GPA ENGINEERING

AER DRAFT DECISION REVIEW

APA Channel Island Bridge Project

APA Group

GPA Document No: 15644-REP-001

Rev	Date	By	Checked	QA	Description
A	17/12/2015	RMcD	SH	APW	Draft for APA Review
0	22/12/2015	RMcD	SH	APW	Issued
		RMcD			

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EXECUTIVE SUMMARY

The Channel Island Spurline provides gas to the 310 MW Channel Island Power Station, which supplies the majority of Darwin's power (the total installed capacity of the Darwin to Katherine Interconnected System is ~500 MW).

The CIPS is regarded as critical infrastructure (as per APA Access Arrangement Submission, page 64), and falls under the definition of critical infrastructure in the *Framework for the Protection of Northern Territory Critical Infrastructure.*

APA has determined that the most significant threat to pipeline integrity is external corrosion. APA is concerned that the current inspection and monitoring regime (based on DCVG survey and targeted dig-up) does not provide sufficient confidence that it can locate and assess whether corrosion is occurring and the extent to which it may have occurred. Depending on location, a gas release due to corrosion has the potential to cause fatal injuries to persons close by, and cause significant disruption to Darