Heytesbury Underground Gas Storage (HUGS) Pipeline

Attachment P

Safety Management Study Report

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Safety Management Study Report

HUGS pipeline FEED engineering services
Long Energy and Resources

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EXECUTIVE SUMMARY

This report has been prepared on behalf of Long Energy to meet the requirements of AS(/NZS) 2885. The SMS can only be considered to be fully conforming to AS(/NZS) 2885 when it has been formally approved by the pipeline licensee (Lochard Energy) in accordance with the requirements of AS 2885.0 and includes the pipeline licensee's high consequence recognition as required by AS/NZS 2885.6 Clause 1.5.6

Lochard Energy is progressing the Heytesbury Underground Gas Storage (HUGS) Project near Port Campbell in south-west Victoria. The scope of the project includes construction of a new 5.3 km DN300 gas pipeline along with DN50 mono-ethylene glycol (MEG) pipeline and fibre optic cable. The pipeline will extend from the North Paaratte Production Station and Meter Station to the MFCT wellsite, via the North Paaratte wellsite.

The two pipelines will be designed, constructed and operated in accordance with AS(/NZS) 2885 *Pipelines—Gas and liquid petroleum*. AS/NZS 2885.6, *Part 6: Pipeline safety management*, requires that a robust Safety Management Study (SMS) is prepared for the pipeline, addressing any threats to the pipeline integrity and identifying how they are controlled.

The project is currently at Front End Engineering Design (FEED) stage. This report documents the pipeline SMS prepared as part of the FEED design, per AS/NZS 2885.6 §5.4.3.

The SMS focused on threats related to conditions that apply to the pipeline – external interference, natural events, and corrosion. Future revision of the SMS must also address the other categories of threats defined in AS/NZS 2885.6, which are: intentional damage, pipeline materials, and design, construction, operation, maintenance and management of the pipeline.

The SMS identified only seven uncontrolled, failure threats, which were subject to risk assessment; two of these – vertical augering for installation of power-poles and cable-ploughs for installation of fibre-optics – could result in a 'Major' consequence as they have potential for fatality of the equipment operator; this was the worst consequence identified on the pipeline. The likelihood of the threats were also assessed. Due to a 'Hypothetical' likelihood of occurrence, the risk from augering was determine to be 'Low'. However, the use of cable ploughs for fibre-optics was designated a 'Remote' likelihood by preliminary assessment and hence an 'Intermediate' risk. It is recommended that a quantitative risk assessment using a Layer of Protection Analysis be conducted to verify the preliminary assessment.

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1 INTRODUCTION

1.1 BACKGROUND

Lochard Energy is progressing the Heytesbury Underground Gas Storage (HUGS) Project near Port Campbell in south-west Victoria. The project aims to increase the underground gas storage capacity of the Iona Gas Plant, through the development of the Mylor Field. The scope of the project includes construction of a new 5.3 km DN300 gas pipeline along with DN50 mono-ethylene glycol (MEG) pipeline and fibre optic cable. The pipeline will extend from the North Paaratte Production Station and Meter Station to the MFCT wellsite, via the North Paaratte wellsite.

The two pipelines will be designed, constructed and operated in accordance with AS(/NZS) 2885 *Pipelines—Gas and liquid petroleum*. AS/NZS 2885.6, *Part 6: Pipeline safety management*, requires that a robust Safety Management Study (SMS) is prepared for the pipeline, addressing any threats to the pipeline integrity and identifying how they are controlled. The overarching objective of the SMS is to demonstrate that residual risk to the public and the environment is As Low As Reasonable Practicable (ALARP).

The project is currently at Front End Engineering Design (FEED) stage. This report documents the pipeline SMS prepared as part of the FEED design, per AS/NZS 2885.6 §5.4.3.

1.2 WORKSHOP REVIEW

The SMS was validated at a workshop on Thursday, 5th October 2023, at Lochard Energy office in Melbourne.

The SMS was attended by the following personnel:

Table 1 : Workshop attendees

Name	Company	Position
Nick Kastelein	GPA Engineering	Lead Mechanical Engineer; *SMS facilitator*
Brad Sayer	Long Energy	Pipelines manager; *Pipeline engineer lead*
Wilson Preece	Long Energy	Graduate pipeline engineer
Chris Lawson	Long Energy	Managing director; *Project manager*
Liam Hatchell	Long Energy	General manager – Brisbane operations; *Principal pipeline engineer*
Susie Bartlett	Lochard Energy	Stakeholder and approvals manager
Rajesh Unnikrishnan	Lochard Energy	Asset engineer
Andrew Wood	Lochard Energy	Pipeline engineer; *Owner's engineer*
Giani Lucchi	Lochard Energy	Engineering manager – HUGS development
Hannah Prosser	Lochard Energy	HSE manager
Matthew Eddy	Lochard Energy	Process engineer
David Kristitz	Lochard Energy	Lead engineer HUGS project
Anthony Curtis	MVC	GIS support

Where supplementary positions are shown in italics, these refer to the individual's project role.

1.3 ABBREVIATIONS

The following table provides definitions of terms used in this document.

Table 2 : Abbreviations

Abbreviation	Meaning
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
AS	Australian Standard
ASME	American Society of Mechanical Engineers
BYDA	Before You Dig Australia
CCTV	Closed Circuit Tele-vision
CP	Cathodic Protection
DCVG	Direct Current Voltage Gradient
DN	Nominal Diameter
EI	External Interference
EIP	External Interference Protection
FBE	Fusion-Bonded Epoxy
FEED	Front-End Engineering Design
FJC	Field Joint Coating
FOC	Fibre-Optic Cable
GIS	Global Imaging System
HBE	High-Build Epoxy
HDD	Horizontal Directional Drill
HFW	High-Frequency Welded
HUGS	Heytesbury Underground Gas Storage
ILI	In-Line Inspection
JHA	Job Hazard Analysis
LE	Lochard Energy
LOPA	Layer of Protection Analysis
3LPE	Three-Layer Polyethylene
MAOP	Maximum Allowable Operating Pressure
MEG	Mono-Ethylene Glycol
MFCT	Mylor, Fenton Creek and Tregony
MIJ	Monolithic Isolation Joint
MOP	Maximum Operating Pressure
NPMS	North Paaratte Meter Station
NPPS	North Paaratte Production Station
NZS	New Zealand Standard

Abbreviation	Meaning
OHL	Over-Head Line
PIMP	Pipeline Integrity Management Plan
PPE	Personal Protective Equipment
PPL	Petroleum Production Licence
PRCI	Pipeline Research Council International
PTW	Permit To Work
ROW	Right of Way
SCC	Stress Corrosion Cracking
SMLS	Seamless
SMS	Safety Management Study
TBC	To Be Confirmed

2 DN300 NATURAL GAS PIPELINE OVERVIEW

2.1 DESIGN SUMMARY

The details of the pipeline are summarised as follows:

Table 3 : Design summary – Raw gas pipeline

Variable	Value
Design standard	AS/NZS 2885.1—2018
Maximum allowable operating pressure (MAOP)	16 MPag
Maximum operating pressure (MOP)	14.5 MPag
Design temperature range	-20 to 70 °C, including transients
Fluid	Natural gas – • Odorised sales quality (injection) • Wet raw gas (withdrawal)
Length	Approx. 5.3 km
Thickness allowance(s)	1.5 mm
Diameter	323.9 mm (DN300)
Wall thickness	12.7 mm
Steel specification	API 5L
Steel type	High frequency welded (HFW)
Steel grade	X65M
Specified minimum yield strength	435 MPa (derated for 70°C)
Actual design factor	0.53
Factory-applied coating	Dual-layer fusion-bonded epoxy (2FBE)
Field joint coating	High-build epoxy (HBE), type 4A
HDD coating	Denso bore-wrap, or similar TBC

2.2 FAILURE MODES

2.2.1 Resistance to penetration

Resistance to penetration determines whether some external interference threats (i.e. when the pipeline is struck by mechanical equipment such as an excavator) will result in a dent/gouge, or a leak. Coating damage and surface damage such as a dent or gouge are not considered to be “failure threats” under AS/NZS 2885.6.

The Resistance to Penetration was assessed according to AS/NZS 2885.1 Appendix E. Results with a B-factor of 0.75 have been applied because this pipeline does not include high-consequence areas (see Section 4.3).

The conclusions are summarised as follows, in terms of machine weight in tonnes:

- Excavators with general purpose teeth – no cases penetrate (> 55t)
- Excavators with tiger teeth – no cases penetrate (> 55t)

- Rippers with penetration teeth – penetration for machinery exceeding 15t weight.

2.2.2 Critical defect length

If a hole is created in the pipeline, it will either leak or rupture. The pipeline will rupture if the hole exceeds a critical length in the axial direction so that the stress due to internal pressure is able to cause the pipeline to burst.

The critical defect length for the pipeline has been calculated as 137 mm. Only external interference threats that create an axial defect longer than 137 mm are expected to lead to pipeline rupture. This assessment is based on the pipeline material having a Charpy V-Notch toughness of at least 40 J.

2.2.3 Fracture propagation

Fracture propagation has been assessed for the pipeline in ductile conditions. Fracture arrest is expected provided the Charpy V-Notch toughness exceeds about 31 J. Consequently, the project has specified 40 J for the pipe specification. This assessment was conducted at the MAOP of 16 MPag, which means it is also conservative for the actual operating conditions.

Brittle fracture propagation may occur if the pipeline is cooled below the brittle-ductile transition temperature for arrest toughness. The pipe is specified to exhibit ductile behaviour down to at least -20°C, which will be demonstrated by Drop-Weight Tear Tests.

Consequently, propagating fracture is controlled and will not occur in any conditions.

2.3 CONSEQUENCE SEVERITY

Consequence under AS/NZS 2885.6 falls into three categories:

People (Safety) – pipeline failures present a safety hazard to people in the vicinity of the release. This hazard is most severe if ignition occurs. Ignition does not occur in all circumstances; according to AS/NZS 2885.6, ignition is expected in under 5% of small leaks, and less than 10% of ruptures, for pipes DN400 and smaller.

Consequence modelling has been used to estimate the safety consequence distances for different leak scenarios. These are summarised as follows:

Table 4 : Energy release scenarios

Release scenario	Energy release rate	Fatality threshold – 12.7 kW/m^2	Injury threshold – 4.7 kW/m^2
Full-bore rupture	51.0 GJ/s	270 m	440 m
90 mm hole	5.3 GJ/s	91 m	154 m

Note that the measurement length (refer Section 4.1) for a full-bore rupture is defined by AS(/NZS) 2885 as the injury threshold distance (4.7 kw/m^2 contour).

Supply – The pipeline does not provide a critical single supply point to the downstream network. The pipeline can also be isolated, so that it will not cause any more widespread impacts to the delivery system in the event of a leak. Consequently, supply consequence will never have a severity greater than *Minor*.

Environment –The pipeline contains “natural gas” which is predominantly sales quality gas that is injected into the storage reservoir, but when withdrawn may also other contain other components

present in the reservoir being water, hydrocarbon condensate and MEG. If a loss of containment occurs, the majority of the contents which are buoyant will readily disperse. However, water and hydrocarbon condensate will spill to grade and will require clean-up from the area surrounding the release. The impact will be localized and typically require short-term rectification (weeks, not years). Consequently, if ignition does not occur, environmental outcomes are *Minor*, per AS/NZS 2885.6 Table 3.1. Should ignition occur, environmental damage will consist of a region of fire-damaged land that will also require rectification. This is also expected to take a matter of weeks and hence is considered *Minor*.

Environmental consequences are less severe for this pipeline than potential safety outcomes, hence were neglected for this FEED-stage SMS assessment, though it is recommended that the environmental consequence category is captured in any future quantitative risk assessments (e.g. Layer of Protection Analyses) in future project phases.

Other – other consequence categories may apply to pipeline incidents, such as reputation, financial, regulatory, and similar. These are not assessed within the Safety Management Study, as they are not part of the defined assessment required under AS/NZS 2885.6, but they may be assessed separately by the design using custom/corporate risk matrices.

