Australia Pacific LNG Project

Volume 1: Overview

Chapter 4: Risk Assessment

Contents

Figures

Tables

4 Risk assessment

4.1 Introduction

Explicit throughout the terms of reference (TOR) for the environmental impact statement (EIS), Australia Pacific LNG is required to identify and manage any adverse construction, operation and decommissioning impacts that its coal seam gas (CSG) to liquefied natural gas (LNG) project (the Project) may create. The identification and management of these impacts may be undertaken through a risk assessment.

Risk assessment is a process that evaluates the likelihood (probability and exposure) and consequences (magnitude) of positive and negative environmental effects occurring as a result of exposure to one or more hazards. Risk is defined in Australia/New Zealand Standard ISO 31000:2009 Risk management – Principles and guidelines (AS/NZS ISO 31000 - developed by Standards Australia)[1] as an effect of uncertainty on objectives (Standards Australia 2009). AS/NZS ISO 31000 provides the following additional notes to assist in understanding risk:

- Risk can be characterised by reference to potential events and consequences, or a combination of these
- Risk is often expressed as a combination of the consequence of an event and the associated likelihood of occurrence.

It is acknowledged that risk assessment is not a cut and dry, precise, or exacting formulaic science, as it needs to deal with assumptions, uncertainties and aspects that are often difficult to measure. The assessment has been conducted in accordance with recognised standards and industry guidelines. The precise terminology and risk matrix structure has been tailored for the Project on the basis of systems, processes and methodologies developed by Australia Pacific LNG's joint venture companies – Origin Energy and ConocoPhillips.

Consistent with Australia Pacific LNG's approach to risk management, risk-based assessments have been undertaken as an essential element for all the EIS studies. The use of a risk-based approach to identify, assess and mitigate the environmental and social risks associated with the Project complements the development of the sustainability principles identified in Volume 1 Chapter 3.

4.2 Scope

The scope of this chapter of the EIS is to:

- Introduce the concept of risk
- Identify the relevant legislative framework associated with risk assessment
- Define the risk-based approach that has been implemented to identify and manage the risks (both individually and collectively) associated with the Project
- Outline the risk assessment process that has been implemented for the life of the Project including the construction, operational and decommissioning phases

[1] AS/NZS ISO 31000 replaced AS 4360:2004 in December 2009

- Discuss the process for determining potential adverse cumulative impacts associated with the identified phases of the Project
- Identify the risk assessment process in accordance with Australia/New Zealand Standard 2885 Gas and liquid petroleum pipelines which has been applied to the risk assessment of the gas pipeline and high pressure gas network
- Discuss the concept of risk contours and the process used in analysing risks to determine fatality and serious injury risk contours
- Outline the process for ongoing monitoring and reviewing for the currency of risk assessments as the Project develops.

The outcomes of the identification, assessment and treatment steps for each of the project elements are documented in the Volume 2 Chapter 22, Volume 3 Chapter 22, and Volume 4 Chapter 22. Treatment of risk is documented in the mitigation and management subsections of these chapters.

4.3 Legislative framework

A number of relevant risk standards and guidelines have been adopted to assist in conducting risk identification and assessment for the EIS:

- AS/NZS ISO 31000-2009 Risk management – Principles and guidelines
- Handbook 436-2004 – Risk management guidelines
- AS 2885.1-2007 – Pipelines gas and liquid petroleum, design and construction (AS 2885.1)
- Handbook 105-1998 – Guideline to pipeline risk assessment in accordance with AS 2885.1
- New South Wales Department of Urban Affairs and Planning (1997) risk criteria for land use safety planning, Hazardous Industry Planning Advisory Paper (HIPAP) No.4
- Department of Infrastructure and Planning (DIP), 2009, social impact management plan guideline.

The above standards and guidelines use the various terms of mitigation, control and treatment measures to identify methods to reduce risk. The term mitigation has been used throughout the EIS to provide consistency.

4.4 Risk assessment tools

A number of tools are available to identify and assess risks as part of a qualitative (using words to describe risks), semi-quantitative or quantitative (numerical) analysis. Regardless of the risk assessment tool that is utilised, they all follow a similar risk management process that is described in AS/NZS ISO 31000 and is shown in Figure 4.1.

