily through rural areas.

Traffic and transport risks are likely to increase with concurrent construction and operation activities undertaken by multiple projects. Australia Pacific LNG will work with local authorities, the Department of Transport and Main Roads and discuss issues with other project proponents to manage traffic and transport related risks.

A fire, started for any reason by any of the proposed project activities, could spread to surrounding vegetation and become a bushfire. Bushfires threaten people, property and the environment. Controls for the prevention of bushfire, such as work procedures and maintaining clearings during construction and around surface pipeline stations are outlined in Section 22.4.2. The risk of such fires increases with concurrent construction and operation activities undertaken by multiple projects.

As the gas pipeline will be co-located with other high pressure gas pipelines for significant sections of the overall route, there will be cumulative risks as a result of the proximity to these other gas pipelines. For example, the consequence of one pipeline rupturing causing a second pipeline to rupture could potentially result in greater damage. This has been assessed in Section 22.4.6.

Further discussion of cumulative hazards and risks is presented in Volume 3 Chapter 25 – Cumulative impacts.

22.4.5 Consequence assessment overview

The purpose of the consequence assessment is to illustrate of the impacts of scenarios where there is a significant hazard related to the gas pipeline during construction, operations and decommissioning. This applies to risks which have the potential to impact persons, property or the environment by heat radiation or explosion overpressure.

All hazards, including those with the potential for catastrophic consequences, will be managed via design and ongoing safety management to reduce the likelihood of an incident to as low as reasonably practicable. While safety management procedures and emergency management plans are important with respect to a holistic approach to the management of risk, design of the gas pipeline is a critical first step with respect the overall hierarchy of controls. The hierarchy of controls including, eliminate, substitute/transfer, engineer, administration and personal protection equipment, and the risk management methodology for the control of risks based on the hierarchy of controls is presented in Volume 1 Chapter 4.

The hazards have been assessed in terms of the potential worst credible consequences of scenarios. This has been done in order to assess the outermost limits of the potential impacts. The limiting scenarios are presented and assessed to ensure that the hazards are inherently limited by design. Where it is shown that the limiting scenario meets design criteria, then other lesser potential impacts are also likely to meet design criteria.

HIPAP no. 4 has guidelines for comparing the consequences of heat flux and overpressure. These are used to identify appropriate hazard end points to be considered. Hazard end points for heat radiation levels were obtained for 4.7 kilowatts per square metre (kW/m^2), $12.6kW/m^2$ and $23kW/m^2$ to assess the risk of serious injury and the risk of fatality. Similarly, hazard end points were obtained for explosion overpressure levels of seven kilopascals (kPa) and 70kPa.

Details of the consequence analysis are presented in the technical report in Volume 5 Attachment 46.

Gas pipeline incidents

The following picture illustrates the potential damage and hazards for a typical pipeline rupture in a remote location.

Natural gas has been safely handled for many years. There has never been a death or injury recorded in connection with damage to a gas pipeline in Australia (Tuft 2009). The industry is not without its incidents and accidents, but it maintains an excellent safety record as a result of the high standards adopted in the design and management standards of present day gas pipelines and facilities.

An analysis of gas pipeline incidents performed by Tuft (2009) of the Australia Pipeline incident database shows a breakdown of all damage incidents recorded. For example, the number of recorded incidents from external interference is 118, with six from construction defects, five from earthmoving, five from lightning, and three from corrosion.

In comparison, an analysis of gas pipeline incidents by the European Gas Pipeline Incident Data Group has been categorised into six different causes. External interference is similarly identified as the leading cause of gas pipeline incidents resulting in a gas leak, with an overall percentage of 49.6. Corrosion and construction defects/material failures are the next most common cause of the failures at 16.5 and 15.5% respectively.

The predominant cause of gas pipeline incidents, no matter which data source is considered, is external interference. AS 2885 contains guidelines for protecting pipeline against such threats, on the basis of the location class (i.e. additional controls for high consequence locations). For example, thicker wall pipes may be used in sensitive areas to reduce the risks of material failure, gouging, deformation and corrosion. The preliminary location classifications found when assessing the gas pipeline route, as part of the safety management study are further outlined in Volume 5 Attachment 49.

In addition to the major events identified above, gas leaks from pipelines and associated infrastructure resulting in minor fires have been known to occur in the industry. The effective response to gas leaks is a culmination of the practices equating to a good approach to process safety management. This includes the development of a gas pipeline safety management plan including emergency response plans, which outline the response to gas leaks and fires.

22.4.6 Gas pipeline hazard scenarios

The following gas pipeline hazard scenarios have been analysed:

- Rupture of gas pipeline – buried and surface
- Restricted release rates
- Rupture of adjacent gas pipeline
- Damage to third party infrastructure
- Uncontrolled detonation of explosives
- Accommodation fire
- Diesel fire involving mobile fuel tanker
- Pipeline gas explosion
- Rupture of gas pipeline through The Narrows

- Road trenches not backfilled.

Details of the modelling, consequences, likelihood and risk assessment for each scenario are presented in Volume 5 Attachment 46. The key findings from this analysis are summarised below.

Rupture of gas pipeline – buried and surface

The gas pipeline will be designed in accordance with AS 2885 to prevent a full bore rupture. Compliance with the requirements of AS 2885 and risk management controls will significantly reduce the risk of any rupture incident occurring.

This scenario has been modelled assuming a full bore guillotine rupture with uninhibited release of gas regardless of being aboveground or underground. This sort of damage could theoretically result from a severe earthquake or significant mechanical impact. This scenario has been modelled with the methodology and results presented in Volume 5 Attachment 46. The key findings are summarised below.