3 DN50 MEG PIPELINE OVERVIEW

3.1 DESIGN SUMMARY

The details of the pipeline are summarised as follows:

Table 5 : Design summary – MEG pipeline

Variable	Value
Design standard	AS/NZS 2885.1—2018
Maximum allowable operating pressure (MAOP)	16 MPag
Design temperature range	0 to 65 °C
Fluid	Mono-ethylene glycol (MEG)
Length	Approx. 5.3 km
Thickness allowance(s)	Nil
Diameter	60.3 mm (DN50)
Wall thickness	5.54 mm
Steel specification	API 5L
Steel type	Seamless (SMLS)
Steel grade	Grade B
Specified minimum yield strength	240 MPa (no derating)
Actual design factor	0.363
Factory-applied coating	3-layer poly ethylene (3LPE)
Field joint coating	Heat-shrink sleeve **HOLD**
HDD coating	Dirax sleeve **HOLD**

3.2 FAILURE MODES

3.2.1 Resistance to penetration

The Resistance to Penetration was assessed according to AS/NZS 2885.1 Appendix E. Results with a B-factor of 0.75 have been applied because this pipeline does not include high-consequence areas (see Section 4.3).

The conclusions are summarised as follows, in terms of machine weight in tonnes:

- Excavators with general purpose teeth – no cases penetrate (> 55t)
- Excavators with tiger teeth –
    - On tooth penetrates > 15t
    - Two teeth penetrate > 40t
- Rippers with penetration teeth – penetration for all assessed cases (5t and above).

It should be noted, however, that the assessment is designed for larger diameter pipes. DN50 pipe may more readily be crushed or deflected than large pipe, without forming a hole.

3.2.2 Critical defect length

The critical defect length for the pipeline has been calculated as 83 mm. However, this exceeds the diameter of the pipe and is outside the range of validity of the assessment. In practice, it is expected that this pipeline would be “no rupture”. That is, under no conditions will a release result in burst of the pipe. This is supported by the low design factor.

3.2.3 Fracture propagation

Fracture propagation is not credible for a MEG pipeline, as it carries a stable liquid, which decompresses very rapidly and cannot drive a propagating ductile fracture.

3.3 CONSEQUENCE SEVERITY

Consequence under AS/NZS 2885.6 falls into three categories:

People (Safety) – MEG does not pose a safety threat as it is not flammable.

Supply – A loss of supply of MEG may result in a requirement to shut down the gas pipeline also, because the MEG is intended to protect against top-of-line corrosion and hydrate formation. However, the supply impacts remain at most *Minor*.

Environment – MEG is miscible in water and biodegradable and it has only a limited, short-term and localised impact on fauna. Note that, if released into a water stream, it will have more widespread exposure (e.g. to water animals and animals drinking), yet it will also be diluted/dispersed more rapidly. The impact will be localised, and rectification will be in a time-frame of days. Hence, the environmental consequence per AS/NZS 2885.6 Table 3.1 in this area is considered to be at most *Minor*.

4 LOCATION CLASSIFICATION

4.1 PIPELINE ROUTE

The pipeline route is shown in Figure 1 below. The figure also marks the area that is within the DN300 pipeline "measurement length" of 440 m—that is, where the radiation intensity for a full-bore rupture would exceed the nominal 'injury' threshold of 4.7 kW/m^2. The land use within this area is used to identify the pipeline location class.

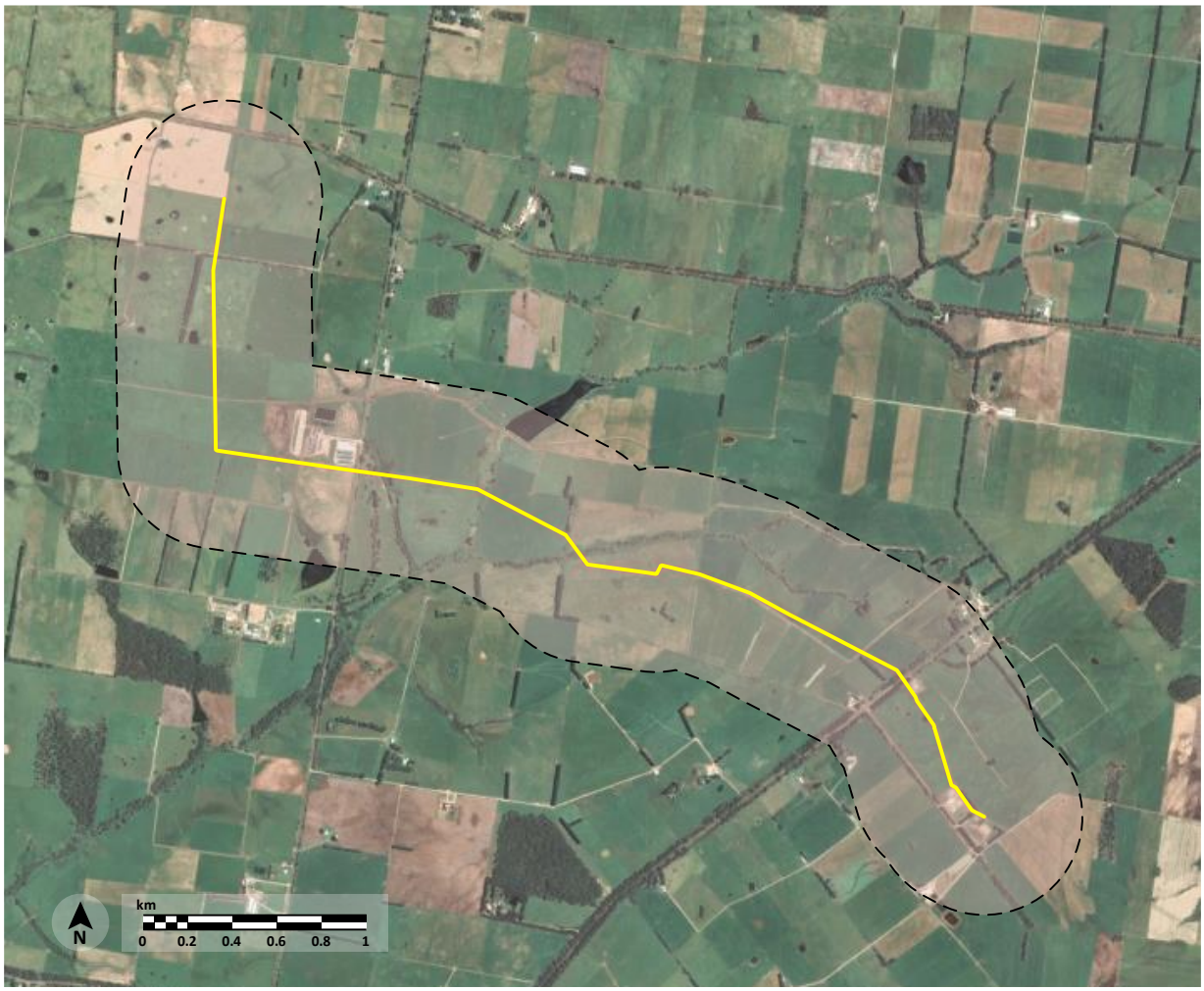

Figure 1 - Pipeline route map with "measurement length" contour

4.2 LOCATION CLASS

Location classification is required in accordance with Section 2 of AS/NZS 2885.6. The primary location class is determined based on the density of dwellings within the measurement length. The location class of the whole pipeline was determined to be:

- *Rural, R1* – "Land that is unused, undeveloped or is used for rural activities such as grazing, agriculture and horticulture. Rural applies where the population is distributed in isolated dwellings. Rural includes areas of land with public infrastructure serving the rural use (e.g. roads, railways, canals, utility easements)."

Additionally, the SMS workshop considered whether any secondary location classifications may apply. The workshop considered the application of Industrial (I) at the dairy facility, which has approximately 5 people working on site during work hours, and Common Infrastructure Corridor (CIC), where the pipeline parallels other pipelines.

However, the workshop agreed that no locations on the pipeline warranted the designation of any secondary location classes. The dairy and the parallel infrastructure should nevertheless be considered in the threat assessment.

4.3 HIGH CONSEQUENCE AREAS

Due to the above location classification, the pipeline does not include any “high consequence areas” per AS/NZS 2885.1 §4.9.

5 EXTERNAL INTERFERENCE THREATS

External interference (EI) threats are incidents in which a pipeline is struck by equipment due to digging activities above the pipeline. External interference threats are assessed through the safety management process, and are controlled in accordance with the External Interference Design requirements of AS/NZS 2885.1 §5.4.

5.1 EXTERNAL INTERFERENCE CONTROLS

There are a range of controls for EI threats applied in the HUGS pipeline design, under the categories defined in AS/NZS 2885.1 §5.4. These are summarised in the following tables.

Table 6 : Physical EIP controls

Separation	
Burial	The gas pipeline is buried with minimum 900mm of soil cover at all trenched locations. 1,200mm cover is applied at: • Fences • Drains and roads • Watercourses • Pipeline facilities The MEG pipeline may be installed with only 750mm cover in some locations, if trench Type B is applied. **ACTION** – Confirm MEG pipeline depth of cover in detailed design.
Burial	At foreign service crossings, the pipeline will be installed at least 600mm deeper than the other service.
Exclusion	The pipeline end-of-line facilities are fenced and locked to prevent uncontrolled access.
Barrier	Within facilities, the pipe is separated from trafficable vehicle routes, including by the use of bollards. **ACTION** – Confirm installation/location of bollards in facilities as part of future design review.
Barrier	**ACTION** – Consider installation of vehicle crash barrier at NP45.
Resistance to penetration	
Wall thickness	The wall thickness of the pipelines provide resistance to penetration, as described in Section 2.2.1. (Note: there is no heavy-wall pipe variant on this pipeline).
Barrier to penetration	Protection slabbing will be installed on any drains with less than 1,200 mm soil cover, and at buried service crossings, between the two services.

Table 7 : Procedural EIP controls

Pipeline awareness	
Marking	Marker signs will be installed intervisible for the whole trenched portion of the route, with minimum 500m spacing, and: • At every *property boundary* fence • At service crossings • On both sides of roads • On one side of tracks and creeks Note that in the Spring Creek HDD section, intervisibility may not be achieved.
Marking	Marker tape will be buried above the pipelines at: • Trenched road crossings, and • Trenched watercourses. **ACTION –** Revise design to install marker tape for the entire extents of trenched construction on the pipeline route. Also, identify what will be written on the marker tape, as there are three services in the trench.
One-call service	The pipeline route will be registered with Before You Dig Australia (BYDA). Alerts will be directed to the Iona control room. **HOLD –** Identify Lochard Energy internal procedure for responding to BYDA alerts.
Landowner Liaison	Landholder – Annual letter, six-monthly visit **HOLD** – Confirm interval of landowner in-person visits.
Third Party Liaison	Various liaison programmes will be used, including: • Community – 3 times per year, including landowner representatives • Utility companies • Corangamite Shire council • Emergency services – annual
Activity agreements	Co-use agreements are planned for overlapping easements: • APA SW pipeline • Beach energy HBW pipeline • Mylor pipeline (decommissioned) • Epic Energy buried HV cable from Timboon West Wind Farm • PowerCorp overhead powerline easements Note that telecom are excluded from these co-use agreements. **ACTION** – Include 'best endeavours to notify' clause in co-use agreements.

External interference detection	
Planning notification zones	**ACTION**: determine if these are in place for Corangamite Shire Council.
Patrolling	Patrolling is conducted on the following basis: • 3-monthly vantage-point ROW checks • Annual ground-based patrol • 5-yearly aerial satellite imagery • Ad-hoc surveillance of facilities on routine site attendance; approx. fortnightly. **HOLD** – reference and work procedures
Remote intrusion monitoring	CCTV will be installed at each fenced facility, which is monitored from the Iona control room.

5.2 THREAT IDENTIFICATION

Threats were identified by an assessment of the land use and crossings on the pipeline, and are also based on the long-term experience of workshop personnel for similar pipelines in the area. The following threats were identified:

5.2.1 Roads and drains

Three threats were identified associated with road crossings, which were all assessed as 'controlled'.

Construction of new roads is considered unlikely, because there are no gazetted roads not yet built, and there are already two sealed roads in the area. Should new road construction occur, it generally involves shallow earthworks activities – grading, dozing and compacting. Excavation is only needed down to the depth of the pipeline if the soil is soft, in order to provide a compactable base; or if needed for levelling ground contours that are not currently trafficable. The pipeline has resistance to penetration for relevant excavation equipment that may be used to dig away to the pipeline's depth.

Unlike construction, road maintenance is a shallow surface activity that involves grading and dozing, and drain clearing. At these locations, the pipeline has at least 1,200 mm cover, or protection slabs, so burial is an effective physical control.

Additionally, the SMS considered the threat of uncontrolled vehicles leaving the road and impacting with the facility. This is considered controlled because the facilities are fenced, and there is separation from the adjacent public roads.

5.2.2 Utilities

The construction and maintenance of third-party utilities present a range of threats, which vary depending on the method of construction.

Installation of buried assets can be conducted using shallow or deep trenched construction, mini or maxi HDDs, or cable-ploughs. The assessment concluded that only maxi-HDD and cable-ploughs using dozer rippers posed a failure threat, because they are capable of penetrating the pipe wall, and may be installed at the same depth of the pipeline. These were both subject to a risk assessment.

Maintenance of buried assets involves excavation to expose the assets; typically small (5 to 10 t)

excavators are used, with flat (mud) buckets or general purpose teeth, which cannot penetrate the HUGS pipeline. Upon initial construction, the HUGS pipeline will be installed *below* all existing third-party assets, and there will be at least 600 mm cover and protection slabs between them to control the threat. If new assets are installed in the future, especially below the HUGS pipeline, these will require a new threat assessment for foreign buried service maintenance.

Lastly, some powerlines are installed above-ground and across the HUGS pipeline. New power-poles, or replaced/relocated power-poles on the existing pipeline, could be installed above the pipeline using augers, and the drill bit could strike the pipe and result in a leak or rupture. This was assessed as a failure threat and subject to risk assessment.

5.2.3 Agricultural land use

Many agricultural activities involve shallow ground-breaking activities, such as ploughing, installing irrigation water lines, constructing farm tracks, installing minor drains, star-pickets, regular fence-posts, planting trees, and similar. These are unable to damage the pipeline because they are too shallow and the pipeline has adequate wall thickness to resist penetration from this equipment.

Landowners in the area may use deep trenching and ploughing, however, for the installation of mole-drains. The header pipes are installed to depths of 2m. They are unlikely to be conducted above the HUGS pipeline, because the terrain is not undulating with sufficiently large hills.

ACTION – Confirm with landowners that no mole drains are planned in the area.

Fence strainer-posts are installed at fence corners and adjacent to gates, to take the strain of the fence wires. They are typically installed using pendulum augers, to a depth of about 1,200 mm, which will exceed the pipeline depth in some locations.

Large tree removal may also involve excavation deeper than the pipeline cover, but this is not credible because large trees are not permitted to grow above the pipeline.

Some deeper excavation may also be conducted for levee construction and dam contouring. Due to the soil conditions, only general-purpose teeth would be used for the excavating, so the pipeline wall thickness has sufficient resistance to penetration.

5.2.4 Vertical drilling

Vertical drilling may be conducted for the construction of water bores, geotechnical survey bores, or oil and gas industry exploration and production wells. In each case, they are a well-regulated activity. Constructors of oil and gas wells are especially likely to be aware of the HUGS pipeline, because it would be a candidate for transporting their product.

In locations where the HUGS pipeline has been installed by trenching, it is most likely that the pipeline would be detected during setup of the drill surface casing and general earthworks for the drill-site (by exposure of the pipeline marker tape). In locations where the HUGS pipeline is installed by HDD, this control does not apply—though sections installed by HDD are also less likely to be candidates for drilling.

Deep drilling equipment is designed to drill through a wide variety of soil and rock. As a result, it is capable of penetrating the pipeline, and would be expected to result in a leak. This presents a safety risk to personnel working on the drill rig.

Due to the lack of effective physical controls, the threat of drilling was subject to risk assessment.

HOLD – Identify which government regulations govern / regulate the installation of new water or geotechnical bores.

5.2.5 First-party activities

Three first-party activities were identified that present external interference threats.

The first is exposure of the buried pipeline for direct inspection. This is conducted to procedures that limit the use of mechanical equipment directly adjacent the pipe. Additionally, the equipment used is light-weight – typically 5 to 10 tonnes – and incapable of penetrating the pipe material.

The second risk is vehicle impacts within the facility from owner or contractor vehicles. Vehicle impacts do not pose a material risk for the main pipe runs but could damage small-bore connections. This threat is controlled where needed (based on facility trafficable routes) by the installation of bollards.

Finally, if lifting is conducted in the facilities, then there is a risk that dropped objects could also damage small-bore connections. No physical controls apply to this threat, so it was subject to risk assessment. Note, when future lifts are conducted, it is usual that a risk assessment (e.g. JHA) will lead to physical controls being used to prevent damage from dropped objects.

5.3 RISK ASSESSMENTS

The following threats were identified as uncontrolled failure threats and were subject to risk assessment. In most cases the expected failure mode is a pipeline leak – rupture is not expected except as a possible outcome of cable plough strike.

E-007 | Use of Maxi-HDD for buried service installation
The consequence of a strike in a HDD is a leak at the location of the strike, which may cause the drilling mud and string to be pushed back out the drill-hole. The consequence is assessed as *Minor*. Additionally, because major projects are well-regulated, the likelihood of this consequence was considered to be *Hypothetical*.

ACTION – Confirm risk assessment for HDD operations.

E-008 | Use of cable-plough for fibre-optic cable installation
A cable-plough strike could result in fatality of the operator, particularly if ignition of the gas occurs. Consequently the consequence was assessed as *Major*. The likelihood is preliminarily assessed as Remote. A Layer of Protection Analysis (LOPA) is recommended to analyse the likelihood and assess the control effectiveness.

ACTION – Conduct risk assessment of cable-plough strike through a Layer of Protection Analysis.

E-011 | Relocation or installation of power-poles
A leak due to an auger strike presents a hazard to the operator of the auger, which would at worst be a fatality (if ignition occurs). The likelihood, however, was assessed as *Hypothetical*, due to the low frequency of the activity, particularly because of the distance of the pipeline from existing power poles.

ACTION – Confirm power-pole distances and crossing locations, and frequency of future installation. Consider use of protection slabs at wire crossings in case of pole relocation.

E-019 | Water or geotechnical bore drilling
E-020 | Gas or oil well drilling

A leak due to a drilling strike is most likely to be comparatively small (and not rupture) due to the cutting action of the bit. The consequence was assessed as *Severe*, as an injury could occur among the drill crew. The likelihood was assessed as *Hypothetical* due to the high effectiveness of procedural controls for this well-regulated activity.

E-022-FAC | Dropped objects in facilities
Dropped objects are likely to result in, at most, an injury. Personnel are excluded from the lifting radius, and the operation is already conducted in controlled circumstanced (i.e. according to Lochard Energy procedures). Hence, the consequence is assessed as *Severe*. The likelihood of this outcome was considered to be *Remote*, as the initiating event is rare (mostly, lifting over pipe can be avoided) and procedural controls are strong, yet dropping of objects does occur.

Table 8 : Risk assessments of EI threats

No.	Threat description	Consequence	Frequency	Risk class
E-007	Maxi HDD	Minor	Hypothetical	Negligible
E-008	Cable plough for fibre-optic	Major	Remote	Intermediate
E-011	Vertical auger for power-pole	Major	Hypothetical	Low
E-019	Drilling for water / Geotech	Severe	Hypothetical	Negligible
E-020	Drilling for oil / gas	Severe	Hypothetical	Negligible
E-022-FAC	Dropped objects	Severe	Remote	Low

6 OTHER THREATS

6.1 CORROSION

Corrosion is controlled for the HUGS pipelines. The pipelines are designed to mitigate both internal and external corrosion. No corrosion threats required risk assessment.

External corrosion is controlled by applying modern pipe coatings. A cathodic protection (CP) system provides a secondary control for locations where the coating fails. The CP system is common for the two pipelines, and will be surveyed on a six-monthly basis to confirm that it is providing voltage, in the correct range, all along the pipeline. Coating defects will be detected by direct-current voltage gradient surveying (DCVG). Corrosion that occurs in the gas pipeline may be detected by in-line inspection tools. The MEG pipeline is not expected to be pigged, but the design includes provision for future installation of pig barrels.

ACTION – Review whether the project will conduct a benchmarking ILI of the gas pipeline at the conclusion of construction.

Above-ground piping is also protected from external corrosion. In this case the pipe is coated, but it is not protected using cathodic protection. Above-ground piping is visually inspected at routine facility inspections, and may be detected at any time during ad-hoc site attendance.

Pipeline risers have a particular vulnerability to corrosion at above-/below-ground transitions.

ACTION – Confirm coating design at above-/below-ground transition locations.

Internal corrosion is controlled for the DN300 pipeline when it is flowing in withdrawal, by means of injection of MEG into the raw gas stream. The pipeline also has a 1.5 mm corrosion allowance due to this internal corrosion potential. Additionally, the MEG stream is sampled routinely to detect corrosion products.

ACTION – Confirm the MEG sampling requirements for the PIMP, and that these are applied to existing similar pipelines in the area.

Internal corrosion of the MEG pipeline, internal erosion, and sulphide stress cracking were all assessed as non-applicable.

Finally, electrical currents can be a contributor to corrosion due to compromising the cathodic protection design, and high-voltage fault discharges can be a cause of coating defects (similar to lightning). This will be taken into account in the CP design.

ACTION – Define and assess the electrical and corrosion-related threats associated with the Epic Energy HV cable crossing.

ACTION – Address general pipeline electrical safety in detailed design.

6.2 NATURAL EVENTS

Several natural events were identified that present a threat to the pipeline.

Bushfire, wind and seismic events present a threat particularly to above-ground facilities. These are controlled by limiting vegetation around the facility (particularly avoiding large trees), and designing the facilities to Australian design codes AS 1170.2 and 1170.4.

The buried pipeline is also vulnerable to waterway erosion and landslip. The most likely location for this would be where a large dam is situated north of the pipeline route. The pipeline will be designed to have over-matched welds, so that the pipe has capacity for some strain. In that case, though the pipeline may deflect if those threats eventuate, it is not expected to fail resulting in a loss of containment.

Tree root damage to the pipe coating was also considered. The initial pipe route will avoid large trees. This threat is then controlled in the future by managing the vegetation on the pipeline Right of Way (ROW) so that no mature trees develop.

ACTION – Confirm negotiation for avoidance/removal of large trees on the RoW.

Lastly, two natural event threats were considered non-credible. Flotation of the pipe due to groundwater cannot occur after construction, as the soil is sufficient to prevent flotation. Additionally, wildlife such as wombats digging above the pipe and damaging the coating was not considered credible in this location.

6.3 OTHER CATEGORIES

Several other threat categories are defined under AS/NZS 2885.6, which were not assessed in this FEED-stage SMS. These include:

- Intentional damage
- Materials
- Design
- Construction
- Operation
- Maintenance
- Management

These shall be assessed at SMS workshops for future design phases.

6.4 RISK ASSESSMENT

Only one non-EI risk has been subject to a risk assessment. Lightning strikes are capable of causing loss of containment on buried pipelines. These result in a pin-hole leak where a plug of metal has been melted and then blown out by internal pressure. Such a leak is unlikely to result in any injuries, because it happens in a random/remote location. Consequently, the threat is assessed as *Trivial*. The likelihood is assessed as *Unlikely*, because this is known to occur, though it does not occur on most pipelines.

Table 9 : Risk assessments of EI threats

No.	Threat description	Consequence	Frequency	Risk class
N-004	Lightning	Trivial	Unlikely	Negligible

7 HYDROGEN COMPATIBILITY

7.1 HYDROGEN READY DESIGN

Potential future hydrogen-carrying is a consideration in the design of the HUGS pipeline. A hydrogen-ready design alternative has been proposed, which primarily appeals to the requirements of American Society of Mechanical Engineers (ASME) standard B31.12.

