Australia Pacific LNG Project

Volume 5: Attachments

Attachment 48: High Pressure Gas Network – Preliminary Safety Management Study – Gas Fields

Contents

Figures

Tables

Appendices

1. Introduction

The APLNG Project is currently preparing an EIS submission in accordance with Terms of Reference issued by the Co-ordinator Generals Department.

Section 6.1.1 of those Terms states in part:

> *"A risk assessment in accordance with Australia/New Zealand Standard AS/NZS 2885 Gas and Liquid Petroleum Pipelines should be conducted on the gas transmission pipeline from the gas processing plant(s) to the LNG plant on Curtis Island. The results of the Location Analysis and Threat Analysis and calculation of 'measurement lengths' should be presented together with management strategies which will be employed to deliver the safety principles of the Standard that require risks to be reduced to as low as reasonably practical, low or negligible."*

Although not stated explicitly in the paragraph above, it is clear that the "risk assessment" mentioned is in fact a Safety Management Study as detailed in AS2885 (Section 2 and various Appendices).

This document records the outcomes of the preliminary Safety Management Study of the APLNG high pressure field gathering pipelines (called the HP Gas Network) within the Walloons Gas Fields.

The Upstream portion of the APLNG Project also includes a high pressure mainline to Gladstone, which was the subject of a separate Preliminary Safety Management Study and Report.

2. Description of Pipelines

This section describes the proposed network of high pressure pipelines to collect gas from a number of compressor stations (spur lines) in the producing fields and deliver it to the Mainline Pipeline System.

The HP Gas Network is shown on the map at Appendix 1. The commencement of the Main Pipeline System to the Gladstone LNG Plant is also identified on this figure.

The HP Gas Network consists of the following:

- Fairview to Spring Gully Pipeline;
- Spring Gully to Wallumbilla Loop;
- Combabula Lateral, including the ;
  - Pine Hills Spur Line;
  - Reedy Creek Spur Line;
  - Combabula 2 Spur Line;
  - Combabula 1 Spur Line;
  - Ramyard Spur Line;
- Condabri South Lateral, including the;
  - Condabri South Nodal Spur Line;
  - Condabri South Spur Line;
  - Condabri Central Spur Line;
- DDPS Pipeline related supply, including:
  - DDPS Condabri Link;
  - Talinga Spur Line (existing);
  - Orana Spur Line;
  - Kainama Spur Line;
- Associated pig launchers and receivers (scraper stations);
- Connections for future GPFs; and
- Mainline Valve facilities.

It is planned that the HP Gas Network will include the installation of fibre optic cable along the pipeline(s). (The need to install the fibre optic into a conduit shall be determined during FEED).

The HP Gas Network is free flow as the Gas Processing Facilities (GPFs) include discharge compressors. Additional booster compression at the Talinga Metering Station may be required to flow gas from the spur lines feeding the eastern section of the existing DDPS Pipeline into the western section of the existing DDPS Pipeline before delivery to the DDPS Condabri Link.

The design, construction, operation and rehabilitation will be in accordance with AS2885.

These pipelines and their associated infrastructure form the Scope of this Safety Management Study.

2.1 Route Description

The methodology for determining the location of the proposed pipeline routes was based on application of the following criteria and related constraints:

- Land Use, Social Aspects and Topography
- Environmental and Cultural Heritage
- Construction and operation requirements
- Engineering
- Safety
- Commercial

Before selecting the preferred route, field surveys were conducted by specialists to assess engineering, construction, social and environmental risk and opportunities.

The HP Gas Network will be located in a predominantly rural area with few residents and little other existing major infrastructure development.

The HP Gas Network consists of several new major pipelines, many shorter spur lines, and utilises the existing DDPS pipeline through planned linkages. As shown on Appendix 1 the HP Gas Network forms a large loop around the producing fields connected at both ends to the mainline to Gladstone.

2.1.1 Fairview to Spring Gully Pipeline

The Fairview to Spring Gully Pipeline will run for approximately 40 km in a south-east direction from the Fairview PCS to Spring Gully GPF. This route passes through relatively hilly forested terrain.

2.1.2 Spring Gully to Wallumbilla Loop

The existing Spring Gully to Wallumbilla pipeline will be looped over a length of approximately 75 km in the north-south direction from the Spring Gully GPF to the Wallumbilla Hub, with a receipt/delivery point facility at Coxton Creek.

2.1.3 Combabula Lateral and Spur Lines

The Combabula Lateral and connecting spur lines collect gas from the GPFs of the Combabula-Ramyard gas field as well as gas from the Fairview and Spring Gully gas fields via a connection to the Spring Gully to Wallumbilla Loop (from the Coxton Creek off-take facility). The Combabula Lateral connects with the Main Pipeline System at the start of the Woleebee Lateral.

Approximate lengths, start and finish locations for pipelines included within this portion of the HP Gas Network are:

Table 2.1

Pipeline	Approx km	End points
Combabula Lateral	85 km	East-west orientation from the receipt point from the Spring Gully to Wallumbilla Loop to the start of the Woleebee start of the Woleebee

Pipeline	Approx km	End points
		Lateral at GPF Wol_01
Pine Hills Spur Line	1 km	Connects GPF MUG_06 to the Combabula Lateral at KP10
Reedy Creek Spur Line	1 km	Connects GPF RCK_04a to the Combabula Lateral at KP35
Combabula 2 Spur Line	15 km	Connects GPF COM_03a to the Combabula Lateral at the Combabula Scraper Station (KP50)
Combabula 1 Spur Line	1 km	Connects GPF LUK_02a to the Combabula Lateral at the Combabula Scraper Station (KP50)
Ramyard Spur Line	1 km	Connects GPF HCK_01a to the Combabula Lateral at KP65

2.1.4 Condabri South Lateral and Spur Lines

The Condabri South Lateral and spur lines collect gas from the GPFs in the Condabri gas fields as well as gas via the DDPS Condabri Link and deliver to the Condabri Lateral of the Main APLNG Pipeline system. Pipeline approximate lengths, start and finish locations are:

Table 2.2

Pipeline	Approx km	End points
Condabri South Lateral	45 km	A north-south orientation from the end of the Condabri South Spur Line to the Condabri Lateral at GPF CNN_04
Condabri South Spur Line	1 km	Connects GPF CNS_03 to the start of the Condabri South Lateral
Condabri South Spur Line	1 km	Connects GPF CON_01b to the Condabri South Lateral
Condabri Central Spur Line	1 km	Connects GPF CON_02 to the Condabri South Lateral

2.1.5 DDPS Pipeline Related Links

Gas from the GPFs of the Talinga/Orana/Kainama gas field feed gas to the existing DDPS Pipeline. The DDPS Condabri Link takes receipt of this gas and connects to the Condabri South Lateral.

Pipeline approximate lengths, start and finish locations are:

Table 2.3

Pipeline	Approx km	End points
DDPS Condabri Link	5 km	Carries gas from the DDPS Pipeline west of the Talinga Metering Station to the Condabri South Lateral at the Condabri DN500/DN900 Launcher-Receiver Facility
Talinga Spur Line (existing)	1 km	Connects GPF at Talinga to the DDPS Pipeine at the Talinga Metering Station

Pipeline	Approx km	End points
Orana North Spur Line	15 km	Connects GPF ORA_04 to the DDPS Pipeline
Orana Spur Line	1 km	Connects GPF ORA_03b to the Orana North Spur Line
Kainama Spur Line	7 km	GPF KIA_01a to the DDPS Pipeline

The addition of these spur lines to the DDPS Pipeline will alter the flow considerably and, based on the current design, would prevent pigs being run through the eastern section, as flows will be from both ends toward the middle, where there are no pig receivers.

Alternative designs for the eastern section of the DDPS shall be evaluated during FEED that will achieve supply requirements of the DDPS and APLNG, and enable pig operations of the eastern section. Alternative designs shall consider the spur line receipt points, and locations for compression or pressure regulation.

2.2 Pipeline facilities

Table 2.4 shows the aboveground facilities currently proposed to form part of the HP Gas Network.