The model assumes a full bore rupture resulting in either a vertical or horizontal release of CSG from a 200km length of pipe. It is assumed that the failure occurs somewhere in the middle of the line so that the overall discharge is a combination of gas released from both directions, which is the worst case.

The distances to the hazard end points based on the most conservative estimates are 1279m for a thermal flux of 4.7kW/m^2 (potential injury), 781m for a thermal flux of 12.6kW/m^2 (chance of fatality) and 578m for a thermal flux of 23kW/m^2 (likely fatality).

Restricted release rates

The maximum energy release of gas in the event of any loss of containment must be less than one gigajoule per second (GJ/s) and 10GJ/s respectively depending on the location class (Table 22.2). Energy release rates will be limited by implementing design and material selection requirements. Furthermore the properties of the gas pipeline material will resist full bore rupture.

The distances to the hazard end points for a restricted release rate of 10GJ/s based on the most conservative estimates are 206m for a thermal flux of 4.7kW/m^2 (potential injury), 126m for a thermal flux of 12.6kW/m^2 (chance of fatality) and 93m for a thermal flux of 23kW/m^2 (likely fatality).

The distances to the hazard end points for a restricted release rate of 1GJ/s based on the most conservative estimates are 65m for a thermal flux of 4.7kW/m^2 (potential injury), 40m for a thermal flux of 12.6kW/m^2 (chance of fatality) and 29m for a thermal flux of 23kW/m^2 (likely fatality).

Rupture of adjacent gas pipeline

This scenario has been included to acknowledge the potential hazard of co-located pipelines. The Australia Pacific LNG gas pipeline will for some distance be located in a 200 metre wide infrastructure corridor in which three other similar gas pipelines are proposed, each allocated easements 50metres wide. It is assumed that adjacent gas pipelines are of a similar size to the Australia Pacific LNG gas pipeline for the purposes of this assessment.

In theory, for two adjacent gas pipelines, if one pipe ruptures then the other pipe may also fail due to the disturbance and heat radiation. Research indicates that for two pipelines to fail they need to be located less than 25 feet (8m) apart (Leis 2002). Based on the proposed easement widths of 50m, it is unlikely that any gas pipelines will be as close as 8m. Hence, the failure of one gas pipeline is unlikely to cause an adjacent gas pipeline to rupture. However this has been modelled to illustrate the

consequences should an adjacent gas pipeline rupture occur alongside Australia Pacific LNG's gas pipeline.

The modelled distances to the hazard end points for adjacent gas pipeline rupture based on the most conservative estimates are 1,809m for a thermal flux of 4.7kW/m^2 (potential injury), 1,105m for a thermal flux of 12.6kW/m^2 (chance of fatality) and 818m for a thermal flux of 23kW/m^2 (likely fatality).

Damage to infrastructure

The infrastructure located near the gas pipeline includes:

- Roadways, including state controlled roads and national highways
- Railway infrastructure
- Electrical power lines
- Telecommunications cables
- Other pipelines (e.g. water, tailings).

Damage to infrastructure, such as possible excavation of data cables or other pipelines, is possible during construction of the gas pipeline. However, there is unlikely to be an impact involving a catastrophic gas fire, as the gas pipeline will not contain gas until after the pipeline is completed. During operations, a gas pipeline rupture might result in an infrastructure collapse. This has been assessed in the preceding sections.

The principal controls to avoid damaging infrastructure will be outlined in construction and other safety management plans and will include those controls indicated in Table 22.3. The design of the gas pipeline and the selection of the gas pipeline route are significant first steps, which considerably reduce the risk of the likelihood of impacts and the consequences of those impacts.

Uncontrolled detonation of explosives

Explosives may be required for the construction of the gas pipeline for trenching in places along the route where conventional trench or rock breaking methods are unsuitable due to hard rock. The locations where this is most likely to occur are through rocky ranges, which are mostly in remote locations.

An uncontrolled detonation of explosives could lead to injuries or fatalities, harm to animals, or damage to surrounding property, including pipelines. Possible causes of uncontrolled detonations of explosives are:

- A vehicle engine fire as an ignition source leading to detonation perhaps due to a vehicle collision, roll-over or overheated engine.
- Misfire
- Premature detonation
- Overcharge.

Uncontrolled detonations have the potential to cause failure of adjacent existing pipelines, but this is a rare event. The risk of an uncontrolled explosion during transportation of explosives also has a remote likelihood of occurring and is a risk associated with the transportation of explosives in general.

Transportation, storage, handling and use of explosives will comply with relevant legislation. For transportation of explosives this currently includes the *Explosives Act 1999*, the Australian code for the

transport of explosives by road and rail and the Australian code for the transport of dangerous goods by road and rail. Complying with current legislation includes giving consideration to travel routes and separation of detonators and primary explosives away from secondary explosives. Measures taken to reduce risk during controlled blasting include the use of exclusion zones and radio silence or shielded fuses where necessary. Australia Pacific LNG will ensure that any persons involved in the transportation, storage, handling or use of explosives are suitably qualified and have the relevant licences.

Advice from relevant authorities, such as Emergency Management Queensland and the Hazardous Industries and Chemicals Branch will be sought regarding the handling and storage of explosive raw material, as well as for transportation of un-used and/or undetonated explosives before storage, handling or transportation.

Explosives will only be used in limited areas dependant on the presence of hard rock. Consequently, only minimal amounts of explosives will be transported or used, with the resultant relatively small potential impact area in the event of an uncontrolled detonation. Australia Pacific LNG's policies and practices will reduce the risk of an uncontrolled detonation of explosives during transportation and handling.

Accommodation fire

Temporary accommodation facilities will be established for work crews during the construction of the gas pipeline. These facilities will comprise of a kitchen and accommodation units. There will also be a laydown area for pipeline supplies and diesel fuel storage for refuelling light vehicles located with these facilities. The facilities will be periodically moved as the gas pipeline progresses.

While a fire in the temporary accommodation facility is possible, it is expected that these would be contained within the facility. Temporary buildings will be constructed in accordance with building code requirements and safety equipment provided in accordance with regulatory guidelines. For example, quantities of flammable materials such as bottled LPG gas will be limited and safely stored. Cleared secured perimeters will be maintained. Fire extinguishers and other emergency response equipment will be provided, in accordance with regulatory guidelines. Fire management and response procedures will be implemented to minimise the risk of injury to personnel at these facilities.

Diesel fire involving mobile fuel tanker

Mobile fuel tankers will be used to supply diesel to site and to re-fuel heavy construction equipment. A fire involving a mobile fuel tanker could lead to fatalities, property damage or environmental harm if an incident occurred during transportation. The transportation of fuel will comply with relevant legislation, which currently is the Australian code for the transport of dangerous goods by road and rail. The selection of travel routes and suitably qualified fuel handling operators is considered fundamental to achieving an acceptable level of risk during transportation and use.

Australia Pacific LNG will ensure that all personnel involved in the handling of fuel are suitably qualified and in compliance with legislative requirements.

Gas pipeline not properly purged during decommissioning

During decommissioning it is possible, although unlikely, that sections of the gas pipeline may not be correctly purged before hot work is undertaken. In the event that the gas pipeline is filled with a mixture of gas and air within the flammability limits an explosion could occur. Proposed controls to manage this risk include: a decommissioning safety plan; pigging the gas pipeline before purging; correct purging of the gas pipeline.

Rupture of gas pipeline through The Narrows

The gas pipeline route requires a marine crossing of The Narrows to connect the pipeline between the mainland and Curtis Island. Through The Narrows on approach to Curtis Island there is the potential for up to four gas pipelines to be installed in a common user corridor. Australia Pacific LNG proposes to install its gas pipeline using horizontal direction drilling in this section under the sea floor.

It is considered that the risk of rupture due to external damage is significantly less than for other sections of the gas pipeline, due to the inherent depth of cover. However, if HDD is not possible for technical reasons or there is agreement to install all pipelines to proposed LNG facilities at the same time, Australia Pacific LNG would install the pipeline by dredging a trench in the seafloor. In this case, there is an increased but minor risk of damage to the pipeline from vessel strike. The result of a rupture under water might be the formation of a flammable gas cloud on the surface.

Studies performed on large scale releases of gas underwater by the Petroleum Safety Authority in Norway using various models showed results were widely varied on the dispersion of gas above the surface where the horizontal dispersion of the cloud varied from 180 to 400m. Given the relatively remote location of the pipeline crossing from dwellings and the very low likelihood of such an incident, it is considered that the risk is negligible.

22.4.7 Consequence assessment summary

A summary of the results from the consequence assessment is presented in Table 22.8.

Table 22.8 Summary of consequence assessment for gas pipeline

Scenario	Thermal flux (kW/m^2)	Effect	Distance to hazard end point (m)
Full bore rupture of gas pipeline (underground section)	4.7	Pain in 15-20 seconds and injury after 30 seconds	1,279
	12.6	Significant chance of fatality after extended exposure, effects on wood and steel	781
	23.0	Likely fatality, effects on wood and steel	578
Full bore rupture of gas pipeline (above ground section)	4.7	Pain in 15-20 seconds and injury after 30 seconds	1,279
	12.6	Significant chance of fatality after extended exposure, effects on wood and steel	781
	23.0	Likely fatality, effects on wood and steel	578
Rupture – 10GJ/s release rate (non-rural)	4.7	Pain in 15-20 seconds and injury after 30 seconds	206
	12.6	Significant chance of fatality after extended exposure, effects on wood and steel	126
	23.0	Likely fatality, effects on wood and steel	93
Rupture – 1GJ/s release rate (non-rural)	4.7	Pain in 15-20 seconds and injury after 30 seconds	65
	12.6	Significant chance of fatality after extended exposure, effects on wood and steel	40

Scenario	Thermal flux (kW/m^2)	Effect	Distance to hazard end point (m)
	23.0	Likely fatality, effects on wood and steel	29
Full bore rupture of two co-located pipelines of the same capacity	4.7	Pain in 15-20 seconds and injury after 30 seconds	1,809
	12.6	Significant chance of fatality after extended exposure, effects on wood and steel	1,105
	23.0	Likely fatality, effects on wood and steel	818

Australia Pacific LNG will design, construct, operate and decommission the gas pipeline and associated facilities in accordance with the appropriate regulations, standards and codes of practice. This includes taking into consideration the distance to hazard end points and designing the gas pipeline to present a minimum risk with respect to the surrounding land uses.

22.5 Safety management study

The EIS terms of reference require a risk assessment in accordance with AS 2885 be conducted on the gas pipeline from the gas processing facilities to the LNG facility on Curtis Island. Such risk assessment is identified in AS 2885 as a safety management study, and this section summarises the activities of the Australia Pacific LNG Project to date in conducting the assessments. This section discusses the gas pipeline and the report is contained in Volume 5 Attachment 49.

These safety management studies have been preliminary only, as some design decisions have not yet been made, and results of some ongoing field studies are not yet available.

The objectives of the AS 2885 Safety Management Study process are different from, but complementary to, those addressed by the previous sections based on the Marsh report. The objective of the safety management study process is to ensure as far as possible that the gas pipeline is designed and installed in a manner which will protect the gas pipeline against any conceivable events which may arise generally or at particular locations in future. The risk assessment in the above section is based on the threats to the surrounding area by the presence of the gas pipeline and other gas field facilities.

Location classification analysis

The safety management study includes a location classification analysis. The location classifications for the gas pipeline route include:

- Rural (R1) - land that is unused, undeveloped or is used for rural activities
- Rural Residential (R2) – land that is occupied by single residence blocks typically in range 1ha to 5ha
- Heavy Industrial (HI) - Site development or zoned for use of heavy industry or for toxic industrial use
- Submerged (W) – land that is continuously or occasionally inundated with water, (i.e. lakes, harbours, flood plains, watercourses and creeks), whether permanent or seasonal

- Common Infrastructure Corridor (CIC) - multiple infrastructure developments within a common easement or reserve.

The route is almost entirely rural with very low population density. With more detailed alignment design, these classifications will be further detailed.

Threat analysis

A significant factor associated with damage to buried pipeline is external activities, which inadvertently contact and cause damage to the pipeline. AS2885 requires certain controls be put in place as external interference protection, and further defines acceptable physical and procedural controls. These are outlined in Table 22.9.

Table 22.9 Physical and procedural controls for external interference protection

Physical controls	Methods
Separation	Burial (depth of cover)
	Exclusion (fencing, access prevented)
	Physical Barrier (crash barrier, concrete slabs/coating)
Resistance to penetration	Wall thickness (if adequate to prevent penetration)
	Barriers preventing penetration
Gas pipeline awareness	Landowner / third party liaison
	Community awareness program
	One call service (Dial before you dig)
	Marker signs or marker tape
	Activity agreements with other entities
External interference detection	Planning notification zones
	Patrolling
	Remote intrusion monitoring

The following are examples of proposed mitigation measures, which will be implemented to protect the gas pipeline against the potential threats:

- Road and rail crossings:
  - Extra depth of cover across the entire road or rail easement
  - Extra wall thickness if required by potential loading
  - Concrete slabs in the areas of future table drain maintenance
  - Marker tape for the entire road or rail easement
  - Liaison with road or rail authorities
- Watercourse crossings:
  - Extra depth of cover

  - Concrete mechanical/weight protection if warranted by stream scour potential
  - Careful rehabilitation of banks to prevent future erosion
- Corrosion (internal and external):
  - Full time gas quality monitoring
  - Periodic intelligent pig for metal loss
  - Quality external coating
  - Periodic DC voltage gradient inspection
- Landslip, subsidence, floods, scour and so on:
  - Routing to avoid potential slip, subsidence, flood prone or scour prone locations
  - Routine patrols to observe movement
  - Liaison with mining /gasification companies
  - Buoyancy control in flood prone areas
  - Extra depth of cover in water courses
  - Concrete protection in scour-prone locations
- Electrical effects (induced voltages, fault currents, lightning and power failures):
  - Design of earthing systems
  - Procedures and training during construction and during operations
  - Procedures to stop work during lightning activity
  - Surge arrestors
  - Back-up battery systems
- Operations and maintenance activities (repairs, dig ups, equipment maintenance):
  - Design of over-pressure protection systems
  - Monitoring and alarm via SCADA system
  - Training to ensure bypass is prevented
  - Procedures and training for repair dig ups
  - Accurate location prior to excavation.
  - Regular audits of equipment condition
  - Application of recommended equipment programs
- Potential construction defects:
  - For coating damage – approved handling procedures, backfill specification, holiday detection on installation
  - For failed field joint coating – qualified coating application procedure approval, design selection of system, holiday detection after completion

  - For dents and wrinkles – qualified bending procedures approval, visual and internal gauge inspection
  - For weld quality – qualified weld procedures approval, non-destructive testing inspection, hydrostatic pressure and leak test
  - For backfill quality – backfill quality inspection, inspection during construction, DC voltage gradient inspection
  - For blasting procedures – qualified blasting procedures, licensed personnel for design and implementation of blast programs, exclusion zones
- Potential design defects:
  - For stress corrosion cracking – engineering design and metal specification, high quality coating, temperature control, periodic intelligent pig inspection for cracking
  - For wall thickness deviations – engineering design quality assurance and audit procedures, inspection, hydrostatic pressure test
  - For inadequate functionality – operations and maintenance input into engineering design, hazardous operations studies, pre-commissioning inspection and testing
- Potential material defects:
  - Engineering design, quality assurance, inspection and test plans
- Intentional damage:
  - Markers and warning signs
  - Security fencing and locks where necessary
  - Routine patrols
  - Surveillance at critical facilities
  - Employee background checks
  - Human resources management.

Threats at specific locations

Several areas were agreed to be different from the typical gas pipeline areas in terms of potential threats. These include:

- The Narrows crossing, as it will be constructed using HDD and will be submerged. This means there is potential for failure of the HDD technique, damage during repair, future dredging activities and possible enhanced corrosion
- Common user corridors, as they will be subjected to threats associated with development of parallel pipelines both during construction and during longer term operations. In addition, these areas may be subject to future re-zoning to allow adjacent infrastructure development not currently contemplated
- Areas of co-located pipelines, as they may be subject to similar threats as common user corridors

- Callide Range crossing, as there are a number of steep slopes and as the gas pipeline will be within around 200m of the Dawson Highway.

Failure and consequence analysis

The failure and consequence analysis, undertaken according to AS 2885, determined the following preliminary parameters for the gas pipeline:

- The critical defect lengths
- The wall thicknesses required to prevent penetration
- Radiation contours for full bore ruptures.

This information will be used to assist in the design of the sections of the gas pipeline with corresponding pipe thicknesses (standard wall, heavy wall and bends) and separation distances to reduce the risk of potential threats. Results were determined for the range of diameters (30, 36 and 42 inch) proposed for the gas pipeline in the safety management study. The results are available in Volume 5 Attachment 49.