The following line-pipe specification modifications have been proposed for a hydrogen-ready design (among other things):

Table 10 : Design summary – Hydrogen-ready raw gas pipeline option

Design element	Hydrogen-ready	Original
Grade	X60	X65
Wall thickness	13.2 mm	12.7 mm
Design code	ASME B31.12 Fracture control Option B	AS 2885.1

If this is adopted, then the implication for immediate operation is that the design is safer than was proposed.

1. Resistance to penetration increases due to an increase in wall thickness, and
2. Critical defect length increases due to increased wall thickness.

7.2 EFFECTS OF HYDROGEN

Hydrogen-operation will also impact the Safety Management Study, adding new threats and changing assessment outcomes. The main impacts of hydrogen operation are noted as follows:

3. Hydrogen embrittlement – a decrease in material toughness when the material is exposed to hydrogen may *decrease* the critical defect length. It will also increase the vulnerability of the pipeline to any weld or construction defects. On this basis, hydrogen pipelines may have tighter weld tolerances, and also may be intentionally hydrotested at a higher pressure than natural gas.
4. Hydrogen-assisted fatigue crack growth – the pipeline may be more sensitive to fatigue crack growth, because hydrogen causes an acceleration of fatigue. This particularly means that if the pipeline will be operated in cycling manner (cycling pressure or cycling temperature), which is likely for operation as a storage facility, gradual crack growth to failure will occur more rapidly for hydrogen service than natural gas.
5. Likelihood of ignition – Hydrogen is more volatile than natural gas. It has a lower ignition energy, and hence is more readily ignited. In fact, because of high flow velocity upon release, it is possible that hydrogen will self-ignite by exceeding auto-ignition temperature in the initial pressure shock. The likelihood of ignition in hydrogen service is typically taken as 100%, resulting in an order of magnitude increase in 'likelihood' that must be factored into risk assessments of ignited releases.
6. Consequence modes – Hydrogen has a higher flame-speed than natural gas, and hence the moment of ignition may be more explosive. Hydrogen cloud explosion may even trigger a

hydrogen detonation, if there is congestion or a pressure shock initiates the explosion. This means that, in addition to the safety consequence from *radiation*, there is a safety consequence from *over-pressure waves*. There is not currently much information regarding this additional consequence mode, but it has potential to be worse than natural gas in like-for-like situation comparisons.

Some factors are also *not* affected by hydrogen, and hence will not alter the SMS conclusions:

1. Resistance to penetration is not considered to be affected by hydrogen, because it depends on material strength, rather than material toughness. (Material strength is not expected to change for pipeline steels under exposure to gaseous hydrogen).
2. Measurement length is not significantly altered by hydrogen, apart from small increase or decrease depending on the calorific value of the natural gas it is being compared to (which applies for all radiation contours). This is because, though the volumetric flow-rate of hydrogen from a release is greater (about 3x), the volumetric energy density is lower (about 1/3), and the two effects cancel each other out.

Note that 16MPa pressure and material strength of X60 are both high relative to historical hydrogen experience (according to the appendices of ASME B31.12). Future conversion will require careful analysis.

8 CONCLUSION

The FEED-stage SMS for the HUGS pipeline was prepared, with a focus on external interference, natural events and corrosion threats, and validated in a workshop. The SMS showed that the FEED design addresses most identified threats. The SMS will be further developed and expanded in the detailed design.

Some threat assessments were subject to a risk assessment. Of these, the risk of a cable-plough strike is recommended to be analysed using a quantitative risk assessment, to refine the likelihood categorisation.

Several actions were raised at the SMS validation workshop. These actions are summarised as follows:

Table 11 : SMS consolidated actions list

#	Action	Responsible party
1	**Landowner mole-drain planning** Confirm with landowners that no mole drain installation is planned in the area.	
2	**HDD risk** Post-workshop, confirm the risk assessment of horizontal directional drilling striking the HUGS pipeline.	
3	**Dozer ripper assessment** Conduct a Layer of Protection Analysis (LOPA) to assess the risk from a strike by a cable plough.	
4	**Vehicle crash barrier.** Consider installation of a vehicle crash barrier at NP45.	
5	**Bollard installation / location review** Review bollard placement in facilities as part of design review.	
6	**Microbial monitoring of MEG** Confirm microbial monitoring is included in the pipeline integrity management plan (PIMP) for current Lochard Energy pipelines, and will be included in the PIMP for the HUGS pipeline.	
7	**Power-pole review** Confirm locations of existing powerpole lines relative to trenched locations. Consider frequency of future powerpole installations. Consider installation of protection slabs at wire crossings, if pole relocation at that location is possible.	
8	**Trench type – MEG depth of cover** Confirm minimum depth of cover for the MEG pipeline as part of detailed design (determine which trench type/layout is used).	

#	Action	Responsible party
9	**Marker tape installation** Revise design to install marker tape for the entire extents of trenched construction. Additionally, finalise the writing that will be on the marker tape, as there are three different services installed in the trench: gas pipeline, MEG pipeline, and fibre-optic cable.	
10	**Co-use agreements** Include 'best endeavour to notify' clause in the co-use agreements.	
11	**Transition coating** Confirm the transition coating solution in the field joint coating specification.	
12	**Electrical safety** Address electrical safety threats during detailed design.	

APPENDIX 1 SMS DATABASE OUTPUT

DB File Name:	LE HUGS Pipeline - FEED SMS Rev 1.db
Pipeline System Name:	
Originator	GPA 230708
Revision:	Nick Kastelein
Date:	05/10/2023
Location:	Lochard Energy, Melbourne

Contents

Pipelines and Sections

Pipelines

Name	Length	Design Life	Fluid	Operational Status	Year Constr.
HUGS Pipeline	5.26 km	25 yrs	Raw Gas		
MEG Pipeline	5.26 km	25 yrs	MEG		

HUGS Pipeline Sections

		Location Class:
000.000 - 005.260	**Whole pipeline**	R1

Land Use: Agricultural properties (predominantly dairy, grazing and cropping). These properties are well established.

Location Class Discussion: Sparse permanent population in vicinity of pipeline, qualifying as Rural R1 use. No conditions for secondary location classes apply.

Predominant Pipe Design: 1. DN300 Standard (Production Gas)

12.6 kW / m2 Radiation Contour: 270 m

4.7 kW/m2 Radiation Contour: 440 m

Minimum Burial Depth: 900 mm

MAOP: 16 MPag

MOP: 16 MPag

Maximum Operating Temperature: 70 °C

Minimum Operating Temperature: -20 °C

MEG Pipeline Sections

		Location Class:
000.000 - 005.260	**Whole pipeline**	R1

Land Use: Agricultural properties (predominantly dairy, grazing and cropping). These properties are well established.

Location Class Discussion: Sparse permanent population in vicinity of pipeline, qualifying as Rural R1 use. No conditions for secondary location classes apply. Note that consequence from MEG is less than the natural gas pipeline.

Predominant Pipe Design: 3. DN50 Standard (MEG)

12.6 kW / m2 Radiation Contour: 0 m

4.7 kW/m2 Radiation Contour: 0 m

Minimum Burial Depth: 750 mm

MAOP: 16 MPag

MOP: 16 MPag

Maximum Operating Temperature: 65 °C

Minimum Operating Temperature: 0 °C

Pipe Details

1. DN300 Standard (Production Gas)

Material Type / Spec:	API 5L X65M PSL2	**Outer Diameter:**	323.9 mm
Design Pressure:	16 MPag	**Wall Thickness:**	12.7 mm
Design Factor:	0.67	**Corrosion Allowance:**	1.5 mm
Design Min Temperature:	70 °C	**Manufacturing Tolerance:**	0 mm
Design Max Temperature:	-20 °C	**SMYS (de-rated if required):**	450 MPa
Main-line Coating:	DFBE	**Critical Defect Length (at MAOP):**	137 mm
Field-joint Coating:	Liquid epoxy (type 4A)		

Resistance to Penetration

Results for general use (B = 0.75):
Excavator – GP teeth, no cases (>55t)
Excavator – Tiger tooth, no cases (>55t)
Ripper – Penetration tooth >15t

Comments

Toughness: 40 J at -20°C (applies to all heats, all test units)

References:

84	UGS-MP-0115	DN300 AS2885 Wall thickness calculations
85	UGS-MP-0117	Energy release rate calculations
86	PRM-0021-UGS-MS-0049	Fracture control plan

2. DN300 HDD (Production Gas)

Material Type / Spec:	API 5L X65M PSL2	**Outer Diameter:**	323.9 mm
Design Pressure:	16 MPag	**Wall Thickness:**	12.7 mm
Design Factor:	0.67	**Corrosion Allowance:**	1.5 mm
Design Min Temperature:	70 °C	**Manufacturing Tolerance:**	0 mm
Design Max Temperature:	-20 °C	**SMYS (de-rated if required):**	450 MPa
Main-line Coating:	DFBE, Denso Bore-wrap or similar at HDD	**Critical Defect Length (at MAOP):**	137 mm
Field-joint Coating:	Liquid epoxy (type 4A)		

Resistance to Penetration

Results for general use (B = 0.75):
Excavator – GP teeth, no cases (>55t)
Excavator – Tiger tooth, no cases (>55t)
Ripper – Penetration tooth >15t

Comments

Toughness: 40 J at -20°C (applies to all heats, all test units)

References:

85	UGS-MP-0117	Energy release rate calculations
84	UGS-MP-0115	DN300 AS2885 Wall thickness calculations
86	PRM-0021-UGS-MS-0049	Fracture control plan

3. DN50 Standard (MEG)

Material Type / Spec:	API 5L Gr B PSL2	**Outer Diameter:**	60.3 mm
Design Pressure:	16 MPag	**Wall Thickness:**	5.54 mm
Design Factor:	0.36	**Corrosion Allowance:**	0 mm
Design Min Temperature:	0 °C	**Manufacturing Tolerance:**	0 mm
Design Max Temperature:	65 °C	**SMYS (de-rated if required):**	240 MPa
Main-line Coating:	3LPE	**Critical Defect Length (at MAOP):**	83 mm
Field-joint Coating:	Polymeric tape wrap (Type 2B)		

Resistance to Penetration

Results for general use (B = 0.75):
Excavator – GP teeth no cases (> 55t)
Excavator – Tiger tooth,
One tooth penetrates > 15t
Two teeth penetrate >40t
Ripper – Penetration tooth, all cases (<5t)
Note: Analysis is conservative for this small diameter, which have more potential for kinking, flattening, and deflecting.

References:

83	UGS-MP-0116	DN50 AS2885 Wall thickness calculations

5. DN50 HDD (MEG)

Material Type / Spec:	API 5L Gr B PSL2	**Outer Diameter:**	60.3 mm
Design Pressure:	16 MPag	**Wall Thickness:**	5.54 mm
Design Factor:	0.36	**Corrosion Allowance:**	0 mm
Design Min Temperature:	0 °C	**Manufacturing Tolerance:**	0 mm
Design Max Temperature:	65 °C	**SMYS (de-rated if required):**	240 MPa

Main-line Coating: 3LPE, dirax sleeve at HDD joints

Field-joint Coating: Polymeric tape wrap (Type 2B)

Critical Defect Length (at MAOP): 83 mm

Resistance to Penetration

Results for general use (B = 0.75):
Excavator – GP teeth no cases (> 55t)
Excavator – Tiger tooth,
One tooth penetrates > 15t
Two teeth penetrate >40t
Ripper – Penetration tooth, all cases (<5t)
Note: Analysis is conservative for this small diameter, which have more potential for kinking, flattening, and deflecting.

References:

83 UGS-MP-0116 DN50 AS2885 Wall thickness calculations

Typical Features Designs

TYP-001 Road Crossing Open Cut

Pipe Design: DN300 Standard (Production Gas)

Design Description: Minimum cover below road surface of 1200mm.
Protection slabs installed if reduced cover at drain inverts.
Marker signs at either side of road crossing, or on one side only for unsealed tracks.

Threat Assessments

E-002 Road and drain maintenance

References

75 UGS-MV-0672 - Road crossing | Typical detail

Actions

N/A

TYP-002 Road Crossing Bored

Pipe Design: DN300 HDD (Production Gas)

Design Description: Minimum cover below road surface of 1200mm.
Protection slabs installed if reduced cover at drain inverts.
Marker signs at either side of road crossing.