Table 2.4 Proposed aboveground facilities and approximate KPs

Pipeline	KP	Facility	Comment
FSG Pipeline	0	FSG Launcher Facility	Metering (TBC) DN300 Launcher
	40	FSG Receiver Facility	DN300 Receiver
SGW Loop	0	SGW Loop Launcher Facility	DN500 Launcher
	40	SGW Loop MLV (Coxton Creek)	MLV Combabula Lateral Tie-in
	85	SGW Loop Receiver Facility	DN500 Receiver Metering (TBC)
Combabula Lateral	0	Combabula Launcher Facility	DN600 Launcher
	10	Receipt Point for Pine Hills Spur Line	DN300 Receiver provision
	35	MLV 01	DN600 MLV DN 300 Receiver provision for Reedy Creek Spur Line
	50	Combabula DN600/DN750 Launcher-Receiver Facility	DN600/DN750 Launcher-Receiver Receiver for DN400 Combabula 2 Spur Line DN 300 Receiver provision for DN300 Combabula 1

Pipeline	KP	Facility	Comment
			Spur Line
	65	MLV 03	DN750 MLV DN300 Receiver provision for Ramyard Spur Line Future receipt point Carinya GPFs
	85	Combabula Receiver Facility	DN750 Receiver Future receipt point Woleebee GPFs
Pine Hills Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Reedy Creek Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Combabula 2 Spur Line	0	Launcher Facility	DN400 Launcher
Comabula 1 Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Ramyard Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Condabri South Lateral	0	Condabri South Launcher Facility	DN400 Launcher Receipt point Condabri South Spur Line
	15	Condabri South DN400/DN500 Launcher-Receiver Facility	DN400 Receiver DN500 Launcher MLV Receiver provision for Condabri 2 Spur Line
	30	Condabri South DN500/DN900 Launcher-Receiver Facility	DN500 Receiver DN900 Launcher DDPS Condabri Link receipt point DN300 Receiver provision for Condabri 1 Spur Line
Condabri South Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Condabri South Nodal Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Condabri Central Spur Line	0	Launcher Facility	Provision for DN300 Launcher
DDPS Condabri Link	0	DDPS Condabri Link Launcher Facility	Metering Water Heater (TBC) Pressure Regulation (TBC)

Pipeline	KP	Facility	Comment
			DN500 Launcher
	5	DDPS Condabri Link Receiver Facility	DN500 Receiver
DDPS Pipeline	-	Booster compression at existing Talinga Meter Station	or DDPS to be confirmed during FEED
	~155	Receipt Point for Orana Spur Line	DN300 Receiver provision
	~190	Receipt Point for Kainama Spur Line	DN300 Receiver provision
Kenya Spur Line	0	Booster compression to flow gas into DDPS above 10 MPag.	To be confirmed during FEED
Orana Spur Line	0	Launcher Facility	Provision for DN300 Launcher
Kainama Spur Line	0	Launcher Facility	Provision for DN300 Launcher

Opportunities to rationalise the pre-FEED design and reduce the number of facilities have been identified. Rationalisation of the following shall be evaluated during FEED:

- Use DN500 instead of DN400 for KP0 to KP15 of the Condabri South Lateral to eliminate a launcher-receiver;
- Eliminate the launcher-receiver facility at the Condabri South Lateral (DN900) to Condabri Lateral (DN900) connection;
- Eliminate the launcher-receiver facility at the Combabula Lateral (DN750) to Woleebee Lateral (DN750) connection.

For a more detailed description of the proposed nature of the MLV sites, scraper stations, and meter stations refer to the HP Gas Network Design Basis Q-LNG03-50-PH-0001.

2.3 Control Systems

Local transmitters, indicators, and other instrumentation at each site will be connected via hard wiring to a local terminal/control panel to be located in a site hut, and powered either by mains power or solar power, both with battery back-up.

Each site will be capable of either remote operation or local (electronic or manual) operation.

Fibre Optic Cable will be used to provide both data and voice communications between each site controls hut and the Operations Control Centre (expected to be located in Brisbane).

Pressure of the gas delivered from the GPFs will be controlled by the discharge pressure of the compressor(s) within the GPF. A secondary overpressure protection level will be provided by an emergency shutdown valve downstream of the compressor at the start of each pipeline. It is assumed that these ESD valves will be located with the GPFs (to be confirmed during FEED).

Subject to final decisions during FEED, there are some locations within the HP Gas Network at which there are changes in the MAOP. Design for pressure control at all such locations will have two levels of overpressure protection, for example a pressure regulation skid and an ESD valve triggered by a separate transmitter. This requirement may be waived at the start of the Mainline if the MAOP of the HP Gas Network and Main Pipeline System are determined during FEED to be the same.

2.4 Basic Pipeline Design Parameters

Following are the key design parameters of the pipelines.

Table 2.5 Common Pipeline Design Parameters

Parameter	Specification
Design temperature	Maximum: 60 ^{0}c Minimum: 10 ^{0}c
Design life	50 yr
Pipeline coating	Three-layer polyethylene (3LPE) or Fusion Bonded Epoxy (FBE)
Internal lining	COPON or equivalent, factory applied
Maximum allowable operating pressure	15.3 MPa
Cathodic protection	External coating and impressed current cathodic protection
Depth of cover	Generally – minimum 750mm Residential, Agricultural – minimum 900mm Deep Ploughing – minimum 900mm Road crossings / road reserves – minimum 1200 mm Watercourse crossings – minimum 1200 mm Railway – minimum 2000 mm GSDA – minimum 1200 mm
Non Destructive Testing	Testing of welded joints and hydrostatic pressure testing of the pipeline in accordance with AS2885
Buried Marker Tape	Installed at open cut roads, throughout Heavy Industrial Secondary Land Classification and other risk areas as defined in the Risk Assessment.
Pipeline Monitoring System	SCADA system for remote monitoring and control of all facilities at each end of the pipeline; periodic patrolling along the pipeline.

Table 2.6 Design Parameters by Diameter

Diameter	Approx. Length (km)	Standard Wall Thickness (mm)	Heavy Wall Thickness (mm)	Induction Bends Wall Thickness (mm)	12.6 kW/m^2 Radiation Contour (m)	4.7 kW/m^2 Radiation Contour (m)
DN300 (12”)	65	8.71	11.59	12.23	224	374
DN400 (16”)	31	8.72	11.60	12.23	299	498
DN500 (20”)	95	10.09	12.04	12.68	399	656
DN600 (24”)	50	12.10	14.45	15.21	490	797
DN750 (30”)	35	15.13	18.06	19.02	631	1038
DN900 (36”)	15	18.15	21.67	22.82	771	1267
	291					

3. Safety management study process

3.1 Study Team

The Safety Management Study team comprised the following personnel:

Table 3.1

Name	Organisation	Role
David West	APLNG	Pipeline Engineer
Jasper Tieland	APLNG	Engineering Manager - Pipelines
John Swanson	APLNG	Deputy Project Manager - Pipelines
Lynndon Harnell	APLNG	HP Gas Network Pipeline Engineer
Geoff Penno	APLNG	Operations Representative
Milo Hernandez	APLNG	Upstream Health and Safety
Rob Ully	APLNG	EIS Co-ordinator
Jenny Thompson	APLNG	Compliance, Risk, and Op'ns.
Paul Shardlow	Marsh Risk Consulting	Risk Engineer
Ted Metcalfe	Metcalfe Engineering	Facilitator

(Note – Not all were available full-time)

3.2 Activities Undertaken

Planning for the Safety Management Study included review of the requirements of both AS2885 and the Terms of Reference for the Environmental Impact Statement. Available data was reviewed and collated into an early draft revision of this report and distributed to selected attendees. Although some threats and mitigations were defined in the draft revision for information, the primary means of identifying the potential threats and appropriate control measures was the workshop itself, as required by AS2885.

The workshop was held on Thursday 10 December, 2009 and facilitated by Ted Metcalfe of Metcalfe Engineering Consultants Pty Ltd. A series of slides were used as an agenda to guide the preliminary discussion session, which included a detailed description of the pipelines supported by maps, schematics, and drawings.

The Safety Management Study process as defined in AS2885 was reviewed with the aid of the flow diagram shown at Figure 3.1. The differences between design, physical and procedural controls were reviewed and the importance of applying a combination of such controls was emphasised. The Scope of Pipelines applicable to the Study were discussed and agreed.

The group then reviewed the AS2885 definitions of Severity class in terms of People, Supply, and the Environment and agreed that these text descriptions seemed appropriate.

