16 HAZARD AND RISK

This chapter describes the existing hazard and risk assessment process applied to the Pipeline Component of the Queensland Curtis LNG (QCLNG) Project. Potential impacts of Pipeline Component construction and operation, to the extent these activities create a hazard or risk to the community or to the environment, are considered. Measures to mitigate these impacts are identified. A preliminary hazard and risk impact assessment of Pipeline Component infrastructure has been prepared and is provided in *Appendix 3.9.*

As part of front-end engineering design (FEED), QGC is considering options for infrastructure type, configuration and location of pipeline works to reduce any hazard or risk that is unnecessary from construction, operation and subsequent decommissioning. The hazard and risk assessment described in this chapter is based on the Environmental Impact Statement (EIS) Reference Case described in *Volume 2, Chapter 2.*

16.1 PROJECT ENVIRONMENTAL OBJECTIVE

The Project's environmental objective for hazard and risk assessment is to protect the ecological health, public amenity and safety of those on site or in proximity to the site from hazardous events.

16.2 LEGISLATION, STANDARDS AND CODES OF PRACTICE

16.2.1 Legislation, Standards and Codes of Practice

A full list of Queensland and Commonwealth Acts and regulations, codes of practice and standards that may apply to the Project are provided in *Volume 5, Chapter 18*. QGC will comply with all applicable legal and statutory requirements, codes and standards during the design, construction and operation of the LNG Component. To ensure that the legislation, codes and standards are applied correctly and in the appropriate parts of its business, QGC will undertake reviews and gap analyses of its internal systems and procedures and revise these accordingly.

A risk-based site assessment will be conducted for all pipelines in accordance with Australian Standard (AS) 2885.

The legislation, standards and codes of practice as applied to health and safety; and to the transport, storage and handling of hazardous materials are identified in *Internal Company Standards* QGC and BG Group company are discussed in Volume 5, Chapter 18 and in *Table 4.16.1*

16.2.2 *Internal Company Standards*

QGC and BG Group company standards are discussed in *Volume 5, Chapter 18.*

Table 4.16.1 ***Legislative Requirements – Hazardous Materials***

Legislation	Requirement	Compliance
Workplace Health and Safety Act 1995 and Regulation 1997	To prevent a person's death, injury or illness being caused by a workplace, by a relevant workplace area, by work activities, or by plant or substances for use at a workplace Preventing or minimising a person's exposure to the risk of death, injury or illness Establishing a framework for minimisation and prevention	Safety in design and safety management system for construction and operational phases
Dangerous Goods Safety Management Act 2001 and Regulation 2001 National Standard for the Control of Major Hazard Facilities (MHF) – NOHSC:1014(2002), if relevant	The objective of the *Dangerous Goods Safety Management Act 2001* is to protect people, property and the environment from harm caused by hazardous materials, and dangerous goods, including those from a major hazard facility To achieve this, the Act creates broad safety obligations for all people involved with the storage, handling and manufacture of hazardous materials	Management of dangerous goods in accordance with the requirements of the relevant Australian Standards for the storage and handling of dangerous goods Safety management system will be designed
Explosives Act 1999 and Regulation 2003	To ensure the safe use, storage, handling and disposal of explosives during all stages of the Project so as not to endanger persons, property or the environment	Contractor Health, Safety, Security and Environment plan during construction
Building Act 1975 and Building Fire and Safety Regulation 1991	The safe design and operation of all buildings so as not to endanger persons, property or the environment	Design and maintenance compliance with Building Code of Australia safety management system
Fire and Rescue Service Act 1990 and Regulation 2001	Establish effective relationships and implementation with the Queensland Fire and Rescue Service (QFRS) and to prevent and respond to fires and certain other incidents endangering persons, property or the environment and for related purposes	Involvement of QFRS in emergency planning
Electricity Safety Act 2002 and Regulation 2002	Eliminating the human cost to individuals, families and the community of death, injury and destruction that can be caused by electricity	Safety in design and safety management system for construction and operational phases

16.3 CRITERIA FOR HAZARD ASSESSMENT

Where feasible, hazards have been assessed using quantitative risk criteria about the likelihoods and consequences of identified hazards. Where quantitative analysis was not possible, hazards have been assessed using qualitative criteria.

16.3.1 *Qualitative Hazard Assessment*

Qualitative hazard assessment is based on professional judgment about the consequence and likelihood of risks associated with a hazard.

Table 4.16.2 describes the criteria for assessing the likelihood of a hazard occurring. The likelihood of occurrence is assessed after internal controls have been implemented to reduce the likelihood of occurrence.

Table 4.16.2 Likelihood

Rare	Unlikely	Possible	Likely	Almost Certain
Highly unlikely to occur	Unlikely to occur	It is possible that this could occur	Above average chance of occurring	Almost certain to occur
<1 per cent chance of occurring	1 per cent to 10 per cent chance of occurrence	10 per cent to 50 per cent chance of occurrence	50 per cent to 90 per cent chance of occurrence	>90 per cent chance of occurrence

Table 4.16.3 describes the criteria for assessing the consequence, on people and the environment, of a hazard occurring.

The combination of consequence and likelihood provides a risk rating for each hazard. The risk ratings adopted are:

- negligible – manage by routine procedures
- low – management responsibility must be specified
- medium – senior management attention required; immediate action to address issue
- high – detailed assessment and management planning required at senior level.

Table 4.16.4 provides a risk matrix, used for qualitative risk assessment, based on the above consequence and likelihood criteria.

Table 4.16.3 Consequence

	Negligible	Minor	Moderate	Major	Critical
Safety and Health[1]	First Aid	Minor injury Restricted work day Medical treatment	Major injury Long-term injury Occupational illness	Single fatality	Multiple fatalities
Environment	Magnitude of change comparable to natural variation. Not significant to the decision to be made on the Project	Detectable but not significant. Impact warrants being brought to the attention of the decision-maker but does not require special conditions to be attached to the approval. Impact can be controlled by adoption of normal good practice. Monitoring to ensure mitigation is working properly and that the impact is not worse than predicted	Significant. Impact warrants being brought to the attention of the decision-maker and deserves careful attention in the decision. Amenable to mitigation but likely to require conditions to ensure mitigation is undertaken. Monitoring to ensure mitigation is working properly and that the impact is not worse than predicted	Significant. Impact mitigation measures must be found to reduce impacts. Impact warrants being given considerable weight in the decision. Conditions should be attached to the approval and residual impacts must be compensated for, if possible. Monitoring to ensure mitigation is working properly and that the impact is not worse than predicted	Intolerable, not amenable to mitigation. Alternatives must be found

1 Based on the QGC Risk Management Plan, Issue 2, February 2009

Table 4.16.4 Risk Matrix

		Consequence				
		Negligible	Minor	Moderate	Major	Critical
Likelihood	**Almost certain**	Medium	Medium	High	High	High
	Likely	Low	Medium	Medium	High	High
	Possible	Low	Low	Medium	Medium	High
	Unlikely	Negligible	Low	Low	Medium	Medium
	Rare	Negligible	Negligible	Low	Low	Medium

16.3.2 Quantitative Hazard Assessment

The methodology adopted by the following references has been used for quantitative hazard assessment:

- Department of Urban Affairs and Planning (DUAP) (1992). *Guidelines for Hazard Analysis* Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 (and *Hazard Analysis Consultation Draft*, July 2008)
- Department of Urban Affairs and Planning (DUAP) (1997). *Risk Criteria for Land Use Safety Planning*. Hazardous Industry Planning Advisory Paper (HIPAP) No. 4
- Standards Australia Association (SAA) HB 105. Guideline to pipeline risk assessment in accordance with AS 2885.1.

The Queensland Government has adopted HIPAP 4 definitions of acceptable and unacceptable risk limits as set out in *Table 4.16.5* for new industrial installations located near residential developments.

Table 4.16.5 HIPAP Suggested Individual Fatality Risk Criteria

Land Use	Suggested Criteria (risk in a million per year)
Hospitals, schools, child-care facilities, old-age housing	0.5 (expressed as 0.5 x 10^{-6}/yr)
Residential, hotels, motels, tourist resorts	1 (expressed as 1 x 10^{-6}/yr)
Commercial developments including retail centres, offices and entertainment centres	5 (expressed as 5 x 10^{-6}/yr)
Sporting complexes and active open space	10 (expressed as 10 x 10^{-6}/yr)
Industrial	50 (expressed as 50 x 10^{-6}/yr)

1. Source: http://www.emergency.qld.gov.au/chem/publications/pdf/Interim_Risk_Objectives_for_MHFs.pdf
Hazardous Industry Planning Advisory Paper 4: Risk Criteria for Land Use Safety Planning, NSW Department of Planning (often quoted as 'HIPAP 4'). This document is not currently available. A draft, HIPAP 10, has been released for comment and covers the same material as HIPAP 4, plus new material.

For an industrial facility in an industrial area, Queensland Government guidelines for risk criteria state that risk of fatality at a neighbouring industrial facility should not exceed 50 x 10^{-6} pa. Risk levels lower than 1 x 10^{-6} per year are defined as acceptable for adjacent residential areas while those greater than 1 x 10^{-6} per year are defined as unacceptable for residential areas. The risk level probabilities are explained in *Table 4.16.6*.

Table 4.16.6 Risk Level Probabilities

Numerical Value Notation	Shorthand	Chance per Year of Fatality
1 x 10^{-3}/year	10^{-3}	One chance in 1,000 of being killed per year
1 x 10^{-4}/year	10^{-4}	One chance in 10,000 of being killed per year
1 x 10^{-5}/year	10^{-5}	One chance in 100,000 of being killed per year
1 x 10^{-6}/year	**10^{-6}**	**One chance in 1,000,000 of being killed per year**
1 x 10^{-7}/year	10^{-7}	One chance in 10,000,000 of being killed per year
1 x 10^{-8}/year	10^{-8}	One chance in 100,000,000 of being killed per year

In addition to the legislated risk criteria levels, QGC also has a set of internal risk acceptability guidelines. For the general public, in areas surrounding new facilities, the following guidelines apply:

- Risk levels lower than 1 x 10^{-7} per year are defined as broadly acceptable.
- Risk levels greater than 1 x 10^{-5} per year are intolerable.
- Risk levels between these values should be reduced to as low as reasonably practicable (ALARP).

16.3.2.1 Risk Acceptability Criteria for Workers

HIPAP 10 provides no guidance on acceptable levels for risk to individual workers at a particular facility that arise from that facility. QGC's internal criteria set out guidelines for worker risk acceptability, as described below.

- Risk levels greater than 1 x 10^{-3} per year are intolerable, and fundamental risk reduction measures are required.
- Risk levels lower than 1 x 10^{-6} per year are broadly acceptable.
- Risk levels between these values will be tolerable if it can be demonstrated that the risks are as low as reasonably practicable.

For new facilities, QGC will strive to keep the maximum worker risk below 1 x 10^{-4} per year.

16.3.2.2 Impact Consequences

The consequences of fires and explosions are expressed in terms of the physiological effects of fires (radiant impact) and explosions (overpressure levels). These are defined in *Table 4.16.7* and *Table 4.16.8* respectively.

Table 4.16.7 HIPAP Defined Radiant Impact Levels

Radiant Flux Level	Defined Impact per HIPAP 10
1.2 kW/m^2	Received from the sun at noon in summer
2.1 kW/m^2	Minimum to cause pain after one minute
4.7 kW/m^2	Will cause pain in 15–20 seconds and injury after 30 seconds' exposure (at least second-degree burns will result)
12.6 kW/m^2	Significant chance of fatality for extended exposure. High chance of injury. After long exposure, causes the temperature of wood to rise to a point where it can be readily ignited by a naked flame. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure
23 kW/m^2	Likely fatality for extended exposure and chance for fatality for instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failures. Pressure vessel needs to be relieved or failure will occur
35 kW/m^2	Cellulosic material will pilot-ignite within one minute's exposure Significant chance of fatality for people exposed instantaneously

Table 4.16.8 HIPAP Defined Overpressure Impact Levels

Overpressure Level	Defined Impact per HIPAP 10
3.5 kPa (0.5 psi)	90 per cent glass breakage No fatality and very low probability of injury
7 kPa (1 psi)	Damage to internal partitions and joinery, but can be repaired Probability of injury is 10 per cent No fatality
14 kPa (2 psi)	House uninhabitable and badly cracked
21 kPa (3 psi)	Reinforced structures distort. Storage tanks fail 20 per cent chance of fatality to a person in a building
35 kPa (5 psi)	House uninhabitable. Wagons and plant items overturned. Threshold of eardrum damage. 50 per cent chance of fatality for a person in a building and 15 per cent chance of fatality for a person in the open
70 kPa (10 psi)	Threshold of lung damage. 100 per cent chance of fatality for a person in a building or in the open. Complete demolition of houses

The methodology for hazard assessment is further detailed in *Appendix 3.9.*

16.3.3 Risk Criteria for Methane Release

The principal constituent of coal seam gas (CSG) is methane, comprising approximately 97.5 mol per cent of CSG. The consequences of unplanned CSG releases were predicted using the model for Areal Locations of Hazardous Atmospheres (ALOHA).

Methane is a non-toxic flammable gas, which means that it can ignite in air on contact with a source of ignition. The lower flammability limit is 4.4 per cent and the upper flammability limit is 15 per cent of the total parts of the atmosphere. If a spark is created while the air and fuel is in the flammable range, then an explosion or fire will result. The risk criteria used in the ALOHA model for potential flammable gas-release scenarios (methane) are summarised in *Table 4.16.9* and *Table 4.16.10*.

The "levels of concern" for explosion overpressure and heat radiation were modified to ensure consistency with DUAP 1997 effect levels (the default ALOHA values are shown in brackets). The consequence analysis of heat effects was also modelled at 35 kW/m^2 and 5 kW/m^2 to compare with criteria specified in the Terms of Reference (ToR) for this EIS.

Although, methane is non-toxic, it is classified as an asphyxiant in the guidelines on National Exposure Standards (NES) for atmospheric contaminants in the occupational environment (Australian Safety and Compensation Council 2009[2]). Asphyxiants are gases that, when present in an atmosphere in high concentrations, lead to a reduction of oxygen.

Therefore, Australian guidelines on toxic concentrations of methane in air from an occupational health and safety perspective do not exist. In this case, the default ALOHA values have been used as the risk criteria. The threshold level of most concern (TEEL-3 in *Table 4.16.9*) of 25,000 ppm (or 2.5 per cent) equals about 57 per cent of the lower flammability limit (4.4 per cent).

Table 4.16.9 Risk Criteria for Methane Release (Not Burning)

Hazard – methane not burning	Threat zone		
	Level of concern		
	Classification	Units	Level
Toxic area from vapour cloud	TEEL-3	ppm	25,000 (2.5%)
	TEEL-2	ppm	5,000
	TEEL-1	ppm	3,000
Flammable area of vapour cloud	60% LEL	ppm	26,400
	10% LEL	ppm	4,400
Blast area of vapour-cloud explosion	Destruction of buildings	psi	10 or 70 kPa (8)
	Serious injury likely	psi	3 or 21 kPa (3.5)
	Shatters glass	psi	0.5 or 3.5 kPa (1)

TEEL = Temporary Emergency Exposure Limits (TEELs) defined by the US Department of Energy.

TEEL – 3 = Maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

TEEL – 2 = Maximum concentration in air below which it is believed nearly all individuals could be exposed without

2 Australian Safety and Compensation Council (ASSC) 2009. Hazardous Substances Information System. http://hsis.ascc.gov.au/Default.aspx. Accessed March 2009.

experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

TEEL – 1 = Maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient health effects or perceiving a clearly defined objectionable odour.

LEL = Lower explosive limit = lower flammability limit. The minimum concentration of fuel in the air needed for a fire or explosion.

Table 4.16.10 Risk Criteria for Methane Release (Burning)

Hazard – methane burning	**Threat zone**		
	Level of concern		
	Classification	Units	Level
Thermal radiation	Potentially lethal within 60 seconds	kW/m^2	12.6 (10)
	Second-degree burns	kW/m^2	4.7 (5)
	Pain within 60 seconds	kW/m^2	2.1 (2)
Downwind toxic effects of fire by-products	No thresholds Not modelled by ALOHA		

16.3.3.1 Separation Distances

Separation distances to gas pipelines are provided by council planning schemes. Schedule 2 of the Murilla Shire (which includes the townships of Miles and Dalby) Planning Scheme Policy recommends a minimum separation distance to petroleum and gas pipelines of 200 m.

16.4 HAZARD IDENTIFICATION, CONSEQUENCES AND CONTROLS

Based on the anticipated construction sequencing, methodologies and activities known at preliminary design, QGC undertook a preliminary hazard identification assessment for construction, operation and decommissioning of the Pipeline Component infrastructure. The following hazards were identified as part of that process:

- unplanned gas release with possibility of fire or explosion through introduction of an ignition source
- live/high-energy sources
- inappropriate/unauthorised infrastructure use or access
- infrastructure or equipment failure, other than gas-processing equipment
- natural disaster
- pollutant release to air, soils or water
- release of Associated Water
- traffic accidents, involving multiple or single vehicles.

Hazards relating to the release of CSG and potential fires and explosions have been assessed through a quantitative risk analyses (QRA), described in

Sections 16.5 to *16.7.*

Other hazardous events, possible causes, consequences and proposed controls to address the identified hazards are provided in *Table 4.16.11* to *Table 4.16.17.*

Site-specific Hazard Identification Assessment or Study (HAZIDs) will be conducted in the detailed design of the infrastructure causing the hazard. Prior to construction and operations commencing, job hazard analyses will identify and address the site and activity-specific hazards.

For further information on decommissioning hazards refer to *Volume 5, Chapter 18.*

Table 4.16.11 Hazard Identification – Live/High Energy Sources

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Contact with live-energy sources: • Electric • Pneumatic • Hydraulic	Accidental contact with third-party power supply Energizing electrical equipment for the first time resulting in electrical short or explosion Faulty equipment Failure to isolate energy sources	Minor – major injury Fatality	Hardwire safety switches at source Quarterly inspection and tag Isolation and tag out procedures Earthing rods for all portable generators and welders Site awareness and training Bunded areas
Unplanned detonation of explosives	Incorrect handling, storage or use of explosives	Minor – major injury Fatality	Explosives will only be used as a last resort for rock blasting All industry safety standards will be followed

Table 4.16.12 Hazard Identification – Unauthorised Access or Use

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Inappropriate / unauthorised infrastructure use or access	Lack of site security leads to unauthorised access to pipelines (buried or exposed), access roads and other infrastructure	Minor – major injury Fatality from heat stress, dehydration, crushing, falling, etc Property damage Environmental damage Stock/fauna injury or death	Comprehensive Site Safety and Security Plan Site-access control Induction for employees and visitors
	Lack of fencing/signing leads to falls and/or entrapment in open trenches		Appropriate fencing, barriers, signage Landholder notification of works
	Landholders ignore safety/security access restrictions		Consultation with landholders to emphasise safety issues
	Stock/fauna contact with infrastructure		Adequate barriers/fencing

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
	New access roads/ RoW encourage non-landholders to access previously unreachable areas		New roads will have locked gates and warning signs.

Table 4.16.13 Hazard Identification – Infrastructure or Equipment Failure

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Infrastructure or equipment failure, other than gas processing equipment	Failure of materials storage including pipes, borrow material and soil stockpiles due to poor storage practices	Minor – major injury Fatality Property damage Environmental damage Stock/fauna injury or death	Safety procedures for pipe storage and handling Safety procedures for stockpiles storage and handling
	Fire at fuel storage		Firefighting equipment available Emergency shutdown procedures Bunded area
	Seismic event from nearby blasting		Consult with local mines/industry about blasting activity
	Construction vehicle failure, or similar		Construction vehicle testing Safety standards/procedures in place with drill rig and construction contractors
	Failure of pressure testing (hydro-testing)		Exclusion zones Limit size of system being tested to minimise stored energy whenever possible Staged pressure increases Calculations to quantify amount of stored energy in system being tested

Table 4.16.14 Hazard Identification – Natural Disasters

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Natural Disaster	Seismic event	Minor – major injury	Design standards for all potentially affected infrastructure, based on probability of seismic activity along pipeline routes
	Bushfire caused internally by cutting, welding and grinding (hot work)	Fatality Property damage Environmental damage Stock/fauna injury or death	Contact the local fire authority prior to commencing hot work to ascertain whether a fire ban applies on that day. If so, the fire officer shall obtain a written permit authorising the work for that day. Works will be carried out in accordance with all conditions of the permit Flammable material within 4 m of the work area will be wetted down and suitably protected A protective screen will be put in place to restrict the escape of sparks generated A minimum of four people will be present in the vicinity of the hot work All mobile plant and all vehicles will have a fully charged fire extinguisher ready for use at all times At the completion of all hot work, the area will be checked thoroughly to ensure no fire has started or may start Adequate medical facilities and resources will be assigned to construction sites Ambulance service will be assigned to Pipeline activities All welding sites will have a spark spotter and a water truck All hot work is normally conducted on a RoW, with a 10 m separation distance to the nearest vegetation
	Bushfire – caused externally		Early notification of potential bushfire size, direction and severity Emergency evacuation and shutdown procedures Firefighting procedures – liaison with Fire Service
	High wind/cyclonic conditions		Early notification of site personnel Tie down loose items and general clean-up Lower crane booms and anchor equipment if possible Shut down site and non-essential road traffic Use heavy equipment to provide windbreak for vulnerable structures
	Flood event		Locate pipeline infrastructure, where possible, above 1:100-year flood zones Pipelines to be buried to a depth of at least 900 mm Weather and upstream conditions will be monitored during construction in a watercourse Pipe will be laid to a sufficient depth to reduce risk of disturbance during flood

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
			Pipe may be concreted to prevent flotation Dedicated teams will be deployed at watercourse crossings to complete the task in the minimum timeframe Emergency evacuation and shutdown procedures of potentially affected infrastructure

Table 4.16.15 Hazard Identification – Pollutant Release

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Pollutant release to air, soils or water	Accidental chemical, fuel, oil spill due to operator error, equipment failure	Toxic effects leading to minor injury or health risk Introduction of disease or pest vectors, such as mosquitoes, midges, rats, etc Environmental damage Stock/fauna injury or death Contamination of soils, water or air resulting in long-term health implications for humans, stock and environment	All refuelling will be carried out away from watercourses to avoid surface water contamination Fuelling area to have containment for spills, and spill kits Response plan for spills Spill management materials will be provided at any fuel or chemical storage location. Training for people using hazardous materials Personal protective equipment (PPE) required for handling chemicals
	Fire at chemical or fuel/oil storage		Diesel fuel used in majority of vehicles[3] Eliminate petrol powered equipment and vehicles as far as possible Special storage for petrol No smoking at fuel station Fire extinguishers at fuelling points Safety showers, eye wash where material properties require it
	Hazardous goods release or spill during transport to site or on site		All hazardous materials to be clearly labelled Training for people using hazardous materials Safe transport of hazardous materials PPE required for handling chemicals Material Safety Data Sheet register on site and available to all employees

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
			Up-to-date list of all hazardous materials plus their storage sites Vehicles equipped with spill mitigation measures where practical Bunding of drainage lines and emergency clean-up and remediation procedures
	Release of acidic waters from acid sulfate soils (ASS)		Prepare ASS Plan (refer to *Volume 11, EMP*) Refer to *Volume 5, Chapter 4*
	Exposure, through trenching and construction of contaminated land to possible contaminants including pathogens from livestock carcass disposal, buried chemicals, heavy metals from animal dips, hydrocarbons/ asbestos on road verges		Landholder consultation prior to construction to determine whether tips or dips are likely to occur Review of Department of Environment and Resource Management (DERM) Contaminated Lands Register and Environmental Management Register for potentially contaminated sites Areas of known or potential contamination will be avoided where possible If areas cannot be avoided or trenchless techniques are inappropriate, site-specific management practices will be developed Contaminated material would only be removed from the work area with the approval of the DERM Training and site management procedures will be implemented
	Raw sewage or effluent release Release of sludge post treatment of sewage		Well-designed and constructed sewage treatment system Secure storage of sludge containers in bunded area
	Pollutant enters surface water (potable water supplies) through accidental release		Waste Management Plan (refer to *Volume 10, EMP*) Refer to *Volume 4, Chapter 15*
	Pollutant enters groundwater		Waste Management Plan (refer to *Volume 10, EMP*) Refer to *Volume 4, Chapter 15*
	Putrescible waste disposal		Waste Management Plan (refer to *Volume 10, EMP*) Refer to *Volume 4, Chapter 15*
	Dust generation – health impacts and visual impairment on roads/RoWs		Watering of roads/construction areas Review of construction techniques Refer to *Volume 4, Chapter 4 and 11*
	Air emission of NOx,		Refer to *Volume 4, Chapter 11*

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
	hydrocarbons, CO, ozone, particulates from in-line compressor		
	Unpleasant odour emissions from camp waste		Refer to *Volume 3, Chapter 12*
	Noise emissions from in-line compressor		Refer to *Volume 4, Chapter 12*
	Pest vectors		Strategies to minimise the potential impacts from mosquitoes will be based on Guidelines to Minimise Mosquito and Biting Midge Problems in New Development Areas (Queensland Health, 2002) Prevent the creation of areas where water stagnates and breeding can occur including washdown areas, sedimentation traps, containers and rubbish areas. Regular inspections will ensure adequate drainage and management controls Earthworks will prevent the accumulation of water and those containing water will be inspected for the presence of mosquito larvae regularly. Pools of stagnant water will be drained and/or the areas filled as soon as practicable Containers capable of accumulating water will be removed from site or stored in an inverted position If larvae are detected in large numbers, Queensland Health will be contacted for assistance in selecting and implementing suitable control methods

Note 3: Diesel fuel is a C1 combustible liquid. It is more difficult to ignite than flammable liquids such as petrol. Diesel is not classified as a dangerous good because of this property. Diesel exhausts (e.g. fine particulates and combustion gases) may cause health effects in confined areas with poor ventilation. Diesel will be stored at the central processing plants in either 5,000 L or 10,000 L tanks. Back-up diesel generators will be stored at the Field Compression Station but storage quantities will be very low. Diesel should be stored in accordance with AS 1940:2004, The Storage and Handling for Flammable and Combustible Liquids.

Table 4.16.16 Hazard Identification – Release of Associated Water

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Release of Associated Water	Failure of untreated water pipelines	Minor – major health risk Fatality Environmental damage	High safety design standards Emergency shutdown procedures Adequate pond storage to handle delays
	Terrorism/deliberate sabotage	Contamination of soils and water with long-term health implications for humans, stock and environment	Site Security and Safety Plan
	Hydro-testing and pigging		Disposal of hydro-test/pigging water to controlled areas

Table 4.16.17 Hazard Identification – Traffic Accident

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Traffic accident, involving multiple or single vehicles	• Driver failure due to speed, drowsiness, judgment error, night travel etc	Minor – major injury Fatality Vehicle damage Environmental spill Increase in road kill/ injury of stock and native fauna	Driver training Fatigue management Ongoing training and awareness Limit night-time driving Monitoring speed and driver behaviour and taking action if unsafe
	• Existing roads inadequate – width, surface, parked vehicles		Road maintenance and inspection Alerts to Project drivers about road hazards and implementation of speed limits for Project drivers Remove public vehicles from site Restrict speeds on private roads, Gas Field roads
	• Vehicle in poor condition • Vehicle not manufactured to safe standards		Vehicle inspection program Heavy vehicles to be fitted with reversing beeper Suitable roll cage or provisions in heavy vehicles and equipment
	Dust causes visual impairment		Dust control on roads, principally road watering Driver training
	Dangerous intersection created or existing intersection becomes more		Adequate signage Traffic management plan

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
	dangerous due to increased traffic volumes.		Community education In consultation with relevant road authorities, consider road standards
	Project causes changed traffic conditions, such as road closures for deliveries		Adequate notice to road users, through mobile signage Attended traffic control where required Consultation with road authorities
	Increased probability of contact with high-risk road users, such as school children, pedestrians and cyclists		Reduced use of roads at times or locations when high-risk road users on road Consultation with road authorities
	Loss of load during delivery		Contractors must abide by high safety standards
	Failure of bridge/floodway crossings due to traffic volume or vehicle size		Bridge/floodway assessment prior to use by heavy vehicles Alternative routes used or bridge/floodway upgraded
	Deterioration of existing roads caused by Project. Poor road design or maintenance activities		Road improvements/maintenance Use of other transport methods such as rail
	Level (rail) crossing incident		Drivers warned of all rail crossing areas
	Roadworks coinciding with increased traffic volumes		Consultation with state and local roads departments
	Increase in heavy load/oversized vehicles on roads		Only in-line compressor movements may result in heavy loads or oversized vehicles Traffic escorts
	Construction crews working in proximity to roads and railways		Construction site safety systems/training Consultation with road authorities about reducing risks, including traffic-warning signs and reduced speed limits

Note 1: Medical preventions, treatment or facilities includes:

- provisions of paramedic services
- pre-employment medical screening
- provision of emergency response team and equipment
- provision of ambulance and emergency response vehicles
- emergency communication procedures and process
- protective clothing issues to worker
- potable water supply
- amenities for rest
- other personal protective equipment (sunscreen, insect repellent, etc.;
- drug and alcohol testing
- health promotion.

16.4.1 Residual Risk Analysis

A residual risk analysis has been conducted for the hazards identified above. Residual risk is the risk that remains after the proposed controls have been implemented. The introduction of controls reduces the likelihood or consequence of an event, thereby reducing the risk.

For each of the causes of hazardous events identified above, the consequence, likelihood and resulting residual risk rating are presented in *Table 4.16.18* to *Table 4.16.24*.

Table 4.16.18 Hazard Risk Rating – Live and High Energy

Hazard	Likelihood	Consequence	Rating
Contact with live-energy sources	Rare	Major	Low
Incorrect handling, storage or use of explosives	Rare	Critical	Medium

Table 4.16.19 Hazard Risk Rating – Unauthorised Access or Use

Hazard	Likelihood	Consequence	Rating
Lack of site security leads to unauthorised access to pipelines (buried or exposed), access roads and other infrastructure	Likely	Moderate	Medium
Lack of fencing/signs leads to falls and/or entrapment in open trenches	Possible	Moderate	Medium
Landholders ignore safety/security access restrictions	Unlikely	Moderate	Low
Stock/fauna contact with infrastructure	Unlikely	Negligible	Negligible
New access roads/RoWs encourage non-landholders to access previously unreachable areas	Possible	Minor	Low

Table 4.16.20 Hazard Risk Rating – Infrastructure or Equipment Failure

Hazard	Likelihood	Consequence	Rating
Failure of materials storage including pipes, borrow material and soil stockpiles due to poor storage practices	Unlikely	Moderate	Low
Fire at fuel storage	Unlikely	Moderate	Low
Seismic event from nearby blasting	Rare	Moderate	Low
Construction vehicle failure, or similar	Possible	Moderate	Medium
Failure of pressure testing (hydrotesting)	Unlikely	Minor	Low

Table 4.16.21 Hazard Risk Rating – Natural Disasters

Hazard	Likelihood	Consequence	Rating
Seismic event	Rare	Critical	Medium
Bushfire caused internally by cutting, welding and grinding (hot work)	Unlikely	Major	Medium
Bushfire – caused externally	Possible	Major	Medium
High-wind condition	Unlikely	Major	Medium
Flood event	Possible	Major	Medium

Table 4.16.22 Hazard Risk Rating – Pollutant Release

Hazard	Likelihood	Consequence	Rating
Accidental chemical, fuel, oil spill due to operator error, equipment failure	Possible	Minor	Low
Fire at chemical or fuel/oil storage	Unlikely	Moderate	Low
Hazardous goods release or spill during transport to site or on site	Possible	Moderate	Medium
Release of acidic waters from acid sulfate soils	Possible	Major	Medium
Exposure, through trenching and construction of contaminated land to possible contaminants including pathogens from livestock carcass disposal, buried chemicals, heavy metals from animal dips, hydrocarbons/asbestos on road verges	Unlikely	Minor	Low
Raw sewage or effluent release or release of sludge post-treatment of sewage	Unlikely	Minor	Low
Pollutant enters surface water (potable water supplies) through accidental release	Unlikely	Minor	Low
Pollutant enters groundwater	Unlikely	Moderate	Low
Putrescible waste disposal	Unlikely	Minor	Low
Dust generation – health impacts and visual impairment on roads/RoWs	Likely	Moderate	Medium
Air emission of NOx, hydrocarbons, CO, ozone, particulates	Possible	Minor	Low
Unpleasant odour emissions	Unlikely	Minor	Low
Noise emissions	Unlikely	Minor	Low
Pest vectors	Unlikely	Moderate	Low

Table 4.16.23 Hazard Risk Rating – Release of Associated Water

Hazard	Likelihood	Consequence	Rating
Failure of untreated water pipelines	Unlikely	Moderate	Low
Terrorism/deliberate sabotage	Rare	Moderate	Low
Hydrotesting and pigging	Possible	Moderate	Medium

Table 4.16.24 Hazard Risk Rating – Traffic Accident

Hazard	Likelihood	Consequence	Rating
Driver failure due to speed, drowsiness, judgment error, night travel etc	Possible	Critical	High
Existing roads inadequate – width, surface, parked vehicles	Possible	Critical	High
Vehicle in poor condition Vehicle not manufactured to safe standards	Unlikely	Critical	Medium
Dust causes visual impairment	Possible	Critical	High
Dangerous intersection created or existing intersection becomes more dangerous due to increased traffic volumes	Unlikely	Critical	Medium
Project causes changed traffic conditions, such as road closures for deliveries	Unlikely	Major	Medium
Increased probability of contact with high-risk road users, such as school children, pedestrians and cyclists	Unlikely	Critical	Medium
Loss of load during delivery	Unlikely	Major	Medium
Failure of bridge/floodway crossings due to traffic volume or vehicle size	Rare	Major	Low
Deterioration of existing roads caused by Project. Poor road design or maintenance activities	Possible	Major	Medium
Level (rail) crossing incident	Rare	Critical	Medium
Road works coinciding with increased traffic volumes	Possible	Moderate	Medium
Increase in heavy load/oversized vehicles on roads	Rare	Major	Low
Construction crews working in proximity to roads and railways	Likely	Moderate	Medium

16.4.2 Mitigation of Risks

Those hazards with a high residual risk rating are listed in *Table 4.16.25*, with further potential risk abatement procedures or reasons for acceptance of the risk.

Table 4.16.25 High Residual Risks

High Residual Risk Hazard	Abatement
Driver failure due to speed, drowsiness, judgment error, night travel etc	Identify travel routes and volumes for various activities. Identify routes, drivers and times of driving that present the greatest risk. Compulsory driver training and repeated safety message for all high risks. Fatigue management as per internal and external guidelines
Existing roads inadequate – width, surface, parked vehicles	In consultation with relevant authorities, upgrade existing high risk roads
Dust causes visual impairment	Increase number of water trucks to keep dust levels low, especially where multiple unsealed roads and multiple projects are in the same area

16.5 HAZARD IDENTIFICATION – GAS RELEASE

Table 4.16.26 describes the possible causes, consequences and proposed controls to address the hazards resulting from unplanned release of CSG from pipelines.

The risk presented by a hazard is a combination of the consequence and likelihood of the hazard.

Table 4.16.26 Hazard Identification – Unplanned Gas Release

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
Unplanned gas release with possibility of vapour cloud, fire or explosion through introduction of an ignition source	In-line compressor failure for variety of reasons (e.g. heat stress, component malfunction, valve failure, corrosion, damage to flanges and gaskets, failure of temperature and pressure control) Possible high temperature (>100°C) and high pressure gas release (>10,00 kPa)	Toxic effects from gas, vapour flash cloud, overpressure (blast force) from vapour, thermal radiation and toxic effects from fires, leading to: • Minor – major injury • Fatality • Property damage • Environmental damage • Stock/fauna injury or death	Isolate the compressor station and stop all compressors Emergency safety systems in design, such as emergency shutdown at gate No ignition sources near compressors No flaring during unplanned gas release Evacuation alarm Automatic isolated valves on suction and discharge Automatic blowdown to atmosphere
	Pipeline sited parallel to power lines, creating electrical interference		500 m corridor width between the Pipeline and powerlines
	Pipeline failure due to stress corrosion, AC corrosion, scour damage, faulty construction, weld failure, pressure surges, valve failure, pump failure ground movement, erosion, subsidence during construction or maintenance activities		Design, test, monitor and maintain in accordance with AS 2885.1 Quality control in pipe fabrication Quality control in pipe-laying operations Physical measures (in accordance with AS 2885.1) • Cross-country sections – minimum depth – 750 mm, although Project will have 900 mm minimum depth • Beneath roads – 1,200 mm unless rock • Fire break – 1,200 mm Physical protection of the pipe in any exposed location Installation of protective devices such as emergency isolation valves and non-return valves Leak detection by automatic sensing devices
	Landholder/third party external interference damages or ruptures pipelines		Signposting of Pipeline routes. In accordance with AS 2885.1 – warning signs required at each change of direction and crossing and must be "line of sight" Information on Pipeline routes publicly available and lodged

Hazardous Event	Possible Causes	Possible Consequences	Proposed Controls[1]
			with relevant authorities – ‘‘dial before you dig’’ R1/R2 location classification under AS 2885 requires one physical and two procedural measures Adequate depth of cover important
	Marine pipeline failure due to corrosion, subsurface obstacles, marine life infiltration, shipping/boating collisions, tidal forces and storm surges		Pipeline route demarcated on shoreline Mitigation measures for ASS Inclusion of pipeline on shipping/boating charts Consultation with harbour authorities Adequate protection if open-trenched
	Ignition source in hazardous zone		Exclusion zone and control of potential ignition sources All electrical equipment is appropriate to the hazardous area classification Permit to work procedures including job safety analysis for each work-over Safety management system
	Natural disaster, including seismic event, bushfire, high winds Seismic event from nearby blasting		Reduction in operations with adequate warning Design basis for permanent infrastructure Rapid response plan following disaster event Removal of all potential ignition sources
	Sabotage or theft of infrastructure Terrorism		Comprehensive site safety and security plan

16.5.1 Likelihood Analysis

The likelihood of hazardous events identified was assessed by reviewing data on equipment failure, ignition probabilities or human error.

The frequency (or likelihood) determination for pipeline threats specified by Australian Standard SAA HB105 is provided in *Table 4.16.27* and *Table 4.16.28*.

Table 4.16.27 Frequency Determination for Pipeline Threats

Frequency of occurrence	Description	Nearest numerical frequency for guidance (per 1,000 km per year)
Frequent	Expected to occur at least once per year	1 or greater
Occasional	Expected to occur several times in the life of the pipeline	0.1
Unlikely	Not likely to occur in the life of the Pipeline, but is possible	0.01
Remote	Very unlikely to occur in the life of the pipeline	0.001
Improbable	Examples of this event have occurred historically, but it is not anticipated for the pipeline at this location	10^{-5}
Hypothetical	Theoretically possible but has not occurred at this date	10^{-6} or lower

Source: SAA HB105[3]

Table 4.16.28 General Failure Rate Data for Gas Pipelines

Cause	Failure Rate (per km-year)	Failure Rate (per 1,000 km per yr)
External force	3×10^{-4}	0.3
Corrosion	1×10^{-4}	0.1
Material defect	1×10^{-4}	0.1
Other	5×10^{-5}	0.05
Total	5.5×10^{-4}	0.55

Source: R2A (2002)[4]

Ignition probability data for gas releases at varying release rates is presented in *Table 4.16.29.*

3 SAA HB105. Guideline to pipeline risk assessment in accordance with AS 2885.1

4 R2A (2002). Issue Paper, Guide to Quantitative Risk Assessment (QRA). Prepared for Office of Gas Safety, Standards Australia ME-038-01 Committee, Pipelines – Gas and Liquid Petroleum. Risk & Reliability Associates Pty Ltd.

Table 4.16.29 Probability of Ignition following CSG Release

Release Rate (kg/mins)	Ignition Probability (Gas or Mixture)	
	Probability	Likelihood (1 x 10^{-6})
<60	0.01	10,000
60–3,000	0.07	70,000
>3,000	0.3	300,000

The following information was reported by Kimber 2005 *in Australian Pipeline Research Program Keynote Address – Keeping the Australian Pipeline Standards Up to Date.*

- The most common cause of pipeline damage is external interference.
- External interference accounts for 76 per cent of all incidents.
- The second-most common cause of pipeline damage is corrosion.
- There have been no deaths or injuries in Australia as a result of pipeline rupture (~1985 – 2005).
- There were six ruptures and 20 leaks reported to the incident database.
- Pipe deformation (scratches, gouges and dents) accounts for two thirds of incidents.
- The average incident rate for loss of containment is 0.015 per 1,000 km a year.
- The overall accident rate is 0.13 per 1,000 km a year.
- The average incident rate for loss of containment is an order of magnitude lower than the loss of containment rates in Europe and the USA.
- The incident rate for external interference varies with location class, ranging from 0.05 per 1,000 km a year in remote rural areas to 0.48 per 1,000 km a year in rural residential and suburban areas.

For this hazard assessment, the likelihood analysis has two components relating to a jet fire:

- the likelihood of loss of containment
- the likelihood of ignition.

The incident rates described by the Australian Pipeline Research Program (2005) were lower than those reported by other sources (see *Table 4.16.28* and *Table 4.16.29*) but generally consistent with the frequency classifications provided by AS 2885 and the SAA HB105. In addition, they are Australian specific and more recent than other failure-rate data. Both the conservative estimate of 0.55 per 1,000 km a year and the Australian value of 0.13 per 1,000 km a year have been used in this report. The higher failure rate presents a worst-case scenario while the Australian rate is most representative of the rates in rural Australia.

There is no information on failure or release rates from compressors. QGC considers there to be a low likelihood of significant releases during operation.

As for the pipeline scenarios, more detailed assessment would consider the number of flanges, valves and instrument fittings to enable use of failure data on a per part basis. More detailed analysis would also consider the risks associated with the failure of more than one component (e.g. compressor) at any one time although this scenario is considered unlikely given emergency shutdown procedures.

Therefore, generic data for failure rates has been used in this assessment. A summary of incident rates, ignition probabilities and total estimate of likelihood are provided in *Table 4.16.30* and *Table 4.16.31.*

16.5.2 Consequence Analysis

The consequences of all types of gas releases were analysed using the ALOHA model. This model provides quantitative estimates of threat zones, such as distance to a pre-defined ''level of concern'' for toxic effects (airborne concentrations, ppm or mg/L), vapour-cloud flash (based on flammable limits of the gas percentage) and thermal radiation (kW/m^2).

The consequences of a CSG release (considered to be 100 per cent methane for the purposes of this hazard assessment) are described in *Figure 4.16.1*.

Table 4.16.30 Summary of Likelihood Data for CSG Release and Ignition – In-line Compressor

Release Source	Hole size	No. parts	Pressure	Likelihood of release	Likelihood of release	Calculated release rate[1]	Ignition Probability	Likelihood of fire (note 1)
	mm		(kPa)	(x 10^{-6} per part per year)	x 10^{-6} per year	(kg/mins)		(x10^{-6} per year)
Screw compressor/FCS	25	8 x 4 (note 2)	1,500	170 (note 2)	5,440	21	0.01	54
					5,440		0.032	174

[1] Derived from consequence modeling described in the following section

Notes:

1 Likelihood of fire = likelihood of release x likelihood of ignition

2 Assuming four valves per compressor on inlet and discharge lines – 25 mm hole size

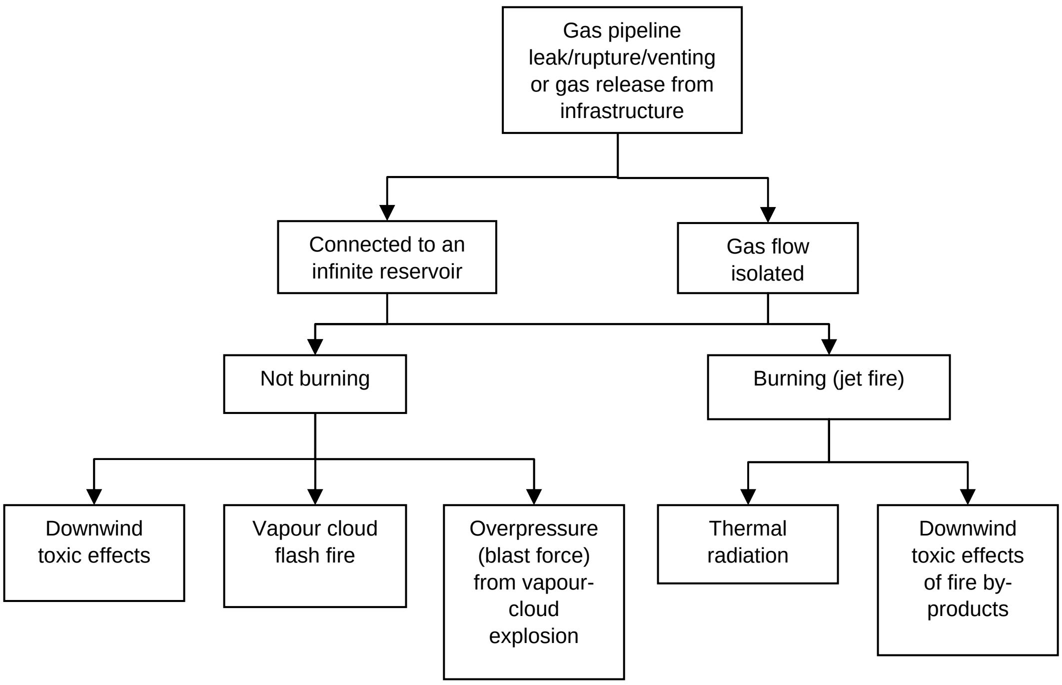
Table 4.16.31 Summary of Likelihood Data for CSG Release and Ignition – Pipeline Scenarios

Release Source	Hole size	1,000 km	Pressure	Likelihood of release	Likelihood of release	Calculated release rate[1]	Ignition Probability	Likelihood of fire (note 1)	Likelihood of fire (note 1)
	mm		(kPa)	(per total km per year)	(per 1,000 km per year)	(kg/mins)		(per 1,000 km per year)	(per million km per year)
Loss of containment rate (POG/APIA 2005)									
Collection Header/Export Pipeline	25	0.583	10,200	0.015	0.008745	504	0.07	0.001	0.61
	150	0.583	10,200	0.015	0.008745	16,600	0.3	0.003	2.62
Incident rate (POG/APIA 2005)									
Collection Header/Export Pipeline	25	0.583	10,200	0.13	0.07579	504	0.07	0.005	5.31
	150	0.583	10,200	0.13	0.07579	16,600	0.3	0.023	23
General failure rate (R2A 2002)									
Collection Header/Export Pipeline	25	0.583	10,200	0.55	0.32065	504	0.07	0.022	22
	150	0.583	10,200	0.55	0.32065	16600	0.3	0.096	96

[1] Derived from consequence modeling described in the following section

Notes: 1 Likelihood of fire = likelihood of release x likelihood of ignition

Figure 4.16.1 Hazard Assessment



The consequences modelled for a gas release that is not burning are:

- downwind toxic area of vapour cloud – the predicted area where the ground-level toxic vapour concentration may be hazardous
- flammable area of vapour cloud – the predicted area where the ground-level vapour (fuel) concentration in air is within the flammable range and can be ignited (the area where a flash fire could occur at some time after the release)
- blast area of vapour-cloud explosion – the predicted area where the blast force from the explosion is hazardous.

The consequences for a gas release that is burning (i.e. when a flammable gas catches on fire as it is released) are:

- thermal radiation (modelled by ALOHA)
- smoke and toxic by-products from a jet fire (not modelled by ALOHA but expected to be minimal from a CSG fire).

16.5.3 Pipeline Infrastructure Modelling Assumptions

The Pipeline Component infrastructure is described in *Volume 2, Chapters 8* and *12*. In addition the modelling parameters relevant to pipeline hazard modelling, based on engineering design, are presented in *Table 4.16.32* to *Table 4.16.33*.

The Collection Header and Export Pipelines have the same parameters for gas release. Impacts from gas release have therefore been modelled collectively.

16.6 IMPACTS – GAS RELEASE

Various types of gas releases from the following equipment or infrastructure were modelled:

- In-line compressor – 25 mm hole
- Gas Collection Header/Export Pipeline – 25 mm hole
- Gas Collection Header/Export Pipeline – 150 mm hole.

16.6.1 Meteorological Conditions

Unplanned gas releases were modelled under a range of meteorological conditions based on average data collated from the Bureau of Meteorology for Dalby, Miles, Biloela and Gladstone. Data from Miles is most representative of the meteorological conditions for the Collection Header which is located in close proximity to the Gas Field. The Export Pipeline will extend from Miles to Gladstone and therefore be subject to coastal conditions (such as higher wind speeds).

While data from Miles is considered representative of most Collection Header pipeline activities, a range of meteorological conditions were modelled to ensure the impacts of lower and higher wind speeds on the potential consequences of CSG releases were evaluated. The higher wind-speed scenario is most relevant to the Export Pipeline, which passes near Gladstone.

The four meteorological scenarios included in the consequence modelling were:

- Gas Field baseline morning conditions
- Gas Field baseline afternoon conditions
- low-wind speed (0.85 m/s)
- high-wind speed (5.9 m/s).

Further details about meteorological conditions modelled are provided in *Appendix 3.9.*

Table 4.16.32 In-line Compressor Parameters

Description	Function	Pipeline type	MAOP	Pipeline inlet pressure	Diameter	Wall thickness	Internal diameter	Gas supply control	Max length from reservoir or isolation valve
			MPa	kPa	mm	mm	cm	type	m
Compressor discharge pipeline	Transport compressed gas	Steel	Gas – 1.25 MPa	1,500 (screw compressor) 10,200 (reciprocating compressor)	109	9	10	Finite – isolation valve before compressor	Not available

Table 4.16.33 Pipeline Parameters

Description	Function	Pipeline type	MAOP	Pipeline inlet pressure	Diameter	Wall thickness	Internal diameter	Pipeline length	Individual lengths	Gas supply control	Max length from reservoir or isolation valve
			MPa	kPa	mm	mm	cm	m	m	type	m
Collection Header	Connection of all QGC's production leases (note 2) for inlet to the Export Pipeline in the Miles area	Steel, Class 600	10.2	10,200 (note 1a)	1,050	15.66	103.4	203,000	18	Finite - isolation valve	30,000 (note 3) Model input = 10,000 max
Export Pipeline	Pipeline from QGC's production leases in south-central Queensland to the LNG Facility in Gladstone	Steel, Class 600	10.2	10,200 (note 1b)	1,050	15.66	103.434	380,000 (note 4)	18	Finite - isolation valve	30,000 (note 3) Model input = 10,000 max

na = not applicable

Notes

1a Inlet pipeline pressure to Gas Collection Header = 10,000 kPa

1b Inlet pressure to Export Pipeline = 9,600 kPa

2 Lateral Pipelines may also connect additional gas fields to the transmission pipeline.

3 Maximum spacing of valves based on risk profile. Expected to be about 90km spacing Maximum input to model is 10 km

4 Sub-sea portion = ~3 km

16.6.2 In-line Compressor

Releases from the in-line compressor were modelled as pipeline sources. The pipeline length was modified to simulate a release of approximately 30 m^3, which is the volume expected to be released during a screw compressor start or blowdown. This gas volume was considered to be a credible release scenario assuming standard control measures, such as unit isolation valves, blowdown valve and vent and pressure safety valves and vent. The in-line compressor is based on screw compressors used in the Gas Field.

The model scenario evaluated is based on a 25 mm-hole size, which is equivalent to a hole caused by fitting failure but conservative for a leak from a valve or flange (more likely to be 10 mm). Results of modelling are presented in *Table 4.16.34.*

Results show that, for a 25 mm hole in a screw compressor:

- The concentration of methane in air at which nearly all individuals could be exposed without developing life-threatening health effects (TEEL-3) is less than 20 m from the compressor
- The potential for ignition, at 60 per cent of the lower flammability limit, occurs within 28 m of a compressor
- There is no possibility of experiencing blast pressures greater than 21 kPa
- There is no potential for fatality and very low probability of injury from a blast (not burning) of 3.5 kPa at a distance of 35 m from the compressor
- The potential for injury after 30 seconds (4.7 kW/m^2) from thermal radiation from burning gas is less than 10 m from the compressor.

16.6.3 Collection Header/Export Pipeline

The results of consequence modelling for a 25 mm hole in either the Collection Header or Export Pipeline are presented in Table 4.16.35.*Table* 4.16.35 results show that, for a 25 mm hole in a pipeline:

- the concentration of methane in air at which nearly all individuals could be exposed without developing life-threatening health effects (TEEL-3) is less than 99 m from the pipeline
- the potential for ignition, at 60 per cent of the lower flammability limit, occurs within 136 m of the pipeline
- there is no possibility of experiencing blast pressures greater than 21 kPa
- there is no potential for fatality and very low probability of injury from a blast (not burning) of 3.5 kPa at a distance of 112 m from the pipeline
- the potential for injury after 30 seconds (4.7 kW/m^2) from thermal radiation from burning gas is less than 24 m from the pipeline
- the potential for significant chance of fatality for extended exposure (12.6 kW/m^2) from thermal radiation from burning gas is less than 15 m from the pipeline.

The results of consequence modelling for a 150 mm hole in either the Collection Header or Export Pipeline are presented in *Table 4.16.36*.

Table 4.16.36 results show that, for a 150 mm hole in a pipeline:

- The concentration of methane in air at which nearly all individuals could be exposed without developing life-threatening health effects (TEEL-3) is less than 577 m from the pipeline
- The potential for ignition, at 60 per cent of the lower flammability limit, occurs within 788 m of the pipeline
- There is no possibility of experiencing blast pressures greater than 21 kPa
- There is no potential for fatality and very low probability of injury from a blast (not burning) of 3.5 kPa at a distance of 542 m from the pipeline
- The potential for injury after 30 seconds (4.7 kW/m^2) from thermal radiation from burning gas is less than 150 m from the pipeline
- The potential for significant chance of fatality from extended exposure (12.6 kW/m^2) and instant exposure (35 kW/m^2) from thermal radiation from burning gas is less than 94 m and 57 m from the pipeline, respectively.

Table 4.16.34 Results of Consequence Modelling – In-line Compressor, 25 mm Hole

Met data	Release duration (mins)	Release rate (kg/mins)	Total amount released (kg)	Threat zone (m) not burning – toxic			Threat zone (m) not burning – flammable		Threat zone (m) not burning – blast			Threat zone (m) burning			
				TEEL-3 (25,000 ppm)	TEEL-2 (5,000 ppm)	TEEL-1 (3,000 ppm)	60% LEL	10% LEL	70kPa	21kPa	3.5kPa	Max flame (m)	35 kW/m^2	12.6 kW/m^2	4.7 kW/m^2
Baseline morning	4	21	22.1	16	35	45	22	53	not exceeded	not exceeded	23	2	<10	<10	<10
Baseline afternoon	4	21	22.1	16	35	45	21	52	not exceeded	not exceeded	23	2	<10	<10	<10
Low wind speed	4	21	22.1	20	45	59	28	68	not exceeded	not exceeded	35	2	<10	<10	<10
High wind speed	4	21	22.1	16	35	45	22	53	not exceeded	not exceeded	21	2	<10	<10	<10

Table 4.16.35 Results of Consequence Modelling – Collection Header/Export Pipeline, 25 mm Hole

Met data	Release duration (mins)	Release rate (kg/mins)	Total amount released (kg)	Threat zone (m) not burning – toxic			Threat zone (m) not burning – flammable		Threat zone (m) not burning - blast			Threat zone (m) burning			
				TEEL-3 (25,000 ppm)	TEEL-2 (5,000 ppm)	TEEL-1 (3,000 ppm)	60% LEL	10% LEL	70 kPa	21 kPa	3.5 kPa	Max flame (m)	35 kW/m^2	12.6 kW/m^2	4.7 kW/m^2
Baseline morning	60[1]	504	29,571	77	174	225	105	262	not exceeded	not exceeded	86	2	<10	15	24
Baseline afternoon	60[1]	498	29,249	76	172	222	105	258	not exceeded	not exceeded	82	2	<10	15	24
Low-wind speed	60[1]	502	29,485	99	223	288	136	335	not exceeded	not exceeded	112	2	<10	15	24
High-wind speed	60[1]	498	29,254	78	180	237	108	278	not exceeded	not exceeded	81	2	<10	15	24

[1] Limited to 60 minutes duration by model

Table 4.16.36 Results of Consequence Modelling –Collection Header/Export Pipeline, 150 mm Hole

Met data	Release duration (mins)	Release rate (kg/mins)	Total amount released (kg)	Threat zone (m) not burning – toxic			Threat zone (m) not burning – flammable		Threat zone (m) not burning – blast			Threat zone (m) burning			
				TEEL-3 (25,000 ppm)	TEEL-2 (5,000 ppm)	TEEL-1 (3,000 ppm)	60% LEL	10% LEL	70 kPa	21 kPa	3.5 kPa	Max flame (m)	35 kW/m^2	12.6 kW/m^2	4.7 kW/m^2
Baseline morning	60[1]	16,600	479,746	454	1,100	1,400	629	1,600	not exceeded	not exceeded	396	12	57	94	150
Baseline afternoon	60[1]	16,400	471,244	450	1,000	1,400	622	1,600	not exceeded	not exceeded	391	12	57	93	149
Low-wind speed	60[1]	16,600	477,497	577	1,300	1,600	788	1,800	not exceeded	not exceeded	542	12	56	93	149
High-wind speed	60[1]	16,400	471,485	506	1,300	1,800	725	2,200	not exceeded	not exceeded	407	12	57	92	148

[1] Limited to 60 minutes duration by model

16.6.4 *Consequences for Human Health*

A classification system for the consequence modelling described above is provided in *Table 4.16.38*. Each potential consequence of a gas release has different levels of impact, as reflected in *Table 4.16.7* to

Table 4.16.10*.* The level of impact from a gas release is assigned a ranking from negligible to critical.

The risk criterion adopted as the level at which fatality from heat radiation occurs for instantaneous exposure is 35 kW/m^2. The classification of fatality therefore, is negligible where the effect level is not exceeded or major where the effect level is exceeded.

Table 4.16.7 indicates there is a significant chance of fatality for extended exposure (> 60 seconds) at the lower level of 12.6 kW/m^2 and a high chance of injury. Extended exposure means the victim is unable to move away from the heat radiation, which might, for example, occur if someone was injured separately prior to the fire. The likelihood of this scenario is very low and therefore exposure to a heat radiation level of 12.6 kW/m^2 is treated as a moderate injury risk.

The consequence to human health for each of the modelled scenarios is presented *in Table 4.16.36* and *Table 4.16.37*

A large puncture or hole to a pipeline, resulting in a CSG release that ignites to produce a jet fire, was the only scenario with an exceedence of the 35 kW/m^2 effect level. This scenario also presented a moderate risk in terms of injury at greater distances from the source.

Table 4.16.37 Qualitative Descriptions of Consequences

Level	Consequence	Example Detailed Description	Heat Radiation (kW/m^2)	Blast Overpressure (kPa)	Toxic Effects (ppm)	Potential flammability (ppm)
1	Negligible	Health – no medical treatment required	1.2	< 3.5	5,000	<4,400
2	Minor	Health – reversible disability requiring hospitalisation	4.7	3.5	25,000	4,400
3	Moderate	Health – moderate irreversible disability or impairment (<30%) to one or more persons	12.6	14	>2,5000	26,400 (at > 50 m)
4	Major	Health – single fatality and/or severe irreversible disability (>30%) to one or more persons	35	21, 35	n/a[1]	n/a[2]
5	Critical	Health – multiple fatalities, or significant irreversible effects to >50 persons	>35	70	n/a[1]	n/a[2]

Note 1: No criteria available above TEEL-3 of 25,000 ppm.

Note 2: Consequence modelling indicates the threat zone from a possible ignition. No criteria above 60 per cent of lower flammability limit assessed.

Table 4.16.38 Consequences for Human Health

Scenario	Incident	Incident Outcome	Incident Outcome Case	Risk to Human Health	
				Fatality	Injury
In-line compressor release	25 mm fitting failure	No ignition – not burning	Toxic effects	Negligible	Minor for distances up to 60 m
			Flammable vapour cloud	Negligible	Minor – isolated pockets up to 70 m
			Explosion	Negligible	Minor for distances up to 36 m
		Ignition – burning	Jet flame	Negligible	Negligible
Collection Header or Export Pipeline	25 mm puncture hole	No ignition – not burning	Toxic effects	Negligible	Minor for distances up to 288 m
			Flammable vapour cloud	Negligible	Moderate for distances up to 136 m
					Minor for distances from 136 to 335 m
			Explosion	Negligible	Minor for distances up to 112 m
		Ignition – burning	Jet flame	Negligible	Minor for distances up to 24 m
					Moderate for distances up to 15 m
Collection Header or Export Pipeline	150 mm puncture hole	No ignition – not burning	Toxic effects	Negligible	Minor for distances up to 1,800 m
			Flammable vapour cloud	Negligible	Moderate for distances up to 788 m
					Minor for distances from 788 to 2,200 m
			Explosion	Negligible	Minor for distances up to 542 m
		Ignition – burning	Jet flame	Major for distances up to 57 m	Moderate for distances from 57 to 94 m
					Minor for distances from 94 to 150 m

The scenarios causing major or moderate consequences from heat radiation are summarised in *Table 4.16.39*. There are no scenarios with critical consequences.

Table 4.16.39 Scenarios with Major or Moderate Consequences

Consequence	Scenario
Fatality (35Kw/m^2)	Pipeline, 150 mm hole , up to 57 m
Injury (12.6 kW/m^2)	Pipeline, 25 mm hole, up to 15 m
	Pipeline, 150 mm hole, up to 94 m

The flammable vapour-cloud scenarios (indicating moderate injury risk) were not evaluated quantitatively because the likelihood of ignition and heat radiation generated was unknown. However, the identified threat zones for these scenarios provide guidelines for separation distances from potential ignition sources.