Threat Assessments

E-002 Road and drain maintenance

References

75 UGS-MV-0672 - Road crossing | Typical detail

Actions

N/A

TYP-003 Watercourse

Pipe Design: DN300 Standard (Production Gas)

Design Description: Minimum cover below creek bed of 1200mm.
Marker signs at one side of water crossing.
Trench breakers and buoyancy control as required.

Threat Assessments

N-005 Erosion in waterways
N-006 Flooding - Buoyancy

References

77 UGS-MV-0673 - Watercourse crossing | Typical detail

Actions

N/A

TYP-003 Watercourse - Bored

Pipe Design: DN300 HDD (Production Gas)

Design Description: Minimum cover below creek bed of 1200mm.
Marker signs at one side of water crossing.
Trench breakers and buoyancy control as required.

Threat Assessments

N-005 Erosion in waterways
N-006 Flooding - Buoyancy

References

77 UGS-MV-0673 - Watercourse crossing | Typical detail

Actions

N/A

TYP-004 Open Drain

Pipe Design: DN300 Standard (Production Gas)

Design Description: Minimum cover below creek bed of 1200mm.
Marker signs at one side of water crossing.
Trench breakers and buoyancy control as required.

Threat Assessments

References

77 UGS-MV-0673 - Watercourse crossing | Typical detail

Actions

N/A

TYP-005 Utility Below Ground - Crossing

Pipe Design: DN300 Standard (Production Gas)

Design Description: Marker sign installed at intersection.
Buried utility above pipeline.
Minimum clearance 600mm.
Protection slabs installed between the two services.

Threat Assessments

C-009 Stray Current Corrosion / CP system interference
E-009 Buried utility - Maintenance of shallow utilities
E-010 Buried utility - Maintenance of deep utilities

References

74 UGS-MV-0671 - Foreign service crossing | Typical detail

Actions

N/A

TYP-006 Pipeline Below Ground - Crossing

Pipe Design: DN300 Standard (Production Gas)

Design Description: Marker crossing at intersection
600mm clearance between services.
HUGS pipeline buried below other pipeline.
Protection slabs installed between services.

Threat Assessments

C-009 Stray Current Corrosion / CP system interference
E-009 Buried utility - Maintenance of shallow utilities
E-010 Buried utility - Maintenance of deep utilities

References

73 UGS-MV-0670 - Foreign pipeline crossing | Typical detail

Actions

N/A

TYP-007 Overhead Powerline

Pipe Design: DN300 Standard (Production Gas)

Design Description: No Typical drawing.
Marker sign installed at crossing point.

Threat Assessments

References

N/A

Actions

N/A

TYP-008 Agricultural land use

Pipe Design: DN300 Standard (Production Gas)

Design Description: Minimum depth of cover of 900mm.
Marker signs intervisible and at boundary fences.

Threat Assessments

E-012 Agricultural activities - Shallow ground-breaking activities
E-013 Agricultural activities - Trenching for mole-drain headers
E-015 Agricultural activities - Fence strainer posts
E-011 Above-ground utility - Power pole installation / replacement
E-019 Water / geotechnical bores - Drilling
E-014 Agricultural activities - Levee bank and dam contouring/ Landscaping

References

N/A

Actions

N/A

TYP-009-FAC Pipeline Facility

Pipe Design: DN300 Standard (Production Gas)

Design Description: Fenced and locked facility.
Minimum depth of cover of 1,200mm.

Threat Assessments

C-003-FAC	External Corrosion - Above Ground Piping
C-004-FAC	External Corrosion - AG/BG transitions
E-003-FAC	Vehicle impacts to facility piping
E-022-FAC	Vehicle movement inside facilities - Collision with pipework
N-007-FAC	Bushfire close to the facilities
N-003-FAC	Wind and Cyclone
E-023-FAC	Lifting in facilities - Dropped object

References

N/A

Actions

N/A

TYP-010 Standard trench

Pipe Design: DN300 Standard (Production Gas)

Design Description: Burial of two pipelines and optical fibre in common trench. Type A - side-by-side installation. Type B - vertical offset installation, with MEG at minimum 750mm cover.

Threat Assessments

References

76 UGS-MV-0139 - Pipeline trench | Typical detail

Actions

43 Open: Trench type - MEG depth of cover

Pipeline Features

HUGS Pipeline Features

KPs	Crossing No.	Name	Description	Owner	Typical Feature
0.000		End of Line	Tie in to the existing North Paaratte Pipeline	Lochard Energy	TYP-009-FAC
	Feature Category	Other			
	Pipe Design:	DN300 Standard (Production Gas)			
0.070		Wallaby Creek Flowline	Crossing buried gas flowline	Lochard Energy	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	High pressure natural gas			
0.170-0.650		North Paaratte Flowline	Parallel buried pipeline	Lochard Energy	TYP-006
	Feature Category	Parallel Service			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	High pressure natural gas			
0.200		North Paaratte Pipeline	Crossing gas pipeline	Lochard Energy	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	High pressure natural gas			
0.580		North Paaratte Flowline	Crossing gas pipeline	Lochard Energy	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			

KPs	Crossing No.	Name	Description	Owner	Typical Feature
	Design Comments:	High pressure natural gas			
0.620			Power-line crossing	N/A	
	Feature Category	OHL Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	22kV power distribution			
0.670		North Paaratte 4/5 offtake	North Paaratte 4/5 offtake	Lochard	TYP-009-FAC
	Feature Category	Other			
	Pipe Design:	DN300 Standard (Production Gas)			
0.710-0.775		Timboon-Peterborough Road	Road Crossing	Corangamite Shire	TYP-002
	Feature Category	Road Crossing			
	Pipe Design:	DN300 HDD (Production Gas)			
	Design Comments:	HDD / Bore			
0.760-0.780		Residential House	House within measurement length to the south of the pipeline, NW of Timboon-Peterborough Rd	Unknown	
	Feature Category	Other			
	Design Comments:	Residential House - Single Dwelling with Large Shed			
0.970		Track - Unsealed	Track - Unsealed	Lot Plan 26~1\PP3360 / Corangamite Shire	TYP-001

KPs	Crossing No.	Name	Description	Owner	Typical Feature
	Feature Category	Road Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Track - Unsealed Private			
1.100-3.050		Paaratte to Allansford pipeline	Parallel pipeline offset <100m	APA Group	
	Feature Category	Parallel Service			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Natural gas pipeline			
1.100-1.670		Halladale pipeline	Parallel pipeline offset <100m	Beach Energy	
	Feature Category	Parallel Service			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Natural gas pipeline			
1.700		Halladale Pipeline	Halladale Pipeline Crossing	Beach	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Halladale Pipeline Crossing			
1.970		Paaratte to Allansford	Paaratte to Allansford Pipeline Crossing	Lochard	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Paaratte to Allansford Pipeline Crossing			

KPs	Crossing No.	Name	Description	Owner	Typical Feature
2.370		Skull Creek	Skull Creek Crossing	Lot Plan 27~1\PP3360 / Corangamite Shire	TYP-003
	Feature Category	Watercourse Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Skull Creek Crossing			
2.870		Leech Creek	Leech Creek Crossing	Lot Plan 27~1\PP3360 / Corangamite Shire	TYP-003
	Feature Category	Watercourse Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Leech Creek Crossing			
2.870		Leech creek dam	Dam - approx. 300m offset	N/A	
	Feature Category	Other			
	Design Comments:	Dam upstream of Leech creek			
3.250-3.370		Creek - Typical	Creek HDD Crossing	Lot Plan 27~1\PP3360 / Corangamite Shire	TYP-003
	Feature Category	Watercourse Crossing			
	Pipe Design:	DN300 HDD (Production Gas)			
	Design Comments:	Creek Crossing HDD			
3.300-3.520		Boundary Road	Boundary Road Crossing - HDD	Corangamite Shire	TYP-002
	Feature Category	Road Crossing			
	Pipe Design:	DN300 HDD (Production Gas)			

KPs	Crossing No.	Name	Description	Owner	Typical Feature
	Design Comments:	Road Crossing HDD			
3.520-3.800		Dairy	Dairy property. Approx. 5 personnel on property during working hours.	N/A	
	Feature Category	Other			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Bury pipeline to 1,200mm within measurement length of dairy property.			
3.710		Track - Unsealed	Track - Unsealed	Lot Plan 1\TP7190	TYP-001
	Feature Category	Road Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Track - Unsealed Private			
3.825		Creek - Typical	Creek Crossing	Lot Plan 1\TP7190 / Corangamite Shire	TYP-003
	Feature Category	Watercourse Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Creek Crossing			
4.322		Track - Unsealed	Track - Unsealed	Lot Plan 1\TP888281	TYP-001
	Feature Category	Road Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Track - Unsealed Private			
4.580		HV Cable	Windfarm Cable - HV	EPIC Energy	TYP-005
	Feature Category	Utility Crossing			

KPs	Crossing No.	Name	Description	Owner	Typical Feature
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Windfarm Cable - HV			
4.600			Dam - 80m offset east	2\LP92940	
	Feature Category	Other			
	Pipe Design:	DN300 Standard (Production Gas)			
4.690		Paaratte to Allansford	Paaratte to Allansford Pipeline Crossing	Lochard	TYP-006
	Feature Category	Pipeline Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Paaratte to Allansford Pipeline Crossing			
4.960			Buried fibre optic cable	Telstra	TYP-005
	Feature Category	Utility Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
4.970		Track - Unsealed	Track - Unsealed	Lot Plan 2\LP92940	TYP-001
	Feature Category	Road Crossing			
	Pipe Design:	DN300 Standard (Production Gas)			
	Design Comments:	Track - Unsealed Private			
5.260		MFCT Well Site	End of Pipeline	Lochard	TYP-009-FAC
	Feature Category	Facility			
	Pipe Design:	DN300 Standard (Production Gas)			

KPs	Crossing No.	Name	Description	Owner	Typical Feature
	Design Comments:	Well Site - End of Pipeline			

MEG Pipeline Features

KPs	Crossing No.	Name	Description	Owner	Typical Feature
				N/A	
	Feature Category				

Threat Assessment Summary

Name	Credible	Controlled	Can Fail	Risk Level	ALARP	Action Numbers
C-001 - External corrosion - DN300 gas pipeline	YES	YES	-	-	-	-
C-002 - External corrosion - DN50 MEG pipeline	YES	YES	-	-	-	-
C-003-FAC - External Corrosion - Above Ground Piping	YES	YES	-	-	-	-
C-004-FAC - External Corrosion - AG/BG transitions	YES	YES	-	-	-	012
C-005 - Internal Corrosion - DN300 gas pipeline	YES	YES	-	-	-	-
C-006 - Internal Corrosion - MEG Pipeline	NO	-	-	-	-	-
C-007 - Internal Erosion	NO	-	-	-	-	-
C-008 - Sulphide stress cracking	NO	-	-	-	-	-
C-009 - Stray Current Corrosion / CP system interference	YES	YES	-	-	-	-
C-010 - Internal Biological Corrosion	YES	YES	-	-	-	006
C-011 - Stress Corrosion Cracking - Production Pipeline / MEG	YES	YES	-	-	-	-
C-012 - Corrosion beneath concrete	NO	-	-	-	-	-
E-001 - New road and drain construction	YES	YES	-	-	-	-
E-002 - Road and drain maintenance	YES	YES	-	-	-	-
E-003-FAC - Vehicle impacts to facility piping	YES	YES	-	-	-	010
E-004 - Buried utility - Shallow trenched construction (water, electricity, comms)	YES	YES	-	-	-	-
E-005 - Buried utility - Deep trenched construction (major pipelines, high voltage power)	YES	YES	-	-	-	-
E-006 - Buried utility - Mini HDD installation	YES	YES	-	-	-	002
E-007 - Buried utility - Maxi HDD installation	YES	NO	YES	Negligible	-	002
E-008 - Buried utility - Cable plough installation (FOC)	YES	NO	YES	Intermediate	YES	003