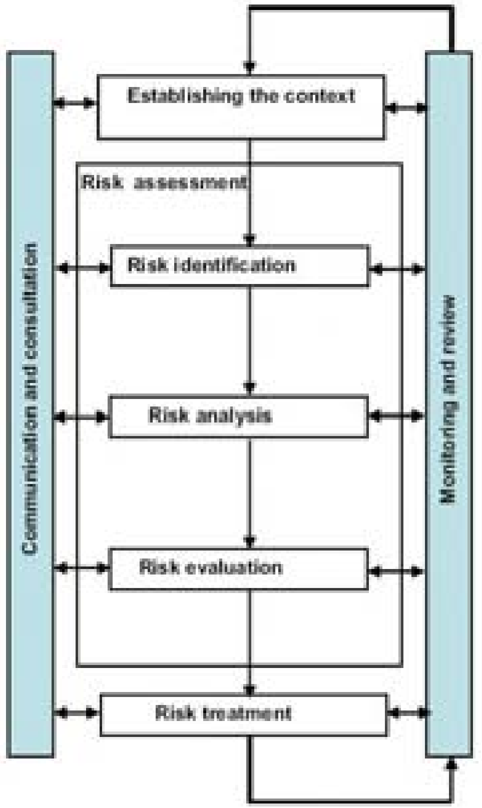

Figure 4.1 Risk management process (Source: AS/NZS ISO 31000 2009)

One tool that has been developed by Australia Pacific LNG for undertaking risk assessments is a risk matrix. The risk matrix is focused on qualitatively estimating the risk of potential events associated with the construction, operation and decommissioning of the Project and is a graphic portrayal of risk as the product of likelihood (exposure and probability) and consequence.

The risk matrix has broad applicability for qualitative risk determination and is designed to be objective to identify potential risks associated with an activity. The technical terms used to describe the risk may be contrary to the personal opinion of the assessor. In doing so, the matrix enables the assessment process to realise the potential implications of a particular activity with terminology such as 'catastrophic' and 'critical' to bridge the qualitative consequence descriptors between impacts, such as fatalities, and resulting outcomes, such as damage to reputation.

Results obtained can be used to identify intolerable risks, prioritise risk reduction efforts and to identify areas for detailed evaluation. It is adaptable to varying levels of information and depths of evaluation. It may be used to identify areas for further evaluation as part of a screening effort or to summarise detailed systematic studies. It has a built-in presentation format that lends itself to review.

4.5 Risk assessment methodology

The methodology used to undertake risk assessments for the Project is consistent with the requirements of the standards/guidelines listed in Section 4.3 and is described in the subsections below. Using this methodology has allowed Australia Pacific LNG to:

- Identify risks associated with the construction, operation and decommissioning stages of the Project so that the EIS technical study teams could be informed of project risks and incorporate them into their respective chapters

- Identify the individual and collective risks on the receiving environment associated with the Project
- Provide a consistent approach and risk rating system across the various technical study areas to enable a comparative assessment of risk across all study areas
- Identify residual risk rankings for the specific activities assessed based on existing mitigation measures in design or standard operation
- Identify risks that require additional mitigation measures to reduce their residual risk rating to levels that are tolerable, and as low as reasonably practicable (ALARP).

The following list describes the assessment sequence in populating the risk register in the context of the overall risk identification and assessment methodology

- Identify risks - risk title, risk causes, consequences, assumptions, existing controls
- Analyse risks – inherent consequence, consequence, exposure, probability, likelihood, residual risk
- Evaluate risks
- Treat risks.

4.5.1 Establish the context

Risk assessments undertaken for the Project address the three major project elements – gas fields, gas pipeline and LNG facility. A detailed description of each of these project elements is provided in Volume 2 Chapter 3, Volume 3 Chapter 3, and Volume 4 Chapter 3, respectively.

Australia Pacific LNG, through its joint venture companies, has considerable experience and expertise in carrying out risk assessments for projects of this nature. Each of the companies has a well-established risk management system and risk assessment methodology. The methodology presented in this chapter reflects the approach taken by both companies and has been adopted by Australia Pacific LNG for the EIS risk-based approach. Potential environmental and social impacts have been assessed using this methodology. The methodology described in this chapter has been modified in a limited number of study areas for the specific reasons outlined below:

- Aquatic and marine ecology risk assessment (Volumes 2 Chapter 9, Volume 3 Chapter 9 and Volume 4 Chapter 10) – while the risk assessment followed the AS/NZS ISO 31000 approach, the consequence descriptors were different from the Australia Pacific LNG standard to more accurately reflect the potential consequences
- LNG facility risk assessment (Volume 4 Chapter 22) – while the risk assessment followed the AS/NZS ISO 31000 approach, the consequence and likelihood descriptors and risk matrix were different from the Australia Pacific LNG standard as the ConocoPhillips risk matrix was implemented to enable a comparison against other operating LNG facilities
- Injury and fatality risk contouring (Volume 2 Chapter 22, Volume 3 Chapter 22, and Volume 4 Chapter 22) – a quantitative risk assessment was undertaken in accordance with HIPAP No. 4. The methodology for this assessment is discussed in the abovementioned chapters
- Gas pipeline design integrity risk assessment (Volume 2 Chapter 22 and Volume 3 Chapter 22) – was conducted in accordance with AS 2885.1 which required both a qualitative and quantitative risk assessment to be undertaken. The methodology and result of these assessments are available in Australia Pacific LNG's preliminary safety management studies for

the high pressure gas network (Volume 5 Attachment 48) and the gas pipeline (Volume 5 Attachment 49)

- Social impact assessment (Volume 2 Chapter 20, Volume 3 Chapter 20, and Volume 4 Chapter 20) – while the risk assessment followed the AS/NZS ISO 31000 approach, the consequence and likelihood descriptors and risk matrix differed from the Australia Pacific LNG standard to conform with the Department of Infrastructure and Planning's guideline
- Terrestrial ecology risk assessment (Volume 2 Chapter 8) – while the risk assessment followed the AS/NZS ISO 31000 approach, the consequence likelihood and risk descriptors were different from the Australia Pacific LNG standard in order to more accurately reflect the calculation of risk associated with the gas field component.

4.5.2 Identify risks

The process of identifying risks has involved various methods to ensure that a comprehensive and credible series of risks (both individually and collectively), including their causes, consequences and unmitigated consequence ratings, are identified. The process includes:

- Undertaking facilitated workshops that draws upon the skills of various subject matter experts relevant to the sustainability aspects of the Project
- Reviewing workshop results by Australia Pacific LNG internal specialists
- Reviewing similar industry hazard and risk registers
- Researching relevant Australian standards and legislation
- Reviewing historical incidents from similar operations.

Once a potential risk activity is identified an assessment is undertaken to determine what aspects of that activity could result in an impact on various areas including impacts to humans, environment, community, social, cultural heritage, financial reputation or legal. This process of assessing the activities that could result in an impact is described as the risk cause.

4.5.3 Categorise consequence

Following the identification of the risk causes, an assessment of the unmitigated consequence arising from a proposed activity can be undertaken. To assist in this process Australia Pacific LNG has implemented qualitative consequence descriptors which are categorised from minor to catastrophic using the definitions in Table 4.1.

Table 4.1 Health, safety and environment consequence categories

	Impact to Australia Pacific LNG personnel	Natural environment	Community damage/ impact/ social/ cultural heritage
Catastrophic 6	Multiple fatalities ≥ 4 or severe irreversible disability to large group of people (>10).	Long term destruction of highly significant ecosystem or very significant effects on endangered species or habitats.	Multiple community fatalities, complete breakdown of social order, irreparable damage of high value items of great cultural significance. Adverse international or prolonged (>2 weeks) national media coverage.
Critical 5	1-3 fatalities or serious irreversible disability (>30%) to multiple persons (<10).	Major off-site release or spill, significant impact on highly valued species or habitats to the point of eradication or impairment of the ecosystem. Widespread long-term impact.	Community fatality. Significant breakdown of social order. Ongoing serious social issue. Major irreparable damage to highly valuable structures/ items of cultural significance. Adverse national media coverage (>2 days).
Major 4	Serious permanent injury/illness or moderate irreversible disability (<30%) to one or more persons.	Offsite release contained or immediately reportable event with very serious environmental effects, such as displacement of species and partial impairment of ecosystem. Widespread medium and some long-term impact.	Serious injury of member of the community, widespread social impacts Significant damage to items of cultural significance. Major adverse media coverage.
Serious 3	Serious reversible/temporary injury/illness (e.g. Lost time 5+ days or hospitalisation or alternate/restricted duties > 1 month).	Moderate effects on biological or physical environment and serious short-term effect to ecosystem functions (e.g. oil spill impacts on shoreline).	Media attention and heightened concerns by local community and criticism by NGOs. Ongoing social issues. Permanent damage to items of cultural significance.
Moderate 2	Reversible temporary injury/illness requiring medical treatment (e.g. lost time <5 days or alternate/restricted duties for < 1 month).	Event contained within site. Minor short-term damage to area of limited significance. Short-term effects but not affecting ecosystem functions.	Medical treatment injury of a member of the community. Minor adverse local public or media attention and complaints. Minor medium term social impact on local population mostly repairable.
Minor 1	Injury/illness requiring medical treatment (no lost time, no alternate/restricted duties), first aid, report	Minor consequence, local response. No lasting effects. Low level impacts on biological and physical environment to an area of low	Public concern restricted to local complaints, low level reparable damage to common place structures.

Impact to Australia Pacific LNG personnel	Natural environment	Community damage/ impact/ social/ cultural heritage
only.	significance.	

This process is conducted multiple times during the risk assessment process with the first time it is introduced relating to a potential risk without control measures in place. This therefore enables the risk assessment to indicate the worst case scenario for an incident or event occurring.

The process also takes into account the fact that one potential risk may have multiple effects such as environmental, reputational, impacts on stakeholder relationships and legal consequences so it is therefore somewhat subjective in the application of the descriptors for a particular project activity.

4.5.4 Identify existing mitigation measures

Once a potential risk and its associated consequences are identified the assessment of existing risk mitigation measures that would be in place for each of the identified risks is undertaken. This process involves consideration of the consequences arising from the risk, and applicable mitigation measures that may be implemented, to reduce the potential for these consequences occurring.

The identified mitigation measures are then assessed for their effectiveness in reducing the unmitigated level of risk through an assessment of their reliability and design of mitigation measures and level of implementation as detailed in Table 4.2. The level of implementation of the mitigation measure is determined by the hierarchy of mitigation measures as defined in Table 4.3. Together these two scores are used to determine the effectiveness of mitigation result. The effectiveness of mitigation matrix is shown in Table 4.4.

Table 4.2 Implementation/reliability of mitigation measure matrix

		Level of implementation		
		Good (3)	Average (2)	Poor (1)
Reliability / design of mitigation	Good (3)	6	5	4
	Average (2)	5	4	3
	Poor (1)	4	3	2

Table 4.3 Hierarchy of mitigation measures

Mitigation measure	Explanation
Eliminate	Remove the hazard (e.g. eliminating the requirement to carry out the task, use a piece of equipment or utilise a chemical).
Substitute/transfer	Replace the material, plant or work practice with a less hazardous one (for example, by replacing a hazardous chemical with a less hazardous one). Transfer or outsource the risk to another party.
Engineer	Make a structural change to the work environment or work process to interrupt the path between the employee and the risk. Redesign the way in which work is performed, modify equipment to change the way a task is performed or engineer change to the process steps to eliminate the hazardous activity. Isolate a hazard by guarding, enclosing the hazard, lock a process/equipment thus preventing unauthorised access, or remove the hazard by means such as ventilation.
Administration	Administration controls are the procedural aspects of managing hazards such as planned and preventative maintenance programs, standard operating procedures, lock-out/tag-out procedures, education and training.
Personal protective equipment (PPE)	PPE is the least preferred control method as it is totally reliant upon human behaviour. Any breakdown in the system immediately exposes the person to the hazard. It involves wearing masks, gloves, safety shoes and other equipment to isolate the person from the hazard.

Table 4.4 Effectiveness of mitigation matrix

		Level of implementation and reliability factor (%)				
		2	3	4	5	6
Hierarchy of mitigation	Eliminate (4)	60	70	80	90	100
	Substitute (2.5)	45	55	65	75	85
	Engineer (2)	40	50	60	70	80
	Administration (1.5)	35	45	55	65	75
	PPE (1)	30	40	50	60	70

The result of this process provides an adjusted consequence rating which is then assessed further with respect to the exposure of the risk and the probability of the consequence occurring, therefore providing the likelihood of an event or incident occurring.

4.5.5 Assess likelihood

Following the identification of potential risks, the likelihood of their occurrence can be determined through an assessment (measured predominately qualitatively) of the level of exposure to the risk and the probability of that risk causing the above calculated consequence once the mitigation measures have been taken into account. Table 4.5 illustrates how the likelihood of occurrence has been categorised through the estimated quantitative probabilities in terms of the expected number of occurrences in a given timeframe.

Table 4.5 Likelihood matrix

			Exposure					
			Not in 100 years	At least once in 100 years	At least once in 10 years	At least once a year	At least four times a year	At least once per week
			E1	E2	E3	E4	E5	E6
Probability	Not known to occur in a comparable activity internationally but plausible 1 in 100,000 to 1,000,000	P1	0	0	0	0	1	1
	Known to occur in a comparable activity internationally but unlikely 1 in 10,000 to 100,000	P2	0	0	0	1	1	2
	Has occurred or could occur for this or a comparable activity in Australia 1 in 1,000 to 10,000	P3	0	0	1	1	2	3
	Expected to occur infrequently during this activity 1 in 100 to 1,000	P4	0	1	1	2	3	4
	Expected to occur occasionally during this activity 1 in 10 to 100	P5	1	1	2	3	4	5
	Expected to occur frequently during this activity 1 in 10	P6	1	2	3	4	5	6

A likelihood rating of zero (0) denotes that the likelihood may not be considered credible and the subsequent risk rating is given as 'not credible'. The likelihood is assessed after existing mitigation measures have been identified and is calculated on an exposure to, and probability of, the event occurring.

4.5.6 Assign level of risk

The combination of likelihood of an event and its consequence enables the overall level of risk to be determined and is known as the 'residual risk'. The level of risk assigned takes into consideration the safeguards that will be implemented, which are identified as 'mitigation measures'. Therefore the applicable risk level is the 'residual' risk that will occur once mitigation measures are implemented.

By using the score calculated from Table 4.5 for the likelihood and the consequence category evaluated from Table 4.1 the unmitigated risk ranking for a particular project activity and/or aspect can be determined using Table 4.6.

Table 4.6 Risk matrix

		Likelihood					
		1 Remote	**2 Highly unlikely**	**3 Unlikely**	**4 Possible**	**5 Likely**	**6 Almost certain**
Consequences	6 Catastrophic	Medium	Medium	High	High	Very high	Very high
	5 Critical	Low	Low	Medium	High	High	Very high
	4 Major	Low	Low	Low	Medium	High	High
	3 Serious	Negligible	Low	Low	Low	Medium	High
	2 Moderate	Negligible	Negligible	Low	Low	Low	Medium
	1 Minor	Negligible	Negligible	Negligible	Low	Low	Low

Risk contours

Risk contouring provides a graphical representation of the distance that a particular injury or fatality risk may occur in relation to the Project. Where a risk contour extends outside the boundary of the Project, the resulting level of change of contours for other existing and proposed industrial facilities is also required to be calculated. This is referred to as cumulative risk. The risk criteria used to determine a tolerable level of risk has been sourced from the nationally adopted New South Wales Department of Urban Affairs and Planning's Hazardous Industry Planning Advisory Paper No. 4 'Risk Criteria for Land Use Safety Planning' (HIPAP No. 4) and is shown in Table 4.7.

The assessment of cumulative risk is discussed in Volumes 2 Chapter 22, Volume 3 Chapter 22, and Volume 4 Chapter 22.

Table 4.7 HIPAP No. 4 risk criteria

Land use	Risk
Hospitals, schools, child-care facilities, old age housing or such 'sensitive developments'	0.5×10^{-6} per year[2]
Residential, hotels, motels, tourist resorts	1×10^{-6} per year
Commercial developments including retail centres, offices and entertainment centres	5×10^{-6} per year
Sporting complexes and active open spaces	10×10^{-6} per year
Industrial	50×10^{-6} per year

[2] Rate per million per year

As low as reasonably practicable

The acceptability of risk depends on the magnitude of the risk, the practicability of the risk reduction methods and the level of risk regarded as 'tolerable'. This introduces the concept of reducing a risk to as low as reasonably practicable (ALARP). According to AS 2885.1 (Standards Australia 2007), ALARP means the cost of further risk reduction measures is grossly disproportionate to the benefit gained from the reduced risk that would result.