However, the suggested ***numerical*** allocations of cost and schedule consequences to each of the Severity classes (from previous transmission pipeline projects) were reviewed and after some discussion it was agreed that the information necessary to understanding the ranking of consequences for this project in terms of cost and schedule figures was not available to the participants. It was agreed to proceed as far as practical without having defined cost and schedule figures to compare consequences of the threats identified.

The actual identification and assessment portion of the workshop then progressed, on the basis of threats previously identified with encouragement that the group should feel free to define additional threats where considered applicable. Assessments of severity and frequency were discussed, agreed, and recorded on the spreadsheet, which automatically assigned the risk level by inspection of the AS 2885 matrix.

As required by the defined process, in each case for which the assessed risk was greater than Low or Negligible, additional control measures were defined, recorded, and assigned for close-out, and the assessments repeated to ensure that Low or Negligible could be achieved with the additional measures.

The process requires that where evaluation after ***additional*** control measures was still Intermediate, then consideration must be given to whether or not the threat with the control measures in place could be deemed ALARP (As Low As Reasonably Practicable). This requires agreement and documentation that "the cost of any additional controls would be grossly disproportionate to the benefit gained". Threats remaining above Intermediate are not acceptable.

Following the workshop the record of activities was edited for typos and references, and this draft Report was distributed to attendees for review and comment.

This Report with participant comments incorporated forms the documented record of the Preliminary Safety Management Study of the APLNG HP Pipelines Network.

AS 2885.1—2007 28

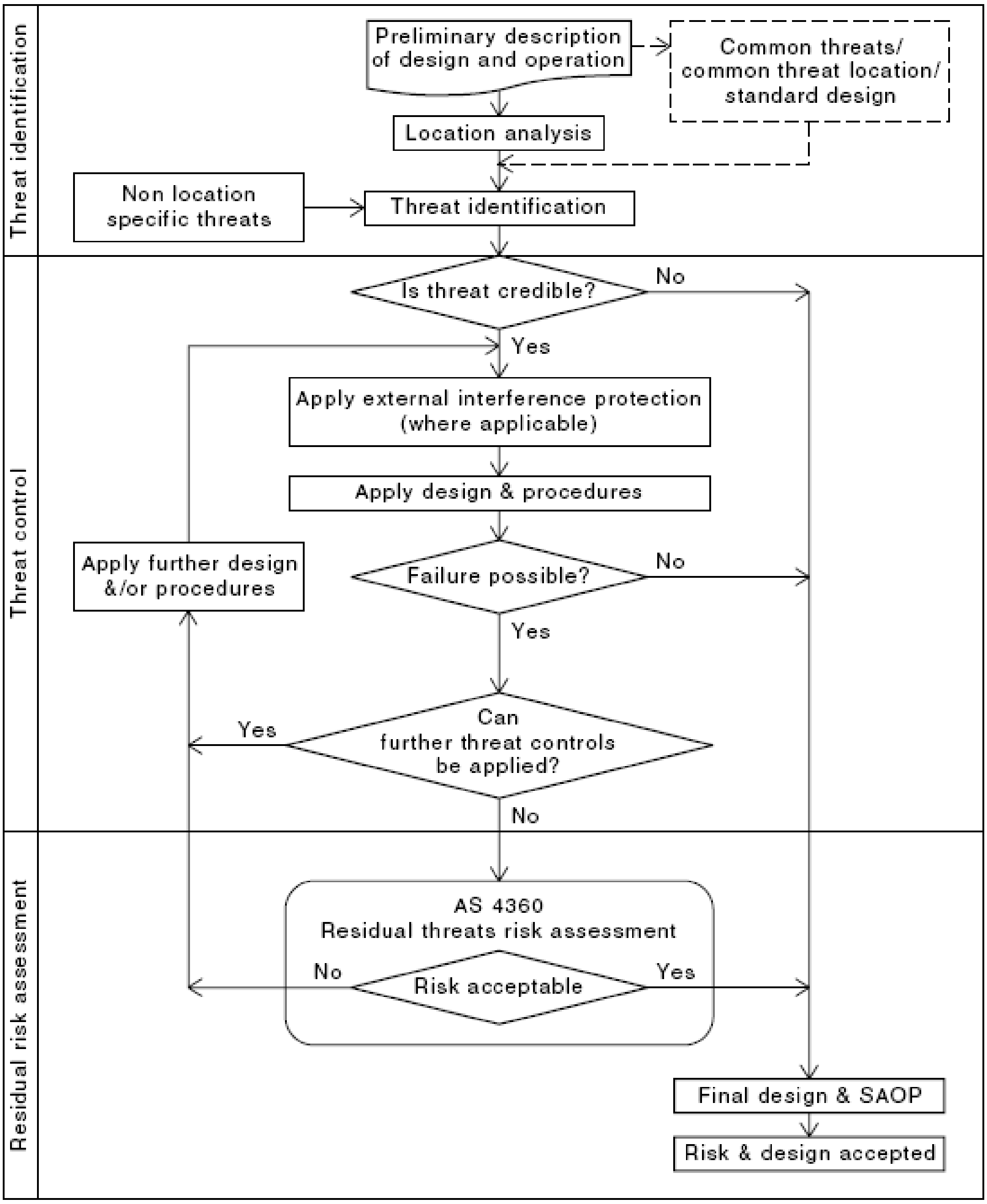


FIGURE 2.3.1 PIPELINE SAFETY MANAGEMENT PROCESS

Figure 3.1 Safety Management Study Process

4. Location analysis

The terrain of the project area is generally rural in land use, flat to undulating with some areas of forested hilly terrain, particularly from Fairview to Spring Gully.

Much of the route is in areas of low population density with limited infrastructure development. There are some areas of remnant forest vegetation but the pipeline route avoids these where possible.

4.1 AS 2885 Location Classifications

Brief descriptions of the primary location classes given in AS2885 are:

- **Rural (R1)** – Land that is unused, undeveloped or is used for rural activities.
- **Rural Residential (R2)** – Land that is occupied by single residence blocks typically in range 1 ha to 5 ha.
- **Residential (T1)** – Land that is developed for community living (i.e. where multiple dwelling exist in proximity to each other and are served by common public utilities).
- **High Density (T2)** – Land that is developed for high density community use (i.e. where multi-storey development predominates or where large numbers of people congregate in the normal use of the area).

Brief descriptions of the secondary location classes are:

- **Sensitive Use (S)** – Area's where consequence of failure may be increased, (i.e schools, hospital and aged care facilities). T2-design requirements apply in Sensitive areas.
- **Industrial (I)** – Industrial location are land that poses a wide range of threats because of its development. T1-design requirements apply in Industrial areas.
- **Heavy Industrial (HI)** - Site development or zoned for use of heavy industry or for toxic industrial use.
- **Submerged (W)** – land that is continuously or occasionally inundated with water, (i.e lakes, harbours, flood plains, watercourses and creeks), whether permanent or seasonal.
- **Common Infrastructure Corridor (CIC)** - multiple infrastructure developments within a common easement or reserve.

4.2 Discussion of Location Classifications

After review of both available mapping and Google Earth images, it was agreed by the workshop that with a few exceptions, the entire project area of the HP Gas Networks could be classified as R1.

During FEED the production of more detailed Alignment Sheets will consider and apply other classifications in limited areas, such as R2 where a greater population density exists or is likely to exist in future.

Areas in close proximity to compression and processing facilities, or where significant CSG or mining activity will occur, may warrant a secondary classification as Industrial however it is unlikely that other secondary classifications will be applied.

Only three specific areas were considered as potentially representing different threats, and these were:

- The Fairview to Spring Gully Loop (as it is parallel and adjacent to an existing operating pipeline),
- The Surface Facilities and the equipment within them, and
- The eastern section of the existing DDPS pipeline, as the proposed flows may prevent integrity monitoring by intelligent pig under some conditions.

5. Failure and Consequence Analysis

The pipelines under review in this Safety Management Study are all have a design pressure of 15.3 MPag and are proposed to built from steel rated to API 5L X-70.

Table 2.3 above provides wall thicknesses for each diameter.