22.6 Health and safety

The health and safety of the community and the Project's workforce is to be protected through the design of safe facilities and by development and implementation of safety and environmental management plans.

Australia Pacific LNG's approach to health and safety contains several key elements including identification of hazards and management of those, education and training, management of contractors and subcontractors, emergency preparedness and providing for recreation.

22.6.1 Community health and safety

Australia Pacific LNG recognises that it has an obligation to reduce the risk of injury and incidents affecting safety, health and environment to as low as reasonably practicable. Australia Pacific LNG has incorporated Origin Energy's health, safety and environment policy, which requires it to 'identify and manage risks to as low as reasonably practicable where they have the potential to cause an accident, injury or illness to people, or unacceptable impacts on the environment or the community' (Origin Energy 2009).

The major health and safety risks to the community are outlined in Sections 22.3, 22.4, 22.5 and 22.6. It is expected that the level of potential health and safety risk to the community posed by the Project will be minimal due to the distances of the gas pipeline from sensitive receptors.

Locations of sensitive receptors

Australia Pacific LNG has considered the location of sensitive receptors in selecting the preferred route for the gas pipeline. The gas pipeline, including the main pipeline and Condabri and Woleebee lateral pipelines, generally traverses primarily through rural areas. The gas pipeline avoids major towns by at least 10km, such as Biloela and Gladstone.

The nearest location to the gas pipeline with sensitive receptors is Miles, which is a small town located 4 to 5km from the Woleebee lateral pipeline. This is outside the distance to the hazard end points as modelled for the consequence assessment. Consequently, in the very unlikely event of a major gas pipeline rupture, the heat radiation in Miles would not be strong enough to result in injuries or fatalities.

Other locations of interest along the gas pipeline route include 'Cockatoo School', Camboon and Callide. Cockatoo School and Camboon have landing strips close to the gas pipeline. These landing strips are not usually manned. Callide coalfields, timber and power station are located near the gas pipeline. These areas are considered to be industrial from a safety planning perspective. Final selection of the gas pipeline alignment, and application of control measures required by AS2885, will be completed during further more detailed engineering to minimise the risk for existing developments in the vicinity of the gas pipeline.

Cumulative risks

Discussion of cumulative hazards and risks associated with concurrent development of similar pipelines is presented in Section 22.4.4 and in Volume 3 Chapter 25. There are some cumulative risks associated with co-located high pressure gas pipelines. Otherwise, the location of the gas pipeline primarily in rural areas and the preferred route means that sensitive receptors are avoided, such that there is unlikely to be any cumulative impact with respect to health and safety of persons associated with activities undertaken in these dwellings.

22.6.2 Health and safety of persons onsite during construction

Health and safety for site personnel will be regulated to meet industry standards, codes of practice and relevant statutory provisions, particularly, the PAG Act. Health and safety management will include:

- A health and safety policy
- Identification of risks associated with construction and operation of the Project
- Assessment of the level of risk of each hazard
- Development of control measures to avoid or minimise the risk
- Implementation of corrective actions on an ongoing basis to avoid or minimise hazards
- Monitoring and review of the effectiveness of the control measures and corrective actions to maintain continual improvement.

The potential workplace health and safety risks and associated mitigation measures directly related to the construction phase of the Project are discussed in the following sections and the resultant risks are summarised in Table 22.10. Many of these potential hazards are the subject of standards, some of which are outlined in Section 22.1.3. Australia Pacific LNG personnel and all construction contractors and operators will implement the safety management plan and relevant environmental management plans to reduce the risk of the potential hazards. Other initiatives to reduce the risk include:

- Vehicle management
- Standard operating procedures
- Restricted access to work areas
- Personal protective equipment and required clothing and footwear
- First aid training
- Emergency response plans
- Auditing equipment and personnel

- Use of competent personnel
- Ongoing safety education and training
- Inductions
- Risk and job safety assessments
- Commissioning plans.

The following section describes the potential workplace health and safety risks associated with the proposed gas pipeline construction activities. The following activities are discussed briefly here, and in more detail in Volume 3 Chapter 3:

- Trenching and excavation
- Boring
- Horizontal directional drilling (HDD)
- Coating and welding.

Trenching and excavation

Trenching involves clearing land and excavating a trench. The pipeline is lowered into the trench and then buried. Potential hazards associated with trenching and excavation are:

- Noise from equipment
- Falls from height into excavation or trench
- Suspended loads
- Working in trenches and confined spaces
- Working on wet, muddy and uneven surfaces
- Trench collapse and rockfalls
- Dust
- Vehicles, including heavy machinery, and people working in close proximity
- Activities undertaken in remote area.

Boring

Boring involves drilling a borehole and inserting the pipeline into the drilled hole. Potential hazards associated with boring include:

- Pipe becomes stuck during insertion
- Infrastructure collapse
- Working in excavations and confined spaces
- Collapse of excavation or trench and rockfalls
- Working with rotating machinery
- Falls from height into excavation.

Horizontal directional drilling

HDD involves drilling a pilot hole, reaming the hole and pipe installation (pullback). Using this method significantly reduces risks of environmental impact, pipeline interference and congestion in within the infrastructure corridor across The Narrows.

The key issues which set the boundaries of the envelope for drilling long HDD holes under difficult terrain and potential geological hazards are as follows:

- Drill pipe buckling down hole or out of hole at drill rig
- Torque and drag on drill pipe and tooling
- Hole stability
- Effective hole cleaning
- Down hole survey accuracy
- Minimising dogleg severity
- Fracture gradient of ground
- Capacity of drilling rig.