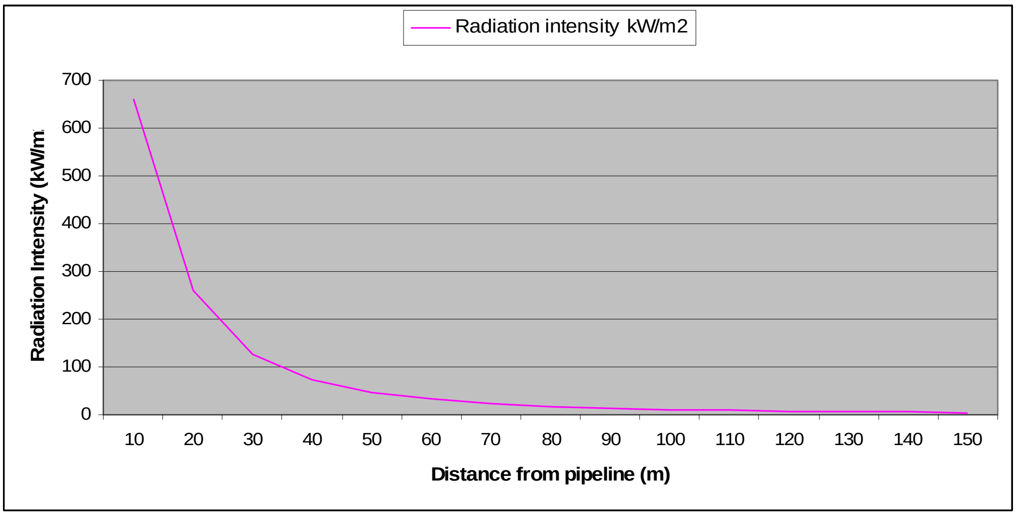
No scenarios resulting from the toxic effects of methane or blast overpressure result in moderate, major or critical consequences.

16.6.5 Individual Fatality Risks

Risk is a combination of the consequence and likelihood of an event occurring. The only scenario where fatality was predicted to occur was a jet fire from the Collection Header or Export Pipeline resulting from a 150 mm puncture hole. The likelihood of this event occurring is described in *Table 4.16.31*. The most conservative estimate of likelihood of fire is highly unlikely at 96 x 10^{-6} per year. This has been adopted in the assessment of fatality risk. Standard control measures required by Australian Standards should reduce the failure rate (likelihood) to that reported by Australian industry of 2.62 x 10^{-6} per annum.

A graph showing the radiation intensity with distance from the pipeline is provided in *Figure 4.16.2.*

Figure 4.16.2 Radiation Intensity with Distance from Pipeline, 150 mm Hole



The individual fatality risk transect from the pipeline is shown in *Figure 4.16.3*. The distances to each fatality risk criterion (refer to *Table 4.16.5*) are summarised in *Table 4.16.40*.

Figure 4.16.3 Individual Risk Transect Perpendicular to the Pipeline, 150 mm Hole

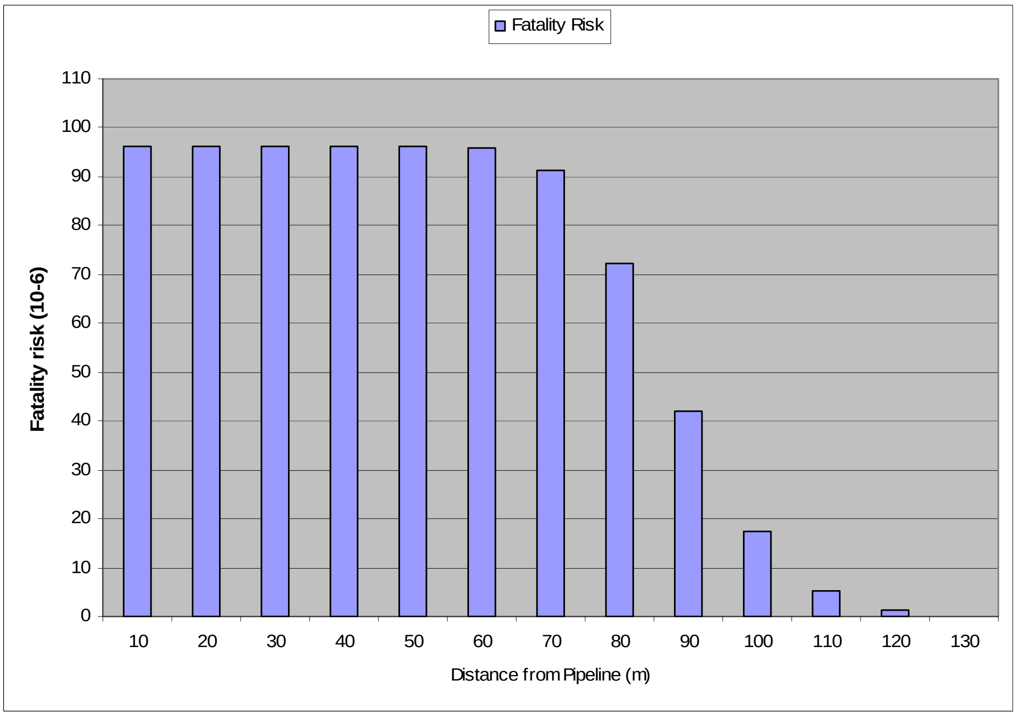


Table 4.16.40 Distances to Criteria for Individual Fatality Risk (Jet Flame, Pipeline, 150 mm Hole)

Land Use	Suggested Criteria (risk in a million per year)	Distance (m)
Hospitals, schools, child-care facilities, old-age housing	0.5	126
Residential, hotels, motels, tourist resorts	1	121
Commercial developments including retail centres, offices and entertainment centres	5	111
Sporting complexes and active open space	10	104
Industrial	50	87

At distances greater than 126 m, the risk of fatality from thermal radiation caused by ignition of methane from a 150 mm rupture in a pipeline, is below the most conservative criterion (0.5 x 10^{-6} per annum).

16.6.6 Individual Injury Risk

16.6.6.1 Pipeline Rupture – 25 mm

The consequence of pipeline rupture of 25 mm, with ignition, is moderate injury at distances less than 15 m. The likelihood of this event occurring is described in *Table 4.16.31*. The most conservative estimate of the likelihood of fire is 22 x 10^{-6} per annum. Assuming a conservative consequence rating (chance of injury) of 100 per cent or one, for injury at less than 15 m, the injury risk is 22 x 10^{-6} per year. (i.e. 1 x 22 x 10^{-6} per annum). This is within the range of injury risk criteria of 10 x 10^{-6} per annum and 50 x 10^{-6} per annum specified in the ToR for this EIS.

At a distance between 15 m and 24 m the risk of injury lies between values approaching zero (0 x 22 x 10^{-6} per annum) and 22 x 10^{-6} per annum (1 x 22 x 10^{-6} per annum). This range includes the injury risk criteria of 10 x 10^{-6} per annum. Thus, at distances of 15 m there is a 22 x 10^{-6} per annum chance of injury and at distances greater than 24 m, the most conservative injury risk criteria are not exceeded.

16.6.6.2 Pipeline Rupture – 150 mm

The consequence of pipeline rupture of 150 mm, with ignition, is moderate injury at distances between 57 m and 94 m (high likelihood of fatality up to 57m). The likelihood of this event occurring is described in *Table 4.16.31.* The most conservative estimate of the likelihood of fire is 96 x 10^{-6} per annum. Assuming a conservative consequence rating (chance of injury) of 100 per cent, or one, for injury at less than 94 m, the injury risk is 96 x 10^{-6} per annum (i.e.1 x 96 x 10^{-6} per annum). This exceeds the range of injury risk criteria of 10 x 10^{-6} per annum and 50 x 10^{-6} per annum specified in the ToR.

At distances between 94 m and 150 m, the consequence of injury is minor, and the consequence rating for a chance of injury is between a value approaching zero and one. At a distance between 94 m and 150 m the risk of injury lies between values approaching zero (0 x 96 x 10^{-6} per annum) and 96 x 10^{-6} per annum (1 x 96 x 10^{-6} per annum). This range includes the injury risk criteria of 10 x 10^{-6} per annum and 50 x 10^{-6} per annum. Thus, at distances greater then 150 m, the most conservative injury risk criterion is not exceeded.

16.6.7 Societal Risks

Assessment of societal risks provides a mechanism whereby the number of people exposed can be taken into account as well as the magnitude of the individual risk to each of these people. This analysis requires population presence data which, due to the uncertainty of the exact location of infrastructure, was not available. The pipeline infrastructure will be located in a predominantly rural area thereby decreasing the risk to society.

16.6.8 Marine Pipeline Route

The risk of fatality from the sub-surface component of the Export Pipeline is minor, due to the limited likelihood of ignition of sub-surface gas releases. However, the potential for ignition of methane gas that escapes from the water has not been assessed. Mitigation measures and controls to minimise impacts on the subsurface pipeline are described in *Table 4.16.26*.

16.6.9 Cumulative Impacts

Cumulative impacts can occur due to interactions between other industrial facilities and the Project infrastructure. However, due to the rural nature of the pipeline routes, the potential for interaction with other industrial facilities is extremely low.

The possibility of interactions will be reduced by infrastructure design, layout and separation distances. Layout and design will include reference to Australian Standards including:

- AS 1940. The Storage and Handling of Flammable and Combustible Liquids
- AS 2885.1. Pipelines – Gas and liquid petroleum. Part 1: Design and construction
- AS 2430. Classification of Hazardous Atmospheres.

The risk of offsite accident propagation is low because most of the surrounding land uses are rural. However, the location of other major infrastructure such as open-cut coal mines, power stations and storage facilities (e.g. anhydrous ammonia storage providing fertilisers) in the area will be considered when locating installations.

The bushfire risk around the infrastructure (mainline valves, scraper stations and in-line compressor station) is low-to-medium because the majority of the surrounding countryside has been cleared for pastures or cropping. Potential pasture and crop fires will be controlled by the local Rural Fire Service.

16.7 *MITIGATION MEASURES – GAS RELEASE*

All risks are manageable with conventional safety and mitigation measures for compressor stations and pipelines. The above estimate of likelihood (96×10^{-6} per annum) of a fire from a pipeline hole of 150 mm used worst-case data based on non-Australian pipeline operations. Standard control measures for pipeline construction and operation, as required by Australian Standards, should reduce the failure rate to that reported by Australian industry of 2.62×10^{-6} per annum.

The potential threat zone from a flammable vapour cloud caused by a CSG release from the pipeline extends to 2,200 m (for a maximum hole size of 150 mm) using the most conservative end point of 10 per cent of the lower exposure limit (LEL).

Council planning schemes recommend minimum separation distances to petroleum and gas pipelines of 200 m. The pipeline will be designed, built and operated in accordance with AS 2885 and protective measures, including minimum separation distances, will be in accordance with AS 2885.

This minimum separation distance is recommended between above-ground installation components and major infrastructure or dangerous goods storage to reduce the likelihood of interactive effects from flammable vapour clouds and ignition sources.

These separation distances are well in excess of the distance (126 m) at which individual fatality risk, from any prospective scenario, exceeds the most conservative fatality risk criteria of 0.5×10^{-6} per annum.

Further mitigation measures (controls) for the unplanned release of gas are described in *Table 4.16.26.*

Emergency Management Plans (EMPs) are described in the following section.