5.1 Penetration Resistance

Section 4 of the referenced document "Network Design Calculations Pre-FEED Q-LNG03-50-TR-0001" provides a detailed treatment of matters relating to penetration resistance for the HP Gas Networks pipelines diameters and wall thicknesses.

For the HP Gas Network, the assumed largest excavator was 55 t, which is consistent with the Main Pipeline System assumption and is the largest excavator considered by AS2885.1 Appendix M. While it is not expected that excavators of this size will operate frequently in the project area, other threats such as coal seam drilling equipment will operate frequently, particularly nearby the small diameter (DN300 and DN400) spur lines to GPFs.

In accordance with AS2885.1 Appendix M and Table M5, a B factor of 0.75 was selected for the standard wall pipe, and 1.0 for heavy wall pipe. The SMS agreed that these B factors were reasonable but recognised the need to review penetration resistance when better data become available on earth moving equipment activity and ability to penetrate.

The wall thicknesses for DN300 and DN400 line pipe required for pressure containment were increased slightly to achieve the 55 t penetration resistance. All other pressure containment wall thicknesses were sufficient to resist penetration.

The resulting wall thicknesses are listed in Table 2.3 above.

5.2 Energy Release and Radiation

Table 2.3 above also provides measurement distances for the nominated radiation contours for each diameter.

Given the outcomes of the penetration resistance preliminary design, a full bore rupture of any of the pipelines in the HP Gas Network is so unlikely as to be not credible.

However, the Safety Management Study is also required to consider the potential for corrosion-related loss of pressure containment integrity, and as with the Mainlines SMS workshop, a threat of undetected corrosion was agreed as a potential cause of full bore pipeline rupture.

6. Threat controls

A significant number of threats to any buried pipeline are associated with third party activities which inadvertently contact and cause damage to the pipeline. As further detailed following, AS2885 requires certain Controls be put in place as External Interference Protection.

Design practices are also used to protect the pipeline against typical threats, and other control mechanisms may also be implemented, also as discussed following.

6.1 External Interference Protection

AS2885 nominates minimum requirements for both Physical and Procedural Controls which can be applied to reduce the probability of particular third party interference threats.

The following shall apply:

a) A minimum of 1 physical control and 2 procedural controls shall be applied in R1 and R2 location classes.

b) A minimum of 2 physical control and 2 procedural controls shall be applied in T1 and T2 location classes.

c) For each control, all reasonably practicable methods shall be adopted.

d) Physical controls for protection against high powered boring equipment or cable installation rippers shall not be considered absolute.

e) In CIC location class, agreements to control the activities of each user shall be implemented with other users of the CIC wherever possible.

6.1.1 Physical Controls

AS2885 defines Physical Controls as follows:

Table 6.1

Physical Controls	Methods
Separation	Burial (depth of cover)
	Exclusion (Fencing, access prevented)
	Physical Barrier (Crash barrier, concrete slabs/coating)
Resistance to Penetration	Wall thickness (if adequate to prevent penetration)
	Barriers preventing penetration

6.1.2 Procedural Controls

Procedural Controls per AS2885 are as follows:

Table 6.2

Procedural Controls	Methods
Pipeline Awareness	Landowner / Third Party Liaison
	Community Awareness Program
	One Call service (Dial Before You Dig)
	Marker Signs or Marker Tape
	Activity Agreements with other entities
External Interference Detection	Planning Notification Zones
	Patrolling
	Remote Intrusion Monitoring

6.2 Controls by Design

The following are examples of design measures which will be implemented in a number of locations to protect the pipeline against potential threats.

Road Crossings:

- Extra depth of cover across the entire road easement.
- Extra wall thickness if required by potential loading.
- Concrete slabs in the areas of future table drain maintenance.
- Marker tape for the entire road easement.

Watercourse Crossings:

- Extra depth of cover.
- Concrete mechanical/weight protection if warranted by stream scour potential.
- Careful rehabilitation of banks to prevent future erosion.

7. Threat identification

This section summarises Typical and Location Specific Threats to the pipeline, and proposed application of Controls for each.

7.1 Review of Typical Threats

There are a number of threats which may be present generally or repeated at many places along the pipeline, and are not specific to defined locations.

Examples of these are readily listed as shown below, each with the mitigation currently proposed by the project.

(These were pre-populated for information and consideration only, and were then validated by the actual Safety Management Workshop.)

7.1.1 External Interference

Table 7.1

Potential Threat	Mitigation Proposed
Foreign Crossings	Depth of cover Marker Signs and Tape Activity Agreements
Accidental Third Party Interference	Depth of cover Marker Signs and Tape Liaison Programs
Agricultural Activities	Extra depth of cover Marker Signs Liaison Programs

7.1.2 Road Crossings

Table 7.2

Potential Threat	Mitigation Proposed
Traffic Loads	Extra depth of cover Liaison with haulage companies Marker signs
Maintenance of Table Drains	Extra depth of cover Concrete slabs Marker tape

7.1.3 Rail Crossings

Table 7.3

Potential Threat	Mitigation Proposed
Derailment	Extra depth of cover Concrete slabs (??) Marker signs
Maintenance	Extra depth of cover Liaison with railway authorities Marker signs
Fatigue	Extra depth of cover Extra wall thickness Liaison with railway authorities

7.1.4 Corrosion

Table 7.4

Potential Threat	Mitigation Proposed
Internal	Full time gas quality monitoring. Periodic intelligent pig for metal loss. Low point drain check ??
External	Quality external coating. Periodic DCVG inspection. Periodic intelligent pig for metal loss.

7.1.5 Natural Events

Table 7.5

Potential Threat	Mitigation Proposed
Land Slip	Routing to avoid potential slip areas. Routine patrols to observe movement. Design??
Subsidence (Natural or Mining) (Sinkholes, Underground mining, underground coal gasification)	Routing to avoid potential subsidence areas. Liaison with mining /gasification companies. Routine patrols to observe movement.

Potential Threat	Mitigation Proposed
Floods	Buoyancy control in flood-prone areas.
Scour	Extra depth of cover in water courses. Concrete protection in scour-prone locations.

7.1.6 Electrical Effects

Table 7.6

Potential Threat	Mitigation Proposed
Induced Voltages	Design of earthing systems. Procedures and training during construction and during operations.
Fault Currents	Design of earthing systems.
Lightning	Design of earthing systems. Procedures to stop work during lightning activity. Surge arrestors.
Power Failures	Back-up battery systems.

7.1.7 Operations and Maintenance Activities

Table 7.7

Potential Threat	Mitigation Proposed
Overpressure	Design of over-pressure protection systems. Monitoring and alarm via SCADA system. Training to ensure by-pass is prevented.
Repair Dig-ups	Procedures and training. Accurate location prior to excavation.
Maintenance of Equipment	Regular audits of equipment condition. Application of recommended programs.

7.1.8 Construction Defects

Table 7.8

Potential Threat	Mitigation Proposed
Coating Damage	Approved handling procedures. Backfill specification.

Potential Threat	Mitigation Proposed
	Holiday detection on installation.
Failed Field Joint Coating	Qualified coating application procedure approval. Design selection of appropriate system. Holiday detection after completion.
Dents and Wrinkles	Qualified bending procedure approval. Visual and internal gauge inspection.
Weld Quality	Qualified weld procedures approval. NDT inspection. Hydrostatic pressure and leak test.
Backfill quality	Backfill quality specification. Inspection during construction. DCVG follow-up inspection.
Blasting procedures	Qualified blasting procedures. Licensed personnel for design and implementation of blast programs. Exclusion zones.

7.1.9 Design Defects

Table 7.9

Potential Threat	Mitigation Proposed
Stress Corrosion Cracking	Engineering design and metal specification. High quality coating. Temperature control. Periodic intelligent pig inspection for cracking.
Incorrect wall thickness	Engineering design QA and audit procedures. Inspection on receipt. Hydrostatic pressure test.
Inadequate functionality	Operations and Maintenance input to engineering design. HAZOP and CHAZOP studies. Pre-commissioning inspection and testing.

7.1.10 Material Defects

Table 7.10

Potential Threat	Mitigation Proposed
Steel Quality	Engineering Design and QA. Inspections and QA in the pipe mills.
Coating Material Quality	Engineering coating selection. QA in the coating material supply and application.
Proprietary Equipment	Engineering Design specifications. QA and Inspection and Test Plans during fabrication. Inspection and acceptance on receipt. Pre-commissioning testing and inspection.