Name	Credible	Controlled	Can Fail	Risk Level	ALARP	Action Numbers
E-009 - Buried utility - Maintenance of shallow utilities	YES	YES	-	-	-	-
E-010 - Buried utility - Maintenance of deep utilities	NO	-	-	-	-	-
E-011 - Above-ground utility - Power pole installation / replacement	YES	NO	YES	Low	-	004
E-012 - Agricultural activities - Shallow ground-breaking activities	YES	YES	-	-	-	-
E-013 - Agricultural activities - Trenching for mole-drain headers	YES	YES	-	-	-	-
E-014 - Agricultural activities - Levee bank and dam contouring/ Landscaping	YES	YES	-	-	-	-
E-015 - Agricultural activities - Fence strainer posts	YES	YES	-	-	-	-
E-016 - Agricultural activities - Tree planting	YES	YES	-	-	-	-
E-017 - Agricultural activities - Tree harvesting/removal	NO	-	-	-	-	-
E-018 - Agricultural activities - Grading or clearing for firebreaks	YES	YES	-	-	-	-
E-019 - Water / geotechnical bores - Drilling	YES	NO	YES	Negligible	-	-
E-020 - Oil/gas well - Drilling	YES	NO	YES	Negligible	-	-
E-021 - 1st party Maintenance Activities	YES	YES	-	-	-	-
E-022-FAC - Vehicle movement inside facilities - Collision with pipework	YES	YES	-	-	-	005
E-023-FAC - Lifting in facilities - Dropped object	YES	NO	YES	Low	-	-
N-001 - Earthquake	YES	YES	-	-	-	-
N-002 - Ground movement	YES	NO	NO	-	-	-
N-003-FAC - Wind and Cyclone	YES	YES	-	-	-	-
N-004 - Lightning strike	YES	NO	YES	Negligible	-	-
N-005 - Erosion in waterways	YES	NO	NO	-	-	-
N-006 - Flooding - Buoyancy	NO	-	-	-	-	-

Name	Credible	Controlled	Can Fail	Risk Level	ALARP	Action Numbers
N-007-FAC - Bushfire close to the facilities	YES	YES	-	-	-	-
N-008 - Tree root damage	YES	YES	-	-	-	013
N-009 - Wildlife digging above pipe	NO	-	-	-	-	-

Threat Assessment Details

Legend

Threat is not credible	●
Failure not possible, or threat is controlled or negligible risk	✓
Threat is low risk or ALARP	✓
Assessment completed elsewhere	●
Threat is intermediate risk	✓
Threat assessment incomplete	●
Threat is ALARP or risk is high or extreme	✕

C-001 External corrosion - DN300 gas pipeline

Category: Corrosion

Description: External corrosion of the buried portion of the HUGS gas pipeline.

Control by design and/or procedures

To prevent corrosion:
- Coating system - 2FBE, HBE on joints
- CP system - impressed current. Boundaries of system to be determined. Contiguous with Wallaby Creek, but otherwise independent of existing systems.

To detect corrosion for treatment:
- DCVG - post-construction and 5-yearly
- 5-yearly pipeline pigging using ILI

Threat is controlled ✓

C-002 External corrosion - DN50 MEG pipeline

Category: Corrosion

Description: External corrosion of the buried portion of the HUGS MEG pipeline.

Control by design and/or procedures

To prevent corrosion:
- Coated - likely 3LPE w. tape-wrap of joints.
- CP protection; not cross-bonded to the gas pipeline (TBC)

To detect corrosion for treatment:
- DCVG (conducted simultaneous with adjacent gas line)

Threat is controlled ✓

C-003-FAC External Corrosion - Above Ground Piping

Category: Corrosion

Description: External corrosion of above-ground pipe, due to corrosive environment (e.g. atmospheric corrosion; after rain due to moisture in crevices at supports).

Control by design and/or procedures

To prevent corrosion:
- Coating.

To detect corrosion for treatment:
- Piping inspection at routine site attendance.

Threat is controlled ✓

C-004-FAC External Corrosion - AG/BG transitions

Category: Corrosion

Description: Corrosion of the pipe steel at above-/below-ground transitions, due to pooling of water, abrasion from pipeline movement, or ingress at end of coating system. Typically CP is ineffective at the transition zone.

Control by design and/or procedures

Threat is controlled ✓

Actions

012	Transition coating	Open

C-005 Internal Corrosion - DN300 gas pipeline

Category: Corrosion

Description: Internal corrosion due to wet gas and impurities in Production Pipeline resulting in loss of Pipeline integrity and possible leak.

Control by design and/or procedures

To prevent corrosion:
- MEG injection

To mitigate corrosion consequences:
- Corrosion allowance = 1.5 mm

To detect corrosion:
- Corrosion product monitoring in MEG stream at discharge.
- 5-yearly pipeline pigging using ILI.

Threat is controlled ✓

C-006 Internal Corrosion - MEG Pipeline

Category: Corrosion

Description: Not Credible - The stream transported in the MEG Pipeline contains MEG only, which is non-corrosive. The MEG tank has nitrogen blanket to avoid oxygen.

Threat is not credible ●

C-007 Internal Erosion

Category: Corrosion

Description: Internal Erosion (abrasion) due to sand in well fluids resulting in failure or leak of Production Pipeline. Velocity in pipeline too low. To be reviewed for well-site facility design, but not a consideration for the pipeline.

Threat is not credible ●

C-008 Sulphide stress cracking

Category: Corrosion

Description: Not credible for the pipeline service.

Threat is not credible ●

C-009 Stray Current Corrosion / CP system interference

Category: Corrosion

Description: Corrosion of Production and/or MEG Pipelines due to Interference from other pipeline CP systems at pipeline crossings, resulting in loss of pipeline integrity and possible leak. Note there are no induced current sources identified. There is one HV cable, which could discharge via the pipeline if it faulted; an action is raised to investigate. In general, fault discharges leading to earth potential rise may discharge through pipeline coating, causing a coating defect.

Control by design and/or procedures

Monolithic insulation joints (MIJs),
CP system design,
DCVG,
6-monthly CP potential surveys.

Threat is controlled ✓

C-010 Internal Biological Corrosion

Category: Corrosion

Description: Internal Biological Corrosion of Production or MEG Pipelines resulting in loss of integrity.

Control by design and/or procedures

Annual testing of the rich MEG stream for corrosive biological organisms.

Threat is controlled ✓

Actions

006	Microbial monitoring of MEG	Open

C-011 Stress Corrosion Cracking - Production Pipeline / MEG

Category: Corrosion

Description: Stress Corrosion Cracking resulting in loss of integrity of the gas or MEG pipelines.

Control by design and/or procedures

Modern coating - 2FBE,
For the MEG line, operating at a low stress level,
Moderate operating temperature,
PRCI risk assessment for SCC.

Threat is controlled ✓

C-012 Corrosion beneath concrete

Category: Corrosion

Description: The pipeline design avoids anchor blocks, so there is no risk of corrosion beneath concrete. Threat is non-credible.

Threat is not credible ●

E-001 New road and drain construction

Category: External Interference

Description: Construction activities for new drains/roads. Note there are no gazetted road crossings that haven't yet been formed and there are already two sealed roads in the area, so this threat is unlikely.
This activity would typically use scrapers, graders, rollers, vibrating compacters, resurfacing machines, and water trucks. If there is soft soil, then activities could exceed pipeline the depth in trenched locations to prepare new firm roadbase. This activity may be conducted by landowners, Corangamite Shire, or Wannon Water.

External interference controls

Physical: Wall Thickness:Pipeline resists penetration from applicable equipment.

Procedural: Signs:Intervisible marker signs.
Marker Tape:Marker tape is installed in trenched locations.
Call Service:HUGS Pipeline will be registered on BYDA
Third Party Liaison:Liaison programmes with all relevant parties.
Patrolling:Ad-hoc site attendance and vantage-point patrolling may detect this activity.
Planning Notification Zone:This control may apply - refer HOLD.

Threat is controlled ✓

E-002 Road and drain maintenance

Category: External Interference

Description: Road maintenance activities to replace road pavement or maintain road surface, and clearing or resurfacing of road-side drains. Typically involves the use of graders and dozers. It is a surface activity; depth of excavation is about 300mm maximum. Activity is conducted by Corangamite Shire, and possibly by some landowners.

External interference controls

Physical: Burial:1200mm min depth of cover.
Barrier:Protection slabs beneath table drains where less than 1,200mm cover.
Wall Thickness:Resistance to penetration is expected for this equipment.

Procedural: Signs:Signage installed both sides of roads and one side of tracks.
Marker Tape:Marker tape is installed where trenching is used.
Call Service:HUGS Pipeline will be registered on BYDA.
Third Party Liaison:Liaison with Corangamite shire.
Patrolling:Ad-hoc site attendance and vantage-point patrolling may detect this activity.

Threat is controlled ✓

E-003-FAC Vehicle impacts to facility piping

Category: External Interference

Description: Threat is is an uncontrolled vehicle leaving the road and crashing into the station pipework. The consequence of an incident depends on vehicle energy, which is determined by its velocity and mass. The well-site above-ground piping is located adjacent to public roads. Note that the other end of the pipeline ties in to an existing facility.

External interference controls

Physical: Barrier:Fencing around perimeter.
Separation by Distance:Distance from roadway.
Wall Thickness:Steel pipe may resist failure from a vehicle impact.

Procedural: Signs:Pipe visibility - painted green.
Other:Road speed limits.

Threat is controlled ✓

Actions

010	Vehicle crash barrier.	Open

E-004 Buried utility - Shallow trenched construction (water, electricity, comms)

Category: External Interference

Description: Shallow buried utilities for water, minor electricity lines and communication connections such as fibre-optic, may be constructed using trenching - either across paddocks or in a road reserve. The installation uses small trenching machines or excavators, typically 5 to 10t; greater than 20t is not expected.

External interference controls

Physical: Burial:900mm minimum depth of cover.
Wall Thickness:Wall thickness resists penetration from equipment.

Procedural: Signs:Intervisible in trenched locations.
Marker Tape:Marker tape is installed along the entire route.
Call Service:HUGS Pipeline will be registered on BYDA.
Third Party Liaison:Liaison with utility companies.
Planning Notification Zone:HOLD - confirm with Corangamite Shire.

Threat is controlled ✓

E-005 Buried utility - Deep trenched construction (major pipelines, high voltage power)

Category: External Interference

Description: Deep buried utilities such as oil and gas pipelines, water trunklines, and high-voltage powerlines, may be constructed using trenching to a depth exceeding the HUGS pipeline. Such installation uses large trenching machines or excavators suitable for the soil conditions - e.g. up to 35t with general purpose teeth may be expected due to soil conditions. This activity will be conducted by Oil & Gas production companies, Victorian water company or their contractors, working to procedure. Note that sewage services are not considered credible in this location.

External interference controls

Physical: Wall Thickness:Wall thickness provides resistance to penetration for this threat.

Procedural: Signs:Intervisible signage for trenched parts of the pipeline.
Marker Tape:Marker tape in trench may alert an excavator operator but is unlikely to provide advance warning for trenching machines.
Call Service:HUGS Pipeline will be registered on BYDA
Third Party Liaison:Liaison with utility companies.
Planning Notification Zone:HOLD

Threat is controlled ✓

E-006 Buried utility - Mini HDD installation

Category: External Interference

Description: Minor utilities may be installed below the pipeline using mini-HDD. This could typically occur at major road crossings where the road authority requires the crossing to be installed by HDD rather than open cut, OR, general cross-country locations (paddocks) where the project is aware of the HUGS pipeline and proposes to cross using HDD (rather than conventional trenching). The depth of cover is typically up to 3,000mm. Work is undertaken by utility companies or their contractors. Note, the HUGS Pipeline is parallel to one or more hydrocarbon pipeline for the majority of its route, so HDD operators are expected to be highly aware of the buried assets.

External interference controls

Physical: Wall Thickness:Note also that HDD damage experiments for mini-HDD rigs conclude that bits cannot penetrate the pipeline and gouging is very unlikely (5%) to be sufficiently deep to cause failure of pipe with this thickness.

Procedural: Signs:Signage is intervisible; with signage at either side of road crossings, and one side of tracks and watercourses.
Call Service:HUGS pipeline will be registered on BYDA.
Third Party Liaison:Liaison with utility companies.