16.8 *EMERGENCY MANAGEMENT PLANS*

The EMPs that will be adopted for the Project fall within the structure of BG Group's existing Crisis Management Standard. The Standard will establish:

- emergency management teams
- systems and procedures at the BG Group level, at a coordinating asset level (i.e. the Project) and at the specific site level

- links between these levels.

An incident and emergency response hierarchy will be used to link the management of incidents for the Project with overall BG Group incident management plans.

BG Group's Standard for Crisis Management requires that a Local Incident Management Plan (LIMP) be prepared for each asset. Such plans will be prepared for each asset component of the Project. The plan includes information on:

- the organisation for incident management of the asset
- the process for identifying incidents
- the procedure for notifying incidents
- the procedure for escalation, if necessary
- the procedure for activation of the incident management organisation
- tools for the management of an incident
- roles and responsibilities of incident management teams.

16.8.1 Emergency Response Plans

In the event of an incident, the primary response will usually occur at site level. In many instances, the incident will be adequately addressed at this level by prevailing Emergency Response Plans (ERPs) that will be prepared in advance of construction, commissioning and operational phases as they develop over the life of the Project. However, in order to prevent an incident from escalating, a LIMP may be activated so that it can bring its greater resources to bear. This may be in terms of command and control and/or support with resources, expertise or logistics. In major incidents, further escalation to a group-level Crisis Management Team can occur.

ERPs are prepared at the site levels and will include descriptions of:

- expectations of individuals at the site responding to an emergency
- roles and responsibilities for emergency response leaders
- resources available (human and material) for response to an emergency
- the process for identification, notification and escalation of incidents
- the linkages to the higher asset and group-level incident management systems.

In accordance with the BG Group Standard, the Crisis Management Team/LIMP arrangement will be tested at least annually to determine the effectiveness of the links between the BG Group and the Project.

Reviews of the Incident and Emergency Management procedures will be conducted after desktop exercises, simulated incidents and actual incidents, and will determine:

- the effectiveness and appropriateness of plans
- the extent to which personnel are capable of implementing plans
- any gaps in planning and implementation and any proposed steps for improvement.

16.8.2 Emergency Management Procedures

While it is not possible to foresee all contingencies, the need for some ERP to apply to almost all sites exists. These ERPs include:

- infrastructure shutdown
- fire.

16.8.2.1 Consultation in Development of ERPs

ERPs will be developed in consultation with regional emergency service providers including:

- Queensland Police
- Department of Community Safety.

16.8.2.2 Contents of ERPs

Emergency response plans will include information on:

- organisation and responsibilities
- site evacuation procedures
- notification and communications
- mobilisation and response
- training
- facilities and equipment
- layout plans and evacuation plans
- release management
- public affairs and media
- investigation and follow up.

The contents of a typical ERP also contain information relating to:

- ownership
- scope and extent
- facility/infrastructure description overview
- Incident Management Team

- organisation
- roles and responsibilities
- incident command
- logistics coordination
- specialised teams.
- Emergency response capabilities will be developed based on detailed risk assessment outcomes and will include the following scenarios:
- road accidents
- facility/infrastructure fires
- security breaches and terrorism
- site evacuation
- hydrocarbon/chemical spillage
- gas/vapour leaks
- natural disasters (bushfire, storms, floods, earthquakes).

16.8.2.3 Site Security and Access

Strategies for site security and access for the construction and operational phases of the pipelines will be developed during the detailed design phase. A number of policies will be communicated to the contractors including:

- behaviour code criteria on site and in construction camps
- no smoking within completed buildings, enclosed spaces, or enclosed areas including vehicles
- exposure to UV light
- dress code
- no domestic animals on site
- no alcohol or drugs
- fatigue management
- the right of the contractors to exclude any person from any organisation found to be in breach of procedures or policies.

Following practical completion of the Pipeline Component facilities, the security and access procedure will be under the control of the operations division and its designated contractors. As a minimum security measure, each static site (once operating) will have security fencing installed to restrict access to unauthorised personnel.

Appropriate signs and warnings are posted to notify the public of the construction site, typically with a contact name and phone number to call for more information.

Public safety officers or police provide security/public safety functions on public property, roads or other public jurisdictions.

Appropriate security-risk assessments and mitigation plans, including for third-party sabotage or terrorism, will be developed to address security risks as they are identified in risk studies. Security plans will be aligned with emergency response and evacuation planning, law enforcement agencies and prevailing Queensland laws and regulations.

16.8.2.4 Dangerous Goods Storage

There will only be minor quantities of dangerous goods stored at the pipeline locations. Typical materials or chemicals stored on site would be those for radiographic inspections of the pipeline; cleaning products used to prepare joints for welding and/or coating, cold galvanizing materials, foam for trench breakers and chemicals used in hydrotest water (e.g. oxygen scavengers or biocides). These would typically be stored in 200 L drums and there would be approximately 20 to 30 drums on site at a time. All drums will be stored in accordance with the dangerous goods regulations. Not all materials and chemicals may be classified as dangerous goods.

Diesel is not classified as dangerous goods as it has a flashpoint greater than 60.5°C.

16.8.2.5 Fire Prevention and Detection

Facility/Infrastructure Fires

The management of fire risks will include collaboration with local fire authorities in reducing the fire hazard risk in areas adjacent to static sites and in areas along the pipeline routes which may pose a significant fire risk. The maintenance of fuel-reduced zones around the sites, of a minimum 15 m in width, will be a key aspect in reducing the impact of bush and grass fires.

Fire Management Systems

The fire protection system for the Project will include the installation of fire hydrants and portable extinguishers in the temporary construction camps. A detailed risk assessment will be undertaken during the detailed design phase and will identify the needs for fire prevention measures. The design of the Pipeline Component infrastructure will incorporate fire mitigation measures identified in the risk assessment process.

Typical fire management systems on a construction site include the following:

- training and education of workforce regarding specific fire hazards and risks, drills and practice
- supply and use of fire extinguishers
    - hand-held for general use

  - trolley-mounted for larger fire risk areas and fuel storage
- water truck with pump to supply limited fire-fighting needs
- no smoking policy
- hot work permit policy
- temporary building specification, materials and spacing which meets Queensland Fire Code/Building Code requirements for temporary structures
- flammable materials storage and use
- coordination with local fire brigade with jurisdiction.

Accommodation Fire Safety Measures

Typical fire management systems for temporary camp accommodations include the following:

- no smoking or cooking permitted in accommodation units
- building specification, materials and spacing which meets Queensland Fire Code/Building Code requirements for temporary living accommodation
- installation and maintenance of a smoke detection and fire alarm system for living quarters, commons areas and cafeteria/mess assembly areas
- supply and use of fire extinguishers
  - hand-held for general use
  - trolley-mounted for larger fire risk areas and fuel storage
  - CO_2 systems for cooking areas of kitchen
- water truck with pump to supply for limited fire-fighting needs
- training and education of workforce regarding specific fire hazards and risks, drills and practice
- volunteer fire response team
  - training of the response team
  - drill and practice for first responders
- coordination with local fire brigade with jurisdiction.

Bushfire Mitigation – SPP 1/03

The overall risk of starting a bushfire is considered fairly low, especially once the site is cleared of tinder and vegetation. The larger impact would be of an external bushfire encroaching on the construction and camp site.

Burning will not typically occur at construction sites. Education campaigns regarding prevention of bushfires are included in the employee induction during high fire risk seasons.

Construction personnel are typically not trained to respond to bushfires, forest fires or wildfires. The overall strategy will be to minimise impact or risk to personnel by either sheltering in place, or evacuation, and minimise impact to physical or mechanical equipment or structures, and to cooperate with civil authorities managing the fire fight.

The highest risk of starting a bushfire would be during the clearing activities. Typically chainsaws can be equipped with spark arresters to help prevent ignition sources. Off-road vehicle use will be restricted to necessity only.

Once the site is cleared, the area will be maintained clear of bush during construction. Bushfire will be included in the overall site risk evaluation and emergency response planning.

16.8.3 Emergency Planning and Response Procedures

A risk assessment will be conducted to identify the highest risks posed to workers and the public during construction.

Emergency response plans will be developed to address the following topics:

- medical emergency response (heart attack, stroke, or similar)
- major accident (construction related) with injury response
- confined space rescue
- high angle rescue
- excavation rescue
- structural rescue
- medical treatment and response as result of major accident
- fire
- environmental response to major spill or chemical release
- weather or seismic event
- tropical cyclone
- transient thunderstorm/lightning
- earthquake
- flooding
- civil disobedience
- labour strike
- external protests.

16.9 CONCLUSION

A preliminary quantitative risk assessment has been undertaken for the unplanned release of gas from the Collection Header, Lateral and Export Pipelines and associated infrastructure, within the Pipeline Component of the Queensland Curtis LNG (QCLNG) Project. All other hazards were identified and assessed using a qualitative risk assessment process.

For each hazard assessed qualitatively, controls have been proposed to minimise the likelihood and consequence of the hazard. Hazards with the greatest residual risk were related to transport incidents. Further control measures were proposed to minimise these risks.

A number of scenarios were considered for the unplanned release of gas, relating to the type of equipment and the size of the hole from which gas is released. For each scenario there are potentially five consequences; toxic effects, potential vapour-cloud flash fire, blast overpressure, thermal radiation from ignition of gas and downwind toxic effects of a fire.

The only consequence that presented a fatality risk other than negligible, or an injury risk greater than minor, was thermal radiation from ignition of gas released from a pipeline. Modelling of this scenario used the most conservative assumptions about consequence (150 mm hole) and likelihood. The most conservative fatality risk criterion of 0.5 x 10^{-6} per annum was not exceeded for distances greater than 126m. This is likely to be less distance than the minimum separation distances under AS 2885. Moderate injury risk criteria (50 x 10^{-6} per annum and 10 x 10^{-6} per annum) are highly unlikely to be exceeded at distances greater than 150 m.

Establishment and maintenance of adequate safety zones for all Pipeline Component infrastructure will ensure that the risk to human health is reduced to as low as reasonably practical (ALARP).

It is probable that both fatality and injury risk will be an order of magnitude less than predicted by the model. Pipelines will be constructed to Australian Standards, which data shows results in a lower likelihood of release of gas than the likelihood used in the model.

Comprehensive Environmental Management Plans as described will be developed to further mitigate potential hazards and manage any hazards should they occur.

The overall Project risk in relation to the environmental factor has been assessed as minor to negligible, due to the mitigation strategies and the hazard and risk identification program to be implemented throughout the Project's lifecycle.

A summary of the impacts associated with hazard and risk outlined in this chapter is provided in *Table 4.16.41*

Table 4.16.41 Summary of Impacts for Hazards and Risks

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short term
Impact extent	Local
Impact likelihood	Likely

Overall assessment of impact significance: negligible.