7.1.11 Intentional Damage

Table 7.11

Potential Threat	Mitigation Proposed
Wilful Damage External (Vandalism, Terrorism, Sabotage)	Markers and warning signs. Security fencing and locks. Routine patrols. CCTV installations in critical facilities??
Wilful Damage Internal (Sabotage)	Employee background checks. Human Resources management. Other??

7.1.12 Earthquake

A full evaluation of the potential for damaging earthquake in the vicinity of the HP Gas Network has not yet been completed, however reference to Geoscience Australia mapping indicates that there is little or no earthquake activity in this area.

7.1.13 Future Blasting

The pipeline route has intentionally avoided all known areas of likely future infrastructure development, or design has taken those into consideration.

It is possible that in future another third party will seek to conduct blasting in the vicinity of the pipeline for infrastructure development, quarrying, or mining. The proposed community liaison program and notification requirements would ensure that APLNG is aware of the proposed blasting and has the opportunity to evaluate and if appropriate, approve the blasting.

7.2 Review of Location-Specific Threats

Three areas were considered to be distinct from the general pipeline in terms of land use, population density, or potential threat to the pipeline. The threats associated with each are briefly described following.

7.2.1 Fairview to Spring Gully Loop

The requirement to construct a new pipeline in close proximity to an existing operating pipeline over some distance presents threats to the existing pipeline, which are to be considered by this workshop. These include:

- Damage with or without penetration to the existing pipeline, either during construction or during future maintenance activities.
- Some potential that a failure of either pipeline in future could affect the other pipeline.

7.2.2 Surface Facilities

The fenced surface facilities represent potential threats such as:

- Damage from local bushfires.
- Vandalism or theft.
- Mistakes during operations activities such as pigging.

7.2.3 Eastern Section of the DDPS Pipeline

The existing DDPS pipeline was designed to flow from west to east to deliver gas to the Darling Downs Power Station (DDPS), and has intermediate pig launching and receiving facilities at the Talinga Metering Station only. Design of the HP Gas Network however includes a major link west of the TMS between the DDPS Pipeline and the Condabri South Lateral, as well as a number of production spur lines adding produced gas east of the TMS.

Under normal operation of the eastern section of the DDPS Pipeline, the power station demand would result in flow to the east but the HP Gas Network demand via the DDPS Condabri Link will result in flow to the west. Under these conditions a pig launched at the western end of the DDPS pipeline could not be received at the power station.

The extent to which this impacts on the ability to launch and receive intelligent pigs as part of an integrity monitoring program was considered by the workshop.

There was some discussion as to whether or not the Spur Lines connecting the processing facilities to the Laterals were potentially subject to different threats, and the workshop agreed that the Spur Lines and the Laterals were no different in terms of threats, despite different diameters and service.

8. Study outcomes and recommendations

The details of the Safety Management Study assessment are recorded in the worksheets referenced from Appendix 2.

8.1 Study Outcomes

8.1.1 Summary of Evaluation Results

A total of 55 threats were identified, nearly all of which were in the category of Typical threats.

As happened at the Mainlines SMS workshop, a number of threats were initially ranked as Intermediate, but additional controls could not be defined to allow the threat to be re-evaluated as Low.

Table 8.1

No.	Threat	Initial	Re-rank	Issue
2	Third party activity at pipeline crossing (with penetration)	Int.	ALARP	Discussed and agreed that any additional controls would not provide further reduction of the threat.
5	Third party activity other than at crossing, with penetration	Int.	N/A	Further field research required.
7	Deep ripping with penetration	Int.	N/A	Better understanding of potential use of rippers in field area is required.
10	Liquid carryover from processing plants	Int.	N/A	Ranking high on probability, not consequence. Further study of an existing CSG pipeline for liquids is proposed.
13	Undetected corrosion leads to rupture	Int.	Int.	Recommendation for annual leak detection survey.
19	Induced voltage leads to corrosion.	Int.	N/A	Study during FEED regarding proximity to existing and proposed new HV power lines.
31	Stress Corrosion Cracking	Int.	N/A	Further study is proposed during FEED.

Some other threats, although initially ranked as Low, resulted in recommendations.

8.1.2 Discussion of Other Key Outcomes

Undetected Corrosion

Wall thicknesses nominated for the diameters under study are all such that rupture due to penetration associated with third party interference is not a credible scenario. However, the workshop agreed that undetected corrosion leading to rupture (as recently occurred on Varanus Island in WA) represented a valid threat, and this was taken as the All Controls Fail scenario.

If indeed all controls did fail and widespread corrosion went undetected to the point of pipeline rupture, then the consequences of rupture in terms of radiation impact distances indicated in Section 5.2 above would eventuate.

Penetration by Drilling

The participants expressed some concern regarding the potential for future CSG drilling operations (either APLNG or other proponents) to damage the pipelines. Although the concept of penetration resistance to excavator teeth is reasonably well understood, the ability of pipelines to withstand sustained attack from drilling machinery is not as well understood.

8.2 Study Recommendations

The HP Gas Networks SMS has generated almost the same recommendations as were defined at the Mainlines SMS.

8.2.1 Design Phase

1. Improved understanding of the size and nature of equipment likely to be used in development of new infrastructure near the pipeline.
2. Study of the potential for liquid carryover into the pipeline from the processing plants, and the success or otherwise of routine pigging of an existing CSG pipeline.
3. Seismic Study of the pipeline route.
4. Geotechnical investigation of any areas of potential natural subsidence (sinkholes).
5. Hydrological Study of potential for Flooding along the pipeline route; as well as potential for migration of watercourse banks during flood periods.
6. Improved understanding of potential developments in the GSDA.
7. Further study of the potential for Stress Corrosion Cracking.
8. SMS workshops should be held again at the end of the FEED phase, and a final Detailed Safety Management Study held at the end of Detailed Design.

8.2.2 Safety and Operating Plan (SAOP)

Operations should develop and implement an annual leak detection survey over the pipeline.

8.2.3 Other

In addition to the above, this SMS recommends that Origin Energy management provide policy direction on matters of security particularly as regards terrorism.

References

Terms of Reference for an Environmental Impact Statement Australia Pacific LNG Project – Under Part 4 of the *State Development and Public Works Organisation Act 1971*(The Coordinator-General - December 2009)

AS 2885.1-2007 Pipelines-Gas and liquid petroleum Part 1: Design and construction (as amended 2009)