Threat is controlled ✓

Actions

002	HDD risk	Open

E-007 Buried utility - Maxi HDD installation

Category: External Interference

Description: Major utilities (major oil and gas and water pipelines) may be installed below the pipeline using maxi-HDD. This may occur at major road crossings or waterways where the crossing is to be installed by HDD / thrust bore rather than open cut. This would typically reach depth of cover exceeding 3,000mm. Such a major Major project HDD would be equivalent to the HUGS Project crossing existing pipelines, and likely to be in the same location (e.g. at the same river crossing). Note - the HUGS Pipeline is parallel to one or more hydrocarbon pipeline for the majority of its route, so HDD operators are expected to be highly aware of the buried assets.

External interference controls

Physical:

Procedural: Signs:Marker signs installed, though less frequent/visible at the creek crossing where this threat is most likely.
Call Service:HUGS Pipeline will be registered on BYDA.
Third Party Liaison:Liaison with utility companies.
Patrolling:Activity may be detected by vantage point patrols and ad-hoc site attendance.
Planning Notification Zone:HOLD

Failure Analysis A strike from a maxi-HDD may persist to achieve a pipeline leak because the drill and pipeline are both constrained; though this would require sustained effort for a 12.7mm thick pipeline.

Risk Assessment

Safety Risk:

Consequence: The release of pressure within the drill string, could leak to injuries at the location of the drill rig as drilling mud is blown back out of the hole. Injuries and fatalities are not expected due to the damping effect of the mud and sufficient escape opportunity.

Minor

Frequency: Procedural controls are very effective for major projects.

Hypothetical

Safety Risk Category : Negligible ✓

Actions

002	HDD risk	Open

E-008 Buried utility - Cable plough installation (FOC)

Category: External Interference

Description: Cable plough equipment, drawn by a D8/D9 dozer, is used to install communications cables (e.g. NBN fibre-optic), damaging the HUGS pipeline. Typically it is installed with a depth of cover of 1000 mm. Work is conducted by a contractor working for the communications company.

External interference controls

Physical:

Procedural: Signs:Marker signs installed intervisible
Call Service:HUGS pipeline is registered on BYDA.
Third Party Liaison:Liaison with contractors.
Planning Notification Zone:HOLD

Failure Analysis Potential leak or rupture from a large ripper strike.

Risk Assessment

Safety Risk:

Consequence: Potential fatality of equipment operator.

Major

Frequency: Likelihood of an equipment operator fatality from a ripper strike is considered remote.

Remote

Safety Risk Category : Intermediate ✓

ALARP

Threat is ALARP ✓

Actions

003	LOPA for Dozer Ripper	Open

E-009 Buried utility - Maintenance of shallow utilities

Category: External Interference

Description: Maintenance activities of other buried utilities could be conducted by the relevant utility company at a crossing with the HUGS pipeline. Excavation would be to the depth of the other utility plus additional margin for working room in the excavation. Typically this would involve 5 to 10tonne excavators with general purpose teeth.

External interference controls

Physical: Burial:Depth margin between assets of 600mm.
Barrier:Standard design includes protection slabs.
Wall Thickness:Wall thickness provides resistance to penetration.

Procedural: Signs:Signage at utility crossings.
Marker Tape:Marker tape is installed at trenched utility crossings.
Call Service:HUGS Pipeline will be registered on BYDA
Third Party Liaison:Liaison with utility companies.
Activity Agreements:Co-usage agreements for overlapping easements (except telecom).

Threat is controlled ✓

E-010 Buried utility - Maintenance of deep utilities

Category: External Interference

Description: Maintenance activities of other utilities that are buried below the HUGS pipeline could be conducted by the relevant utility company at a crossing with the HUGS pipeline. Excavation would be to the depth of the other utility plus additional margin for working room in the excavation. Typically this would involve up to 20 tonne excavators with general purpose teeth.

There are no existing utilities crossing below the HUGS pipeline, hence this is not credible (this should be reconfirmed at future SMS workshops).

Threat is not credible ●

Physical:

Procedural:

E-011 Above-ground utility - Power pole installation / replacement

Category: External Interference

Description: An auger is used by the Power Corp to install new power poles above the HUGS pipeline. The existing power network is well established in the area, so new power poles are only likely to be installed to supply to new building or facilities on existing properties, or to replace existing poles, which is conducted near existing poles (typically less than 3m away) and in-line with the existing wires. The depth of drill is likely to exceed 1200mm, so a strike is credible in any locations where the HUGS pipeline is installed by trenching. Note that there is only one existing cross-country powerline, which is being crossed using HDD, and others are within road reserves.

External interference controls

Physical:

Procedural: Signs:Signage at utility crossings, and intervisible in other trenched areas.
Call Service:HUGS Pipeline will be registered on BYDA
Third Party Liaison:Liaison with utility companies.
Activity Agreements:For pole replacements - co-use agreements in place.
Planning Notification Zone:HOLD

Failure Analysis An auger strike with persistent drilling would be expected to result in a pipeline leak only (not a rupture).

Risk Assessment

Safety Risk:

Consequence: Worst consequence anticipated is fatality for equipment operator.

Major

Frequency: Current assessment is hypothetical due to combined low frequency of activity, low likelihood that pipeline remains undetected, and probability of equipment operator escaping. Refer ACTION.

Hypothetical

Safety Risk Category : Low ✓

Actions

004	Power-pole review	Open

E-012 Agricultural activities - Shallow ground-breaking activities

Category: External Interference

Description: Shallow agricultural activities are conducted by landowners in the area, including ploughing, installation of irrigation water lines, track construction, footings for farm buildings, minor drains, star-pickets and regular fence-posts etc. Landowners may use excavators weighing up to 20t.

External interference controls

Physical: Burial:900mm minimum depth of cover.
Wall Thickness:Wall thickness is sufficient to resist penetration.

Procedural: Signs:Signs are intervisible and installed at boundary fences.
Marker Tape:Marker tape is installed along the entire route.
Call Service:HUGS Pipeline will be registered on BYDA.
Landowner Liaison:

Threat is controlled ✓

E-013 Agricultural activities - Trenching for mole-drain headers

Category: External Interference

Description: Deep trenching/excavating is conducted by landowners in the area to depths of 2,000mm for the construction of mole-drain collector pipes. The header installation is a one-off activity; subsequent ploughing above the header is shallower (typically 400mm deep). Note that this is more typically where there is undulating terrain with hills which are larger than generally found on this pipeline route; hence the likelihood is considered low.

External interference controls

Physical: Wall Thickness:Wall thickness is expected to provide resistance to penetration for this equipment.

Procedural: Signs:Marker signs intervisible and on boundary fences.
Call Service:HUGS Pipeline will be registered on BYDA

Threat is controlled ✓

E-014 Agricultural activities - Levee bank and dam contouring/ Landscaping

Category: External Interference

Description: Landowners, (or Corangamite Shire / Wannon water) may use excavators, dozers and graders to contour the ground for water management. Soil in the area is clay. Landowners will use excavators up to 20t, and general purpose teeth. Contractors may use excavators up to approx. 30t for this type of activity, but penetration teeth or tiger teeth are not expected due to the soil conditions.

External interference controls

Physical: Wall Thickness:Wall thickness provides resistance to penetration.

Procedural: Signs:Marker signs are intervisible.
Marker Tape:Marker tape is installed along the entire route.
Call Service:HUGS Pipeline will be registered on BYDA; landowners will limit their activity to approx. 300mm depth without supervision.
Landowner Liaison:

Threat is controlled ✓

E-015 Agricultural activities - Fence strainer posts

Category: External Interference

Description: A landowner or their designated contractor uses boring equipment to install fence strainer posts (at fence corners and adjacent to gates), which may damage the pipeline. Typically pendulum-augers up to 600mm diameter would be used, either truck-mounted or mounted on a 5t excavator. Such posts are installed to typical depth of around 1,200mm.

External interference controls

Physical: Wall Thickness:Pendulum auger is expected to deflect off the pipeline without penetrating it.

Procedural: Signs:Marker signs installed intervisible and
Call Service:HUGS Pipeline will be registered on BYDA
Landowner Liaison:

Threat is controlled ✓

E-016 Agricultural activities - Tree planting

Category: External Interference

Description: Augers are occasionally used by the shire and landowners for tree planting. Typically this is to a depth of 500mm maximum. It is most likely on fencelines, but could happen anywhere.

External interference controls

Physical: Burial:900mm depth of cover protects from this threat.
Wall Thickness:Wall thickness provides resistance to penetration for small augers.

Procedural: Signs:Marker signs on boundary fences.
Call Service:This may be used for activities deeper than 300mm.
Landowner Liaison:

Threat is controlled ✓

E-017 Agricultural activities - Tree harvesting/removal

Category: External Interference

Description: Tree removal is non-credible, because large trees will not be planted above the pipe. Any large trees will be detected by patrolling and removed while still small.

Threat is not credible ●

Physical:

Procedural:

E-018 Agricultural activities - Grading or clearing for firebreaks

Category: External Interference

Description: Landowners, Corangamite Shire, and Wannon Water may all conduct land clearing or grading of their properties for firebreaks. This may use scrapers, graders, rollers, and excavate to maximum 300mm depth. this occurs on property boundaries and roadways. The pipeline Right Of Way will already be kept free of significant vegetation, so it is unlikely that this will be done above the pipeline.

External interference controls

Physical: Burial:Depth of cover provides protection at all locations.

Procedural: Signs:Marker signs intervisible and at road crossings.
Marker Tape:Marker tape installed above the pipeline at all trenched locations.
Landowner Liaison:
Third Party Liaison:Liaison with councils and water.

Threat is controlled ✓

E-019 Water / geotechnical bores - Drilling

Category: External Interference

Description: Water boring is conducted above the pipeline by a drilling contractor on behalf of a landholder or for a commercial project. The drilling equipment used is capable of drilling through multiple geological layers, with the intent of cutting the soil, so is capable of damaging the pipeline, resulting in loss of containment. In trenched locations, the pipe and/or marker tape may be detected while setting up the drill, prior to commencement of drilling; in HDD locations, this threat is less controlled.

External interference controls

Physical:

Procedural: Signs:Marker signs are intervisible in trenched locations.
Marker Tape:Marker tape is installed in trenched locations.
Call Service:HUGS Pipeline will be registered on BYDA
Landowner Liaison:
Third Party Liaison:Liaison with contractors in general stresses the importance of using BYDA.
Other:Action - confirm government regulations.

Failure Analysis Drill strike on pipeline potentially results in a pipeline leak.

Risk Assessment

Safety Risk:

Consequence: Leak from a pipeline strike may result in an injury on the drill rig.
Severe

Frequency: BYDA and approvals are effective controls.
Hypothetical

Safety Risk Category : Negligible ✓

E-020 Oil/gas well - Drilling

Category: External Interference

Description: Drilling an oil/gas is undertaken by a drilling contractor above the HUGS pipeline. It is expected that the pipeline or pipeline marker tape would, in trenched locations, be encountered while setting up the drill, before deep drilling has commenced. A drilling project requires multiple planning steps to be completed prior to mobilising the the rig to site - desktop planning, site surveys, landowner liaison, construction of an access road, and well pad preparation (civil works). The activities occur under the Victorian Petroleum Act 1998 and the activities require the relevant government department to be notified, assess the application and confirm other assets in the area. Requirements to manage Oil & Gas Drilling Projects are addressed on a case by case basis. Drilling activities are carried out by experienced, professional contractors working to procedure under the direction of the Petroleum Company Licensee. Planning and internal approvals processes are completed for route selection, environmental clearance, land access etc, prior to mobilising to site.

External interference controls

Physical:

Procedural: Signs:Signage is intervisible in trenched locations, and installed at either side of road crossings.
Marker Tape:Marker tape is installed along the entire trenched portion of the pipeline route.
Call Service:HUGS Pipeline will be registered on BYDA .
Third Party Liaison:Liaison with Oil and Gas companies.
Patrolling:Patrolling is expected to identify setup of a wellsite before drilling commences.
Planning Notification Zone:Regulatory Instruments: The Victorian Pipelines Act 2005 requires that easement holders affected by new developments are notified and consulted in advance of construction activities.
Other:PPL - petroleum production licence

Failure Analysis A drill strike would result in a pipeline leak.