Significant research and planning will be undertaken the asses the potential of these risks and reduce the risk of them occurring. HDD is an established practice and pipelines of this calibre have been directionally drilled over these kinds of distances in the past. General health and safety risks include:

- Working with rotating machinery
- Heavy drill bits and reaming equipment
- Wet and muddy conditions around entrance to bore
- Crane operations during pullback
- Use of heavy machinery for excavations.

Coating, welding and commissioning

Hazards related to coating, welding and commissioning of the gas pipeline include:

- Fumes from welding and coating substances
- Burns associated with welding hot work
- Heat and sun
- Radiation hazards involved with weld testing
- Potential failures of gas pipeline at pressure during hydrostatic pressure testing.

Summary of onsite construction risks

Health and safety risks during construction and their mitigation measures are summarised in Table 22.10.

Table 22.10 Potential workplace health and safety risks during construction

Potential health and safety risk	Mitigation measures (included in safety management plan)
Injuries from moving plant and vehicles	Appropriate signage Driver training Vehicle speed limits Use of designated roadways and walkways Exclusion areas around vehicles (e.g. cranes)
Dropping heavy loads, e.g. pipes during unloading of trucks and other heavy construction work	Prescribed work procedures Equipment maintenance Regular certification of lifting equipment Competent certified operators (riggers and doggers)
Working with rotating machinery	Guarding over rotating or moving parts of machinery Operator training
Working at heights and falling from heights	Fall arrest and restraint equipment will be worn when working at heights Exclusion zones whilst working adjacent to excavations Controls to prevent persons from working off vehicles at height (e.g. the back of utes, top of drill rigs and from bonnets) and provision of elevated work platforms where necessary Guardrails will be fitted where necessary
Falls, slips and trips	Appropriate signage Designated walkways Footwear that reduces the risks of slipping with respect to muddy and uneven field surfaces
Trench collapse and rock falls	Operating procedures in and around trenches Personal protection equipment, including hard hats
Working in confined spaces	Confined space procedures complying with Australian Standards
Continual working with airborne contaminants (including dust)	Dust suppression, road watering Appropriate vehicle and machine maintenance

Potential health and safety risk	Mitigation measures (included in safety management plan)
Hearing impacts from prolonged noise exposure	Specification of equipment that meets noise level requirements Personal protection equipment and signage
Vibration impacts from prolonged exposure	Monitoring for possible damaging vibration (e.g. prolonged vibration as a result of operating an excavator) Assessing whether activities or equipment is creating a nuisance vibration
Heavy lifting, awkward postures and manual handling	Manual lifting guidelines (avoid heavy lifting and awkward postures) Provide information related to appropriate handling of items
Burns and fumes from welding and other hot work	Procedures for welding in open spaces No welding activities will be undertaken in enclosed spaces Personal protection equipment, including gloves and masks.
Eye, respiratory or other damage from sandblasting	Personal protection equipment, including masks worn during sand blasting
Pressure testing	Standard operating procedures including restriction of personnel in the vicinity of the gas pipeline during pressure testing
Injuries from handling hazardous substances/chemicals	Signage Material safety data sheets and associated spill clean up equipment for chemicals Personal protection equipment
Working with electricity	Electrical equipment will be regularly checked Isolation procedures
Heat exhaustion, dehydration and/or sunburn from continual working in the sun.	Training and awareness Provision of sun protection and personal protective equipment Measures to identify signs of heat stress and actions to avoid and treat
Fire and explosions resulting from the presence of combustible gases and liquids, oxygen and ignitions.	Isolation procedures See Sections 22.3 and 22.4
Snake, mosquito and other animal bites	See Section 22.4.2 and Section22.7
Natural disasters (e.g. bushfire, landslides, floods)	See Section 22.4.2 and Section22.7

Potential health and safety risk	Mitigation measures (included in safety management plan)
Lighting	Assess lighting level to determine if it is in accordance with Australian Standards for night time work Direct lighting away from dwellings
Water quality	Potable water quality Water quality is further discussed in Volume 3 Chapter 10 – Groundwater, Volume 3 Chapter 11 – Surface water and Volume 3 Chapter 12 – Associated water management
Mental and physical health	Provide amenity, recreational and health programs that support a workforce which is fit for work, enjoys a healthy work-life balance and transfers these values into the home or community Standards for the health and fitness for work of employees, including first aid, medical examinations and rehabilitation Initiatives to promote and encourage a healthy lifestyle

22.6.3 Health and safety of persons onsite during operations

As for construction, health and safety for site personnel during operations will be regulated to meet mandatory industry standards, codes of practice and relevant statutory provisions, particularly, the PAG Act. Procedures will include the steps for normal operation, pigging, corrosion, isolation and repairs. Hazards will be identified for each operation. For example, specific hazards related to pigging include:

- Loads at height
- Awkward postures
- Pinch points.

These risks will be dependant on the final design of the pigging stations. Risks will be assessed for normal operation and maintenance, as the design progresses and controls put in place to reduce the risks. The controls for the hazards outlined in Table 22.10 for construction will follow on for the commissioning and operation stages of the Project where applicable. Prior to commissioning, a commissioning plan and a safety plan will be developed and maintenance and inspections persons will be trained in these procedures.

Australia Pacific LNG will conduct regular training sessions and undertake regular auditing and integrity inspections. The safety management plan will be regularly reviewed and updated based on feedback, which will be proactively obtained. Other relevant ways to reduce the risk of incidents will include:

- Traffic management
- Consultation with the local community
- Signage and identification of buried pipe

- Safety and operational procedures
- Ongoing training and education of site personnel
- Emergency response procedures
- Environmental management plans.