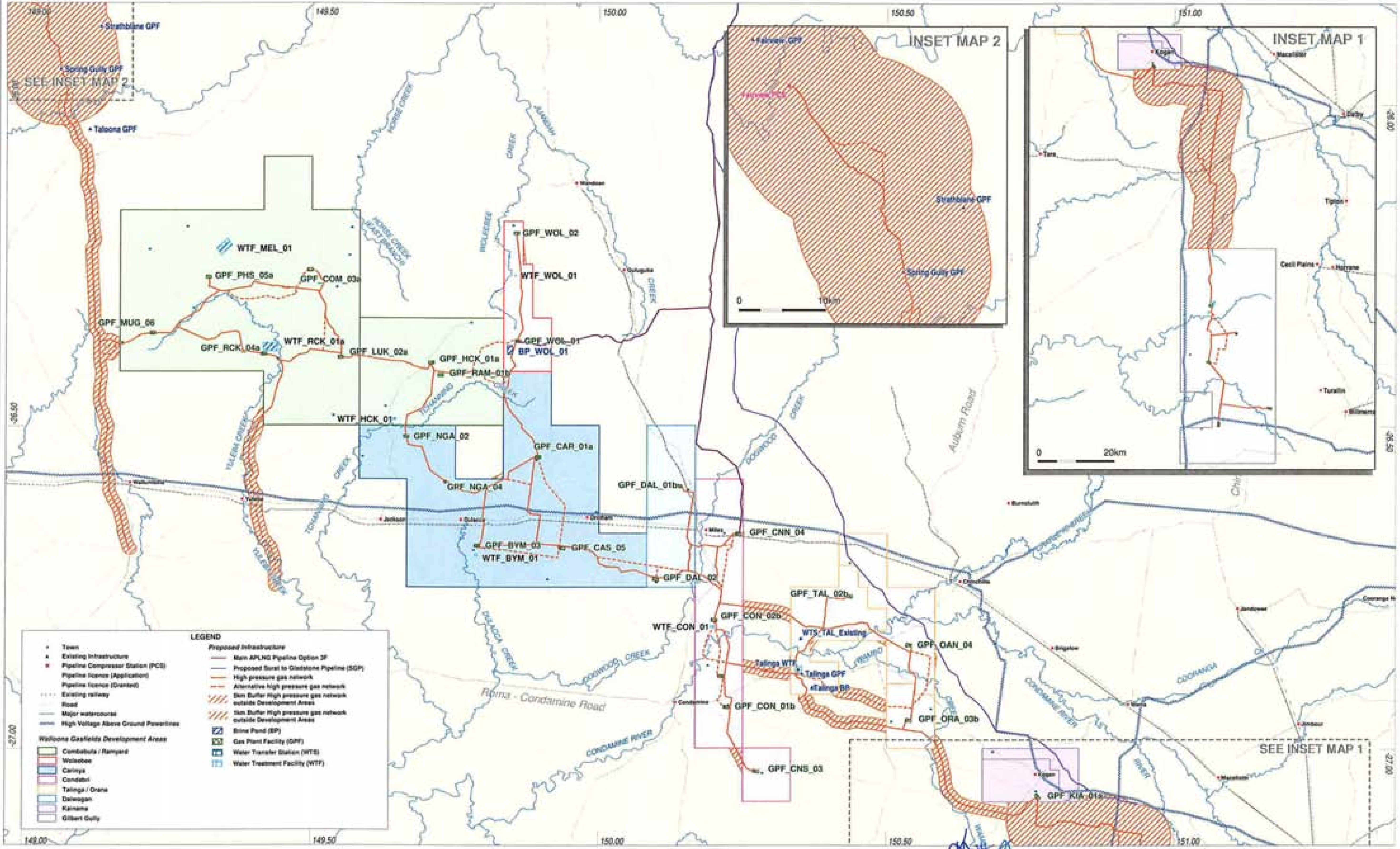
Network Design Basis Q-LNG03-50-PH-0001

Network Design Calculations Pre-FEED Q-LNG03-50-TR-0001

Appendix A Abbreviations

Acronym	Meaning
3LPE	Three layer polyethyene
ALARP	As Low As Reasonably Practicable
APLNG	Australian Pacific LNG (Origin/ConocoPhillips)
AS	Australian Standard
CCIC	Callide Common Infrastructure Corridor
CDL	Critical Defect Length
CP	Cathodic Protection
CSG	Coal Seam Gas
DCVG	Direct Current Voltage Gradient
DDPS	Darling Downs Power Station
DN	Nominal Diameter
EIS	Environmental Impact Statement
ERW	Electric Resistance Welded
FEED	Front-End Engineering Design
GPF	Gas Processing Facility
GSDA	Gladstone State Development Area
HAZOP	Hazard and operability study
HDD	Horizontal Directional Drilling
HP	High Pressure
KP	Kilometre post
Km	kilometre
LNG	Liquefied Natural Gas
MAOP	Maximum Allowable Operating Pressure
MLV	Mainline Valve
MPa	Megapascal
NDT	Non-Destructive Testing
PCS	Pipeline Compressor Station
PFD	Process Flow Diagram
QA	Quality Assurance
QGC	Queensland Gas Company
Qld	Queensland
RP	Recommended Practice
ROW	Right of Way
SAOP	Safety and Operating Plan
SCADA	Supervisory Control and Data Acquisition
SMS	Safety Management Study
TMS	Talinga Metering Station

Appendix B Map of HP Pipelines Network



0 12.5 25km

SCALE - 1 : 300,000 (at A1)

Latitude - Longitude
Geocentric Datum of Australia 1994

NOTES 1: Routing between Spring Gully GPF and Fairview still being finalised

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
4	11/11/2009	Re-issued for Use	KM	DH	AS	
3	05/11/2009	Re-issued for Use	MM	KM	RM	
2	2/10/2009	Re-issued for Use	WT	DH	RM	
1	18/08/2009	Re-issued for Use	JB	DH	RM	
0	30/07/2009	Issued for Use	JB	DH	RM	
D	19/06/2009	Issued for review	JB	DH	RM	

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AUSTRALIA PACIFIC LNG PTY LIMITED

AUSTRALIA PACIFIC LNG PROJECT
Proposed HP Gas Network

Project No: 401001-00502 | Figure: Q-LNG01-05-MAP-0006 | Rev: 4

Compiled by BRISBANE INFRASTRUCTURE GIS SECTION

K:\ORIGIN\401001-00502\GIS\Maps\00502-00-EN-DAL-0002-4(Walloons_HP_Gas_Network_A1).wor

Appendix C Safety Management Study Record

SAFETY MANAGEMENT STUDY IN ACCORDANCE WITH AS2885.1

Scope of Activities of Interest:
Design, installation, and operation of:
> High Pressure pipelines in the CSG production fields
> Associated Infrastructure / Surface Facilities

Project:	HP Pipeline Networks
Client:	APLNG
Date:	10-Dec-09
Facilitator:	Ted Metcalfe

Time Period of Activities of Interest:
Installation through abandonment.
Design Life of 50 years.

CONSEQUENCE MEASURES		SEVERITY CLASSES				
		Catastropic	**Major**	**Severe**	**Minor**	**Trivial**
Occupational health and safety effects.	**People**	Multiple fatalities.	A few fatalities and/or life threatening injuries.	Hospitalisation required.	First Aid required.	Mimimal impact.
(per AS2885 as applicable to pipeline risk assessments).	**Supply / Commercial Impact**	Long term interruption	Prolonged interruption or long term restriction.	Short term interruption or long term restriction.	Short term interruption or restriction; alternatives available.	No impact.
Impact on flora or fauna or general area.	**Environment**	Widespread effects. Permanent major changes.	Major off-site impact. Long term severe effects. Rectification difficult.	Local short term effects. Easily rectified.	Very localised and short term. Easily rectified.	No effect. Negligible residual.
Information necessary to update Cost and Schedule ranking figures was not available to Workhop participants.	**Cost from**	$500,000	$100,000	$10,000	$1,000	Zero
	up to	??	$500,000	$100,000	$10,000	$1,000
	Schedule	One month	One week	Full working day	Few hours	No lost time.
	up to	??	One month	One week	Full working day	Few hours

FREQUENCY CLASSES:		**Catastropic**	**Major**	**Severe**	**Minor**	**Trivial**
Expected to occur at least once during the period.	**Frequent**	**Extreme**	**Extreme**	**High**	**Intermediate**	**Low**
May occur during the period.	**Occasional**	**Extreme**	**High**	**Intermediate**	**Low**	**Low**
Unlikely to occur during the period, but possible.	**Unlikely**	**High**	**High**	**Intermediate**	**Low**	**Negligible**
Not anticipated for this project during the period.	**Remote**	**High**	**Intermediate**	**Low**	**Negligible**	**Negligible**
Theoretically possible, but there is no precedent.	**Hypothetical**	**Intermediate**	**Low**	**Negligible**	**Negligible**	**Negligible**

Notes:

Re-assess consequence severity costs and durations for each study scope and circumstances.
Document any threats raised but deemed non-credible, with reasons.

Consider an "All controls fail" worst case scenario and assess.