Figure 4.2 provides an overview of the ALARP principle. The three risk regions can be summarised as:

- Region 1: risk intolerable
  - Risk is so high that it is not tolerable unless extraordinary circumstances apply. Risk reduction must be undertaken
- Region 2: risk tolerable if ALARP
  - Risk reduction measures must be implemented where reasonably practicable – that is, unless further risk reduction is clearly not possible or the cost is disproportionate to the improvement gained
- Region 3: risk tolerable
  - Risks must be managed to ensure that they remain at this level and, if practicable, are continually reduced. In principle, the ALARP concept extends to this region as well.

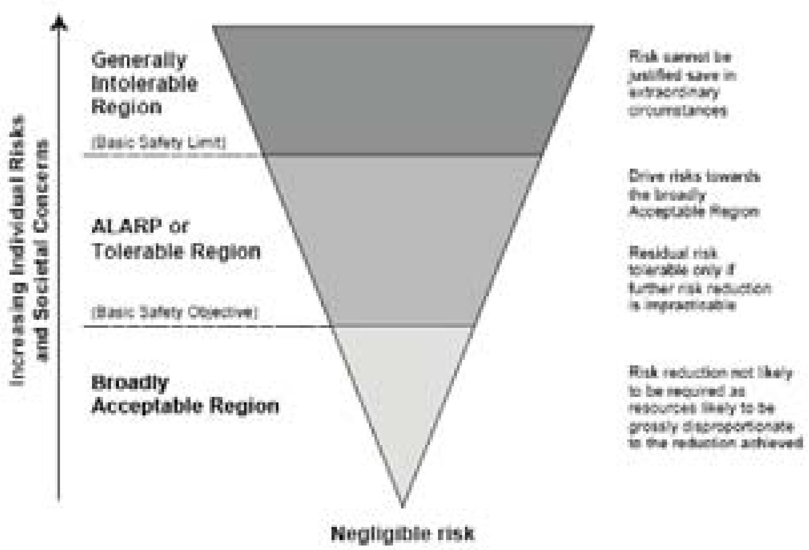

Figure 4.2 ALARP Principle (Source: HB 436-2004 Risk Management Guidelines (Standards Australia 2005))

An assessment of what is 'reasonably practicable' requires judgements to be made. To make risks ALARP, opinions of technical experts are considered as well as standards, industry practice, availability of mitigation measures and cost-benefit analyses.

Uncertainty

As the development of risk assessments requires judgements to be made, a level of uncertainty exists in any risk estimations. These uncertainties can arise due to:

- Lack of historical information for similar situations

- Natural variability
- Knowledge of risks by the risk assessment team
- Assumptions required for predictive modelling/forecasting
- Lack of scientific knowledge.

Methods to reduce the level of uncertainty normally involve conducting further research/analysis. A balance is required to be struck between the effort required to obtain the information and the value the information provides to the decision-making process.

4.5.7 Treat risks

Consideration is given to a range of potential mitigation measures that can be implemented and these are recorded in the risk registers along with the resulting treated risk rating. Mitigation measures are reviewed against ALARP principles and the residual risk level is then considered. Risk assessment teams determine whether treated (or residual) risks can be further mitigated, are tolerable, or require further treatment. Action plans are developed to further reduce risks if required. Proposed mitigation measures for specific aspects of the Project are described in the relevant chapters of Volumes 2, 3 and 4.

For quantitative risk assessments, the calculation of tolerable risk and ALARP is considered on a case-by-case basis and is discussed in Volume 2 Chapter 22, Volume 3 Chapter 22, and Volume 4 Chapter 22.

4.5.8 Monitor and review

Ongoing monitoring and review is essential to ensure the risk assessments that have been conducted remain relevant. Factors and assumptions that were used are subject to change, such as new risks identified, new mitigation measures implemented, existing mitigation measures removed, new consequence identified and so on. These have the potential to alter the risk rankings, either positively or negatively.