Summary of onsite risks during operation and maintenance

Health and safety risks for operation and maintenance of the gas pipeline and their mitigation measures are significantly less than during the construction phase. The key risk areas are considered to be:

- Injuries from vehicles
- Heavy lifting, awkward postures and manual handling
- Fire and explosions resulting from the presence of combustible gases, oxygen and ignition
- Heat exhaustion, dehydration and/or sunburn from continual working in the sun.

The proposed mitigation measures are the same as those for the construction phase of the gas pipeline, set down in Table 22.10.

Safety tools

Planning and management during construction, operations and decommissioning will be undertaken in accordance with regulatory requirements. This will include the following:

- Safety management plans
- Systematic risk assessments
- Emergency response plans and procedures
- Education and training
- Incident reporting and investigation
- Rehabilitation planning.

Australia Pacific LNG will develop and implement a robust safety management plan that will apply to all personnel, including contractors and operators. Tools used to develop and implement this plan include the following:

- Statutory acts and regulations
- Safety standards and codes of practice
- Internal safety procedures and safe work standards
- Health and safety objectives, targets and key performance indicators
- Competency and training, including induction
- Hazard assessment and risk management
- Risk register and mitigating action plans
- Hazardous materials management

- Subcontractor management
- Safety management system planning and development and improvement
- Job hazard analysis
- Communications including daily pre-start meetings
- Personal protective equipment
- Emergency response
- Incident investigation and reporting
- Health and safety issues/resolutions
- Health and safety auditing
- Communication and organisational learning.

22.6.4 Mitigation and management

Australia Pacific LNG has a hazard and risk management procedure which provides a risk assessment process for personnel, facilities, the public, customers and the environment, and includes a regular review process. This risk and opportunity assessment process has been utilised to identify key potential hazards and controls for the Project. Plans will be developed for the gas fields, gas pipeline and LNG facility elements of the Project as a part of this whole-of-life risk management and safety management.

Induction and training programs will be used to ensure personnel have the required skills and training to competently perform their work in a safe and environmentally sound manner. Subcontractors will be subject to pre-qualification, auditing and inspection by Australia Pacific LNG with respect to their health and safety standards.

Australia Pacific LNG's emergency response plan will describe emergency response procedures including drills, involvement of emergency services, adjacent neighbours and any emergency equipment that may be required. In addition, Australia Pacific LNG will keep documentation of potential emergency situations and impacts and will update its emergency response plan as new information became available.

Australia Pacific LNG has standards for the health and fitness of employees, including first aid, medicals, and rehabilitation. It will undertake initiatives to promote and encourage a healthy lifestyle. This might include recreational activities or the provision of recreational facilities.

Health and safety risks to the local community have been assessed in the risk and opportunity assessment process. Matters of community health and safety will be regularly communicated through a range of channels including Australia Pacific LNG's community shop-front and consultation sessions that allow for regular two-way dialogue. In particular, Australia Pacific LNG will strive to improve the standard of health and wellbeing for Indigenous people through, for example, implementing a community partnership program and celebrating and supporting Indigenous cultural values amongst the project workforce.

22.7 Emergency management

Australia Pacific LNG will maintain a state of emergency preparedness as a commitment to its workforce (including subcontractors), customers, neighbours, communities and shareholders in

providing a safe, healthy and environmentally responsible working environment. While prevention will be the first defence against any incident, Australia Pacific LNG will be prepared to respond to potential incidents, regardless of how large or complex.

Emergency response is a component of Origin's current safety management system. It is a corporate expectation that emergency response plans will be developed for all business units. Australia Pacific LNG is liaising with other CSG and LNG participants with a view to establishing an emergency response capability that permits initial medical care of injured personnel within one hour of mobilisation and primary medical care with four hours of mobilisation.

Origin Energy has emergency response plans for its existing gas pipelines. Australia Pacific LNG will utilise these as the basis for its emergency response plans, which will be developed for the gas pipeline.

22.7.1 Contents of the emergency response plan

Current Origin emergency response plans for gas pipelines will be updated to reflect the scale of the Project. The emergency response plan will contain necessary information that could be readily accessed during an emergency. Australia Pacific LNG will conduct drills on a regular basis to train personnel with respect to responses to credible emergency scenarios. The plan will describe emergency response procedures including drills, involvement of emergency services and adjacent neighbours.

These plans provide for the identification of crisis and emergency situations and impacts, identify emergency equipment to be provided, responsibilities of personnel, and indicate when regular simulations including relevant stakeholders are conducted. The relevant sections of the plan will use the State Planning Policy 1/03, Mitigating the Adverse Impacts of Flood, Bushfire and Landslide for reference.

The emergency response plans will be developed using the latest standards, and updated to account for any learnings where appropriate. The following is a guide to their contents:

- Guidelines for the use of the plan
- Document control
- General information - this section may include:
  - Responsibilities
  - Emergency alarm
  - Interaction with emergency services
  - Interaction with community
  - Helicopter use
  - Emergency response plan preparedness
  - Emergency equipment
  - Contact with relatives
- Emergency organisation structure - this outlines the organisation to handle an escalation of an incident. This section will include different levels of organisation for different magnitudes of emergency. This section may include:

  - Emergency control organisation
  - Emergency awareness
  - Emergency response centre
  - Emergency response locker contents
- Roles and responsibilities - this outlines the roles and responsibilities of persons in the event of an incident. This section may include the roles and responsibilities of:
  - First person at the scene of an incident
  - Emergency coordinator
  - Site emergency response personnel
  - Safety advisor
  - Logistics support officer
  - Incident record keeper
  - Duty manager
  - Emergency services
- Emergency contact numbers - the list of emergency contact numbers may include:
  - Temporary construction accommodation facilities
  - After hours contacts
  - Emergency services numbers including Emergency Management Queensland, Queensland Ambulance Service and Queensland Fire and Rescue Service
  - Government contacts including the Hazardous Industries and Chemicals Branch and the Department of Community Safety
  - Nearby operating companies
  - Nearby landowner contact numbers
  - Equipment hire or contractor/s contacts
- Spill contingency plans - this section will contain the spill contingency plans. This may include information regarding:
  - Assessment of spill type and spill risk
  - Selection of field response techniques
  - Recommended field response techniques
  - Spill on ground
  - Location of material safety data sheets or recommended spill clean up procedures for different substances
  - Procedures with respect to the inadvertent release of contaminants
- Emergency shut down – this section will contain information concerning the safe shut down of the gas pipeline

- Gas leak without fire – this section will contain procedures to follow in the event of a gas leak, which has not been ignited. This will include elimination of potential sources of ignition, safely locating the leak, any necessary isolation of sections of pipe or equipment and repair or replacement of the offending parts
- Fire - this section will contain the procedures to follow in the event of a fire. These might be different depending on the location and nature of the fire. There will, for example, be plans for the following fire situations:
  - Gas pipeline rupture and subsequent jet flame fire
  - Field fire
  - Fire in workshop or stores
  - Encroaching bushfire
  - Fire at chemical or flammable goods storage
- Explosion - this section will contain the procedures to follow in the event of an explosion. This may include:
  - Gas pipeline rupture
  - Uncontrolled detonation of explosives
  - Explosion related to bomb, sabotage or terrorism
- Bomb threat, sabotage and terrorism - this section will contain the procedures to follow in the event of a bomb threat, sabotage and terrorism at facilities and pipeline and will be consistent with Queensland's counter-terrorism and critical infrastructure policies
- Medical emergency - this section will contain the procedures to follow in the event of a medical emergency. This may include a fatality, musculoskeletal injury, disease event, an amputation, heat stress (hyperthermia) or other injury
- Missing worker(s) - this section will include general assistance regarding how to locate a missing person especially in remote locations. This may include the use of a helicopter
- Environmental emergency - this section will include general information about what to do in the event of an environmental emergency, such as potential spill and contamination and/or the death of wildlife
- Unauthorised entry - this section will contain the procedure to follow if an unknown person enters a secure facility or exclusion zone
- Natural disasters - this section will contain the procedures to follow in the event of a natural disaster, such as a flood, storm or landslide
- Lightning strike - this section will provide assistance in the event of a lightning strike
- Wildlife and disease vectors - this section will provide assistance in the event of:
  - A snake bite
  - Illness after a rodent bite
  - Illness after a mosquito bite
  - Illness after an insect bite

- Shift changeover procedure in an emergency - this section will deal with shift changeover, which can be critical in an emergency
- Termination of emergency - at the end of an emergency, order may need to be returned to a facility or area. This section may include procedures for:
  - Return to control of a facility from emergency services
  - Reporting and investigation
  - Recovery and restoration
  - Debrief
- Reports and forms – this section will include standard reports, forms and checklists. Typical forms will include:
  - Emergency report form
  - Log sheet
  - Change over check
  - Change over brief
  - Debrief report
  - Bomb threat checklist.

Australia Pacific LNG will use emergency procedures, which have been developed for and used for gas pipelines in Queensland. These contain the typical emergencies that might be encountered for the gas pipeline. Australia Pacific LNG will update or add to the emergency response plan with new information and any new emergency that is a credible threat.

22.8 Conclusion

22.8.1 Assessment outcomes

Controls that manage the risk of the hazards for the gas pipeline, as outlined, would reduce the risk of incident for the Project. Hazards will be managed such that they present a risk that is as low as reasonably practicable. Most risks are considered to be able to be managed, such that they present a negligible or low risk to people, property, fauna or the environment.

Table 22.3 through to Table 22.7 summarise the hazards and risks of:

- Construction of the gas pipeline
- Operation and maintenance of the gas pipeline
- Decommissioning the gas pipeline
- Natural hazards (seismic events, bushfire, floods, venomous animals and disease vectors), particularly during construction of the gas pipeline
- Traffic and transport activities.

Each table identifies the potential risks, possible causes and consequences, proposed control or mitigation measures and the assessed residual risk level after the controls are implemented.

The following environmental values are applicable to each one of these hazard and risk categories:

- Life, health and wellbeing of people
- Diversity of ecological processes and associated ecosystems.

Similarly, the relevant sustainability principles are also applicable to each one of these hazard and risk categories:

- Adhere to an over-riding duty to safety, ensure operations are carried out in a safe way and to authorise employees and contractors to place safety considerations above other priorities
- Minimise adverse environmental impacts, enhance benefits associated with its activities, products or services; maintain, and enhance where the opportunity exists, biodiversity values and water resources in its operating areas
- Identify, assess, manage, monitor and review risks to its people, property, the environment and the communities affected by its activities.

22.8.2 Commitments

In order to minimise the potential risk to people, property and the environment of abnormal events, natural hazards or accidents associated with construction and operation of the gas pipeline, Australia Pacific LNG will:

- Operate the gas pipeline under a formal safety management plan, which considers whole-of-life safety management in accordance with the requirements of the *Petroleum and Gas (Production and Safety) Act 2004*, to be updated as required during operations
- Maintain an up-to-date traffic management plan which will include driver fatigue monitoring, driver education and training, enforced speed limits for project vehicles, use of buses to reduce private vehicle use, public access restrictions to work areas; and use of in-vehicle monitoring systems
- Initiate and participate in ongoing community campaigns to reduce the likelihood and consequences of vehicle accidents.

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