Type of Threat	
External Interference	Ext
Corrosion	Corr
Natural Event	Nat
Electrical Effect	Elec
Operations and Maintenance	O&M
Construction Defect	Cons
Design Defect	Des
Intentional Damage	Int
Other	Oth

PROJECT: HP PIPELINES NETWORK **SECTION:** Typical Threats

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls (*Must have one Physical and two Procedural if External Interference in R1 area*)		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			**Physical / Design**	**Procedural / Awareness**						(Individual)
	Example Only *- Pipeline punctured by post hole driller.*	Ext	*Hydrocarbon leak.* *Personnel injury.* *Equipment damage.*	Unl	Sev	*Burial*	*Warning Signs*	Int	*Liason with local landowners and contractors.* *Permit to Work and supervision.*	Rem	Sev	Low	*Operations Manager*
	TYPICAL THREATS **(Relevant to entire pipeline or to several locations on pipeline):**												
1.0	**Activity by third party damages pipeline at pipeline crossing point (no loss of containment).**	Ext	Coating damage Surface scoring.	Occ	Min	Depth of Cover Separation between buried services.	Marker Signs Agreements in place with other asset owners. "Others" are also CSG operators and are aware of risks.	Low					
2.0	**Activity by third party damages pipeline at pipeline crossing point (With penetration).**	Ext	Coating damage requiring repair. Surface scoring. Loss of containment.	Unl	Sev	Depth of Cover. Wall thickness. Separation between buried services. Network loop arrangement provides alternative flow path to Gladstone mainline.	Marker Signs DBYD Agreements in place with other asset owners."Others" are also CSG operators and are aware of risks.	Int	ALARP. Additional physical and procedural measures considered but deemed overly expensive (full length slabbing, constant patrols and surveillance, etc.)				
3.0	**Activity by third party damages pipeline at road/rail crossing point (no loss of containment).**	Ext	Coating damage Surface scoring.	Unl	Min	Depth of Cover Additional wall thickness (if required) at crossings.	Marker Signs Agreements in place with other asset owners.	Low					
4.0	**Activity by third party damages pipeline at road/rail crossing point (Penetration).**	Ext	Coating damage requiring repair. Surface scoring. Loss of containment.	Hyp	Maj	Depth of Cover. Additional wall thickness (if required) at crossings.	Marker Signs DBYD Agreements in place with other asset owners.	Low					
5.0	**Activity by third party damages pipeline other than at crossing point.** **(Other CSG development activities; dam construction, mining, etc.)**	Ext	Coating damage requiring repair. Surface scoring. Possible penetration and loss of containment.	Occ	Sev	Depth of Cover Wall thickness. Alternative gas supply flow paths are available.	Marker Signs Liaison programs with local entities to advise of pipeline location and to learn of proposed future development. Higher level of local supervision available in the production field area.	Int	Requires re-consideration after collection of more information regarding the size of equipment potentially used in the area for future developments.			#N/A	Engineering Manager
6.0	**Deep ripping or blade ploughing or irrigation channel construction damages pipeline.**	Ext	Severe coating damage. Scoring of metal surface. Potential for loss of containment.	Occ	Min	Extra Depth of Cover in agricultural areas.	Marker Signs Liaison programs with local farmers.	Low	Need further research in discussion with landholders regarding potential activities to allow determination of appropriate depth of cover.			#N/A	Engineering Manager
7.0	**Deep ripping or blade ploughing or irrigation channel construction damages pipeline.**	Ext	Severe coating damage. Scoring of metal surface. Assume small penetration.	Rem	Maj	Extra Depth of Cover in agricultural areas.	Marker Signs Liaison programs with local farmers.	Int	Need further research in discussion with landholders regarding potential activities to allow determination of appropriate depth of cover.			#N/A	Engineering Manager
8.0	**Heavy traffic loads damage pipeline at a point not designed as a road crossing.**	Ext	Some deformation possible.	Occ	Min	Design calculation.	Liaison with drilling rig companies and landowners. Warning marker signs.	Low	FEED to consider heavy loads at points not designed as road crossings.			#N/A	Engineering Manager

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls *(Must have one Physical and two Procedural if External Interference in R1 area)*		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			**Physical / Design**	**Procedural / Awareness**						(Individual)
9.0	**Derailed train damages pipeline.**	Ext	Barely credible. Possible pipe deformation and coating damage.	Hyp	Sev	Depth of cover.	N/A	Neg				#N/A	
10.0	**Liquid carryover from processing facilities into pipeline.**	O&M	Accumulating liquid slug. LNG Plant feed gas quality issues.	Fre	Min	Coalescing filters at LNG Plant inlet.	Laterals may be pigged routinely to check for glycol accumulation.	Int	Additional study of an existing CSG pipeline is required to assist resolution. Consider drip pots at low points in main pipelines.			#N/A	Engineering Manager
11.0	**Internal Corrosion damages pipeline.**	Corr	Metal loss. Pinhole leak.	Hyp	Maj	Transmission gas quality monitoring.	Periodic intelligent pigging to check for metal loss.	Low				#N/A	
12.0	**External corrosion damages pipeline. (Pinhole leak only)**	Corr	Loss of containment Metal loss.	Rem	Sev	High quality external coating (specs and installation procedures.). CP system design.	Monitoring of CP system operation. Routine DCVG survey. Routine intelligent pigging. Warning markers to prevent damage to coating.	Low				#N/A	
13.0	**External corrosion damages pipeline. PROPOSED AS "ALL CONTROLS FAIL" SCENARIO**	Corr	Widespread metal loss. Loss of containment (rupture)	Rem	Maj	High quality external coating (specs and installation procedures.). CP system.	Monitoring of CP system operation. Routine DCVG survey. Routine intelligent pigging. Warning markers to prevent initial damage to coating.	Int	Consider annual leak detection survey for this pipeline system.	Hyp	Cat	Int	Operations Manager
14.0	**Land slip damages pipeline; probably side slope related.**	Nat	Deformation. Exceed design strain limits.	Rem	Sev	Route selection to avoid potential land slip areas. Slope stabilisation specified in high potential areas.	Routine patrols to note movements.	Low				#N/A	
15.0	**Natural subsidence (sink holes, etc.)**	Nat	(Review of threat still in progress)			(not yet specifically considered in route selection)	Routine patrols to note movements.	#N/A	Further study required.			#N/A	Engineering Manager
16.0	**Man-made subsidence (underground activities eg. Coal to liquids)**	Ext	Uneven settlement of the pipeline. Potential to exceed design strain limits.	Hyp	Min	Route selection to avoid existing and future underground developments.	Liaison programs.	Neg	Need to confirm future development activity proposed by any coal gasification operator.			#N/A	Engineering Manager
17.0	**Flood activity exposes and damages pipeline.**	Nat	Pipe floats to surface. Coating damage.	Rem	Min	Buoyancy control in potential flood areas.	Routine patrols.	Neg	To be further addressed in FEED.			#N/A	Engineering Manager
18.0	**Scour activity exposes and damages pipeline in watercourses.**	Nat	Coating damage. Potential for flood debris to impact and strain pipe.	Rem	Sev	Depth of cover. Concrete mechanical protection. Bank rehabilitation after construction.	Routine patrols to identify bank progression.	Low	To be further addressed in FEED.			#N/A	Engineering Manager
19.0	**Induced HV power line voltage effects cause corrosion.**	Corr	Metal loss.	Unl	Sev	Earthing and CP system design. High quality coating system.	DCVG and intelligent pig surveys.	Int	Further investigation required during FEED regarding proposed HV line locations.			#N/A	Engineering Manager
20.0	**Induced HV power line voltage effects injure workers.**	Cons	Possible shock to personnel during construction.	Rem	Sev	Earthing and CP system design. High quality coating system.	Procedures to earth pipe during construction.	Low				#N/A	
21.0	**HV Fault currents damage coating and pipeline.**	Elec	Coating damage. Possible pitting.	Rem	Min	Earthing and CP system design.		Neg				#N/A	