Risk Assessment

Safety Risk:

Consequence: Leak from a pipeline strike may result in an injury on the drill rig.

Severe

Frequency: Very effective procedural controls. Additionally, the pipeline would most likely be detected during establishment of the wellsite, prior to drilling.

Hypothetical

Safety Risk Category : Negligible ✓

E-021 1st party Maintenance Activities

Category: External Interference

Description: The HUGS pipeline owner will conduct maintenance and inspection activities damaging the buried pipeline. Typically, exposure of the pipeline is conducted for direct inspection, to validate the results of other inspections (in-line inspection, DCVG, etc.). Typically, they will use excavators of around 5t - 10t weight fitted with flat buckets. Work will be conducted by the owner, or a contractor working to the owner's procedures.

External interference controls

Physical: Wall Thickness:Wall thickness provides resistance to penetration.

Procedural: Other:Company Procedures apply that limit equipment used (also permitting system, JHA, site supervision, personnel training).

Threat is controlled ✓

E-022-FAC Vehicle movement inside facilities - Collision with pipework

Category: External Interference

Description: Owner and contractor vehicles, typically 4WD vehicles or light trucks, may operate inside the pipeline facilities and contact the aboveground pipework, causing damage. Note that the wall thickness of the main pipe runs provide resistance to penetration, but breakage of small-bore connections would be possible.

External interference controls

Physical: Barrier:ACTION - confirm bollard locations.

Procedural: Signs:Pipe visibility - green paint.
Other:Company Procedures: limiting equipment used, PTW system, JHA, site supervision, trained personnel, speed limits, crane lifting plans, spotters etc.

Threat is controlled ✓

Actions

005	Bollard installation/location review	Open

E-023-FAC Lifting in facilities - Dropped object

Category: External Interference

Description: When lifting within the facilities using craneage, dropped objects may damage the pipe. Note that the wall thickness of the main pipe runs provide resistance to penetration, but breakage of small-bore connections is still possible.

External interference controls

Physical:

Procedural: Signs:Pipe visibility - green paint.
Other:Company Procedures: limiting equipment used, PTW system, JHA, site supervision, trained personnel, speed limits, crane lifting plans, spotters etc.

Failure Analysis Leaking from small-bore connection breakage.

Risk Assessment

Safety Risk:

Consequence: Small-bore connection leakage in a facility may result in an injury. More severe outcomes are unlikely due to opportunity to escape, use of PPE and safe work procedures within gas facilities, and especially because personnel are excluded from the lift radius during the lifting operation.

Severe

Frequency: Effective procedural controls, the rareness of the activity, and the fact that projects usually can avoid lifting over pipework, all make this a low probability scenario.

Remote

Safety Risk Category : Low ✓

N-001 Earthquake

Category: Natural Events

Description: Earthquake (vibration / ground movement) leading to excessive pipe strain leading to possible plastic deformation or loss of containment. (Note that minor tremors are infrequent in Victoria; a minor earth tremor occurred in southern Victoria 2009 but it was not of sufficient intensity to adversely affect pipeline facilities.)

Control by design and/or procedures

Above ground facility consequences due to seismic activity will be addressed in the detailed design by designing to AS 1170.4. No specific earthquake design requirements apply for the buried pipeline in this general location. E.g.: No active faults or known significant seismic activity.

Threat is controlled ✓

N-002 Ground movement

Category: Natural Events

Description: Ground movement may occur from several causes: Land Slip on sloped terrain, differential settlement, sinkhole formation (due to limestone underlay/karst formation), or liquefaction. Such causes ground movement, leading to excessive pipe strain leading to possible plastic deformation or loss of containment.

Control by design and/or procedures

Route selection to avoid areas of potential land slip where possible, though some locations within creek crossings are unavoidable for potential landslip. Where traversing embankments, the crossing will be perpendicular. Strain-capacity is provided in the material design, by means of overmatching the welds, which will be specified in the pipe weld procedure. Additionally, the pipe specification will limit line-pipe overstrength to 100 MPa.

Failure Analysis Due to provision of strain capacity, landslip on the route may result in pipe deflection, but not a leak.

Failure not possible ✓

N-003-FAC Wind and Cyclone

Category: Natural Events

Description: Threat is high winds causing damage to above-ground facilities - either directly, or by causing trees to fall over the facility. Note, the HUGS pipeline is not located in a cyclone area.

Control by design and/or procedures

Above-ground piping will be designed to AS 1170.2 loading, and has vegetation clearance to limit potential for trees to fall onto the facility piping.

Threat is controlled ✓

N-004 Lightning strike

Category: Natural Events

Description: Lightning strikes either a facility or the pipeline, resulting in damage to the pipeline coating of the pipe wall. Note that a number of Australian pipelines have suffered lightning damage. There is currently no known mitigation for protection of pipe itself against lightning damage.

Control by design and/or procedures

Pipeline design at above ground facilities addresses this threat through earthing design. Production and MEG Pipelines are isolated from all above ground facilities via Monolithic Isolating Joints and the facility piping is earthed to ground directly adjacent the MIJs. Additionally, lightning is prevented from damaging the soft components of the MIJs at the above ground facilities by installation of surge diverters. If surface defects are caused by lightning, these may be detected prior to a failure through ILI.

Failure Analysis Lightning leads to either surface damage (equivalent to pitting) or a pin-hole leak.

Risk Assessment

Safety Risk:

Consequence: The leak from a pinhole poses negligible risk to the public (remote area, likelihood of ignition is low, radiation zone is only a couple of metres). Note that if a person were present (unlikely) the lightning strike itself is a greater hazard.

Trivial

Frequency: Lightning strikes do not occur often, but have occurred on Australian pipelines several times.

Unlikely

Safety Risk Category : Negligible ✓

N-005 Erosion in waterways

Category: Natural Events

Description: High water flows lead to erosion of cover, resulting in either exposure of the pipe and consequent impact damage, or erosion beneath the pipe and free-spanning of the pipe, resulting in overstress. In particular, there is a large dam near the pipeline route; if this breaks, then there is potential for a large local erosion event.

Control by design and/or procedures

The pipeline depth of cover is increased watercourses, to at least 1200mm. After pipeline construction, the pipe route is rehabilitated, which includes bank stabilisation.

Failure Analysis Due to provision of strain capacity in the design, the threat results in deflection of the pipe and overstress, but a loss of containment is not expected.

Failure not possible ✓

N-006 Flooding - Buoyancy

Category: Natural Events

Description: Flooding in a region, or high water table, could result in flotation of the pipeline. Though the pipe itself is buoyant, analysis shows that soil cover is sufficient to prevent flotation (which has also not occurred on other pipelines in the area. Note: buoyancy must still be mitigated/controlled during construction when the trench is open.

Threat is not credible •

N-007-FAC Bushfire close to the facilities

Category: Natural Events

Description: Radiant heat from a bushfire causes damage to the facilities resulting in a release and suspension of production. Note also that cleanup and restoration after a bushfire poses potential external interference threats.

Control by design and/or procedures

Though there is potential for grassfire near facilities, there is not sufficient fuel load near facility boundaries for major bushfires, and vegetation control is practiced on the right of way and around facilities.

Threat is controlled ✓

N-008 Tree root damage

Category: Natural Events

Description: Trees above the pipeline present a threat to the pipeline, from gradual coating damage by tree root growth.

Control by design and/or procedures

Route selection avoids trees (HDDs are also deep enough to avoid tree routes). Subsequently, Right of Way maintenance will remove trees before they can grow large. Tree removal for initial construction is a matter of ongoing negotiation and will be considered again in the detailed design SMS.

Wall Thickness:Standard Wall.

Threat is controlled ✓

Actions

013	Large trees	Open

N-009 Wildlife digging above pipe

Category: Natural Events

Description: In some locations, wombats can burrow above pipelines, causing damage to the coating. This is not credible in this area.

Threat is not credible

SMS Actions

001 Landowner mole drain planning

Status: Open

Description: Confirm with landowners that no mole drain installation is planned in the area.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

002 HDD risk

Status: Open

Description: Post-workshop confirm risk assessment of horizontal directional drill strike on HUGS pipeline.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

003 LOPA for Dozer Ripper

Status: Open

Description: Perform quantitative risk assessment using Layer of Protection Analysis for a strike from a Dozer Ripper installing fibre-optic cable.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

010 Vehicle crash barrier.

Status: Open

Description: Consider installation of vehicle crash-barrier at NP45.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

005 Bollard installation/location review

Status: Open

Description: Review bollard requirement in facilities as part of design review.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

006 Microbial monitoring of MEG

Status: Open

Description: Confirm microbial monitoring is included in the pipeline integrity management plan (PIMP) for current Lochard Energy pipelines, and will be included in the PIMP for the HUGS pipeline.

Priority: Not Specified

Responsible: Lochard Energy - Gianni Lucchi

004 Power-pole review

Status: Open

Description: Review locations of existing powerline poles relative to trenched locations. Consider frequency of future powerline installations. Consider installation of protection slabs at wire crossings, if pole relocation to that location is possible.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

007 Trench type - MEG depth of cover

Status: Open

Description: Confirm minimum depth of cover for the MEG pipeline, as part of detailed design, when trench layout / type is finalised.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

008 Marker tape installation

Status: Open

Description: Revise design, to install marker tape for entire extents of trenched construction. Additionally, finalise the writing that will be on the marker tape, as there are three different services installed in the trench: gas pipeline, MEG pipeline, and fibre-optic cable.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

009 Co-use agreements

Status: Open

Description: Include 'best endeavours to notify' clause in co-use agreements.

Priority: Not Specified

Responsible: Lochard Energy - Susie Bartlett

012 Transition coating

Status: Open

Description: Confirm the coating design at the AG/BG transition design from the FJC spec.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

014 Electrical safety

Status: Open

Description: Address electrical safety threats during detail design.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

011 Buried HV cable

Status: Open

Description: Confirm any electrical threats associated with the buried HV cable (not considered likely due to perpendicular crossing). Identify how/if wind farms produce stray discharges, fault currents etc.

Priority: Not Specified

Responsible: Long Energy - Brad Sayer

013 Large trees

Status: Open

Description: Confirm negotiation to avoid or remove large trees on the pipeline ROW (noted, one has been identified).

Priority: Not Specified

Responsible: Lochard Energy - Susie Bartlett

References

Ref No.	Document Number	Revision	Title	Originator/Author
73	UGS-MV-0670	P.B	Foreign pipeline crossing | Typical detail	AV
74	UGS-MV-0671	P.B	Foreign service crossing | Typical detail	AV
75	UGS-MV-0672	P.B	Road crossing | Typical detail	AV
76	UGS-MV-0139	P.B	Pipeline trench | Typical detail	AV
77	UGS-MV-0673	P.B	Watercourse crossing | Typical detail	AV
78	UGS-MK-0046	B	Pipeline overview | Alignment sheet	Evolve Geospatial
79	UGS-MK-0047	B	HUGS pipeline | Alignment sheet 1 of 4	Evlove geospatial
80	UGS-MK-0048	B	HUGS pipeline | Alignment sheet 1 of 4	Evlove geospatial
81	UGS-MK-0049	B	HUGS pipeline | Alignment sheet 1 of 4	Evlove geospatial
82	UGS-MK-0050	B	HUGS pipeline | Alignment sheet 1 of 4	Evlove geospatial
83	UGS-MP-0116	P.A	DN50 AS2885 Wall thickness calculations	B Sayer
84	UGS-MP-0115	0	DN300 AS2885 Wall thickness calculations	B Sayer
85	UGS-MP-0117	P.A	Energy release rate calculations	B Sayer
86	PRM-0021-UGS-MS-0049	P.A	Fracture control plan	Long Energy & Resources
87	AS 2885.0	2018	Pipelines—Gas and liquid petroleum | Part 0: General requirements	Standard Australia
88	AS/NZS 2885.1	2018	Pipelines—Gas and liquid petroleum | Part 1: Design and construction	Standards Australia
89	AS/NZS 2885.6	2018	Pipelines—Gas and liquid petroleum | Part 6 : Pipeline safety management	Standards Australia