The risk registers were reviewed and revised as necessary during the development of the EIS when additional information became available through specialist technical reports. The risk assessment process will continue to be reviewed and revised throughout all phases of the Project. As a minimum, these reviews will be done in accordance with the following frequency/events:

- Annual basis
- Emergency incident
- Identification of non-compliance with environmental authority conditions
- Legislative changes (including standards and guidelines)
- New or changed in processes (including addition or removal of mitigation measures)
- When further risk studies are undertaken (e.g. HAZID, HAZOP, job hazard analysis).

Australia Pacific LNG will also ensure that its risk assessment methodology remains current and reflects industry accepted norms as part of the annual review process.

Monitoring of the effectiveness of mitigation measures will also be undertaken throughout all phases of the Project. This monitoring will be undertaken through a combination of continuous monitoring (e.g. measuring parameters), and internal and external audits. Volume 2 Chapter 25, Volume 3 Chapter 25, and Volume 4 Chapter 25 contain an environmental management plan and will be the guiding reference for the frequency and type of monitoring to be undertaken.

4.6 Cumulative impacts

The TOR for the EIS also requires the identification of cumulative impacts from other known, existing or proposed projects where details of such projects have been provided to Australia Pacific LNG by the Department of Infrastructure and Planning or which are otherwise published to the greatest extent possible. The following methodology was undertaken by Australia Pacific LNG in identifying cumulative impacts:

- Identify current and proposed projects that have the potential to impact upon the Project
- Review publicly available information on these projects
- Identify and assess cumulative impacts. This assessment has been undertaken on a qualitative basis due to the limited data available to undertake a quantitative analysis.

In determining the cumulative impact, Australia Pacific LNG has considered the impacts arising from multiple effects within the Project area (e.g. increase of biting insects with introduced feral animals and pest fauna) and from a single effect within multiple project areas (e.g. visual amenity as a result of multiple LNG facilities on Curtis Island). The results of each of these assessments are presented in Volume 2 Chapter 25, Volume 3 Chapter 25, and Volume 4 Chapter 25.

4.7 Conclusions

Risks associated with the Australia Pacific LNG Project have been assessed using a well-established approach to identification and evaluation. These assessments have been conducted in accordance with Australian Standards and industry guidelines. Whilst the terminology used within the various standards/guidelines may vary, the methodology is consistent. This methodology is a self-sustaining loop:

- Establish the context
- Identify risks and hazards
- Analyse risks
- Evaluate risks
- Treat risks
- Monitor and review.

Where practicable, a common risk matrix and scoring system has been used to provide consistent risk assessment results for qualitative risks and to allow comparison throughout the various study areas identified for the Project. For those study areas that have adopted alternate descriptors in their risk assessments these have been noted in their respective EIS chapters. Quantitative risk assessments were undertaken where sufficient data was available to determine the risk in accordance with Australian Standards and guidelines.

The EIS hazard identification and risk analysis process utilised the skills of subject matter experts in various technical and social disciplines. Some of these disciplines normally use risk evaluation methodology as detailed in applicable legislation, guidelines or design standards and codes relevant to that discipline. An example of this is the risk evaluation process presented in Australian Standard

AS 2885.1 for design of gas pipelines. For the EIS, a common risk methodology detailed in this section was generally used to achieve uniformity in method. The 6 x 6 consequence and likelihood risk matrix was developed using common nomenclature (negligible, low, medium, high and very high) to consolidate and standardise the output from each of the different risk evaluation processes.

The results of both qualitative and quantitative risk assessments are discussed within the relevant chapters of Volumes 2, 3 and 4. Where mitigation measures are required to reduce the risk to a tolerable level, these have also been identified within the relevant chapter.

In addition to the risk assessment process identifying the individual and collective risks associated with the Project, consideration has been given to the cumulative impacts that other projects (existing and proposed) may have within the study areas. These cumulative impacts have been identified and are discussed within Volume 2 Chapter 25, Volume 3 Chapter 25, and Volume 4 Chapter 25.

All risk assessments have been conducted in a holistic manner, in accordance with the TOR for the EIS, and have taken into account the risks to people, property and the environment associated with each Project area.

References

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