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls (Must have one Physical and two Procedural if External Interference in R1 area)		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			Physical / Design	Procedural / Awareness						(Individual)
22.0	**Lightning damages pipeline.**	Nat	Pinhole leak. Coating damage.	Rem	Sev	Design of earthing systems. Surge arrestors.		Low				#N/A	
23.0	**Power Supply Failure causes system shutdown.**		(Not really a threat to the pipeline)	Hyp	Sev	Battery back-up system. MLV to be fail last position controls design.		Neg				#N/A	
24.0	**Pipeline overpressure during operations.**	O&M	Exceeding design strain limit. (Rupture not credible.)	Hyp	Maj	Overpressure protection design. SCADA monitoring and alarms. Compressor capability limited.	Operations training.	Low				#N/A	
25.0	**Repair dig-up accidently damages pipeline.**	O&M	Coating damage. Scoring of the pipe surface.	Occ	Min	Wall thickness.	Pipeline location procedures. Operations training. Machinery size limitation.	Low				#N/A	
26.0	**Construction Defect - Damaged Coating**	Cons	Potential corrosion if not repaired.	Occ	Min	Construction Specification Backfill Specification	Inspection and QA checks. (DCVG) Job training.	Low				#N/A	
27.0	**Construction Defect - Incorrectly applied Field Joint Coating**	Cons	Potential corrosion if not repaired.	Occ	Min	Field Joint Coating application procedures. Design selection of appropriate system.	Qualified coating application procedure approval. Holiday detection after completion.	Low				#N/A	
28.0	**Construction Defect - Dents and Wrinkles in Pipe**	Cons	Pipe local deformation.	Occ	Min	Material and Bend Specifications.	Bend Procedure Qualification QA checks/guage plate.	Low				#N/A	
29.0	**Construction Defect - Failed Weld Undetected**	Cons	Pinhole leak.	Hyp	Sev	Welding specification.	Weld procedure qualification. QA and NDT checks. Hydrotest. DCVG Survey post-construction.	Neg				#N/A	
30.0	**Incorrect Construction Blasting damages nearby infrastructure**	Cons	Repair costs.	Rem	Min	Design of blasting charge size and timing.	Licenced personnel. Approved procedures. Pre and Post blast inspections.	Neg				#N/A	
31.0	**Design Defect - Stress Corrosion Cracking**	Des	MAOP limitation. Repair costs for clocksprings, etc.	Rem	Maj	Engineering Design and metallurgical specifications. High quality coating specified.	QA inspections in pipe mill. Process temperature control. Periodic intelligent pig inspection for cracks.	Int	Additional study required during FEED			#N/A	Engineering Manager
32.0	**Incorrect Wall Thickness / Material Strength supplied.**	Des	Replacement costs. Delay.	Rem	Min	Engineering Design and Specification.	Audit of design. MDR Review. Inspection in pipe mill; QA. Hydrotest.	Neg				#N/A	
33.0	**Inadequate system functionality.**	Des	Restricted operations.	Unl	Min	O&M input to Design.	HAZOP. CHAZOP. Pre-commissioning inspection. Post commissioning testing.	Low				#N/A	
34.0	**Material Defect - Poor Steel Quality**	Des	Replacement costs. Delay.	Rem	Min	Engineering Design.	QA and inspection in pipe mills. Hydrotest.	Neg				#N/A	
35.0	**Material Defect - Poor Quality Coating Material or Application**	Des	Replacement costs. Delay.	Rem	Min	Engineering Design and Specification.	QA inspections in coating mill. Holiday testing during construction. DCVG survey post-construction.	Neg				#N/A	

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls (Must have one Physical and two Procedural if External Interference in R1 area)		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			**Physical / Design**	**Procedural / Awareness**						(Individual)
36.0	**Material Defect - Failure of Proprietary Equipment**	Des	Replacement costs. Delay.	Rem	Min	Engineering Design and Specification.	Inspection and QA checks on fabrication and receipt. Pre-commissioning testing and inspections.	Neg				#N/A	
37.0	**Wilful Damage External (Vandalism, Terrorism)**	Int	Possible rupture.	Hyp	Sev	Security Fencing and monitoring at facility sites. High strength steel and wall thickness.	N/A	Neg	Warrants elevation to senior management for consideration as part of an overall security plan implementation.			#N/A	Project Manager
38.0	**Wilful Damage Internal (Sabotage)**	Int	System shut-down or restriction. (Rupture unlikely)	Unl	Min		Employee interview and reference checks. Human resources management.	Low	Warrants elevation to senior management for consideration as part of an overall security plan implementation.			#N/A	Project Manager
39.0	**Earthquake**	Nat	Deformation of pipe. Coating defect.	Hyp	Min	Not a known earthquake area.		Neg				#N/A	
40.0	**Future Blasting by others near pipeline.**		Deformation of pipe. Coating defect.	Rem	Min	Depth of cover. Selected backfill.	Liaison programs. Warning markers.	Neg				#N/A	
41.0	**CP systems from adjacent pipelines interfere with each other**	Corr	Coating defect. Localised corrosion.	Occ	Min	Coordination during design between parties with pipelines in the same area.	System monitoring. Routine intelligent pigging to detect metal loss.	Low				#N/A	
42.0	**Water pipeline leak damages gas pipeline**	Corr	Salts in water cause corrosion if coating has defect.	Rem	Min	High quality coating. CP system design.	DCVG and intelligent pig surveys. Routine patrols to note water leaks.	Neg				#N/A	

PROJECT: HP PIPELINES NETWORK **SECTION:** Location Specific Threats

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls (Must have one Physical and two Procedural if External Interference in R1 area)		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			**Physical / Design**	**Procedural / Awareness**						(Individual)
	SPRING GULLY TO WALLUMBILLA LOOPING:												
1.0	**Construction activity hits existing pipeline.**		Deformation and gouge.	Rem	Min	Same easement, but minimum separation between the pipelines.	Existing pipeline and easement are internally owned.	Neg					
2.0	**Construction activity hits existing.**		Loss of containment.	Hyp	Maj	Same easement, but minimum separation between the pipelines.	Existing pipeline and easement are internally owned.	Low					
3.0	**Future maintenance activity on one pipeline contacts the other.**		Deformation and gouge.	Rem	Min	Wall thickness.	Same operator both pipelines. As-built information readily available.	Neg				#N/A	
4.0	**Knock-on effect of an incident on one pipeline affecting the other.**		Theoretical rupture, but not credible with adequate separation distance.	Hyp	Cat	Separation distance. Other pipeline designed and operated to AS2885 as well.	Research reports considered during design to assist setting minimum separation distance.	Int	ALARP. Alternative of acquiring new easement for entire distance not practical.			#N/A	
								#N/A				#N/A	
	SURFACE FACILITY SITES (SCRAPERS AND MLV'S):		**(INCLUDING ABOVE GROUND SECTIONS INSIDE FENCE)**										
1.0	**Vandalism and Theft**	Ext	Damage, potential shutdown of facility.	Rem	Min	Secure fencing, locked gates. Door opening alarms connected to SCADA. Consider locking enclosures for key instrumentation.	Warning signs. Public awareness and liaison	Neg				#N/A	
2.0	**Bushfire**		Scorching and minor equipment damage, potential shutdown of facility.	Unl	Min	Cleared area outside of fence.	Operations personnel respond to affected facilities when fire reported.	Low				#N/A	
3.0	**Operator error (particularly pigging)**	O&M	Shutdown. Equipment damage.	Unl	Min	HAZOP. Operations input to design.	Training Job procedures.	Low				#N/A	
4.0	**Low temperature effects during station venting.**	Des	Piping damage.	Hyp	Min	Material selection. Modelling during design.	Training Job procedures.	Neg				#N/A	
5.0	**Low temperature effects from MLV pipeline section venting.**	Des	Piping damage.	Hyp	Min	Material selection. Modelling during design.	Training Job procedures.	Neg					
6.0	**Flood damage**	Nat	Sites inaccessible. Potential equipment damage.	Rem	Min	Intentional location above known flood levels.		Neg				#N/A	
	REVERSING FLOW IN DDPS EASTERN SECTION:		**(INCLUDING ABOVE GROUND SECTIONS INSIDE FENCE)**										
1.0	**Reversing flow prevents running intelligent pigs.**	O&M	Lack of integrity monitoring. Non-compliance with licence conditions.			Design does not currently prevent this situation developing under certain flow conditions.		#N/A	Study and development of alternatives or appropriate management procedures required during FEED. This represents a change of service for DDPS.			#N/A	Engineering Manager.

No.	Threat	Category	Consequences	Frequency	Severity	Existing Controls (*Must have one Physical and two Procedural if External Interference in R1 area)*		Risk Rank	Additional Risk Reduction / Corrective Actions Required	Frequency	Severity	Revised Risk Rank	Responsible for Close-out
	(Specifically identify potential threatening event)		(Identify key negative consequences; or reason why non-credible.)			**Physical / Design**	**Procedural / Awareness**						(Individual)
2.0	**Potential to back-pressure Kenya compressor (rated only at 10.0 Mpag)**					DDPS HAZOP has already dealt with this. Overpressure protection is already existing.		#N/A				#N/A	
3.0	**Increased operating pressure in DDPS eastern end will result in greater heating load at Power Station.**		Additional heater capacity required.					#N/A	Study and development of alternatives or appropriate management procedures required during FEED. This represents a change of service for DDPS.			#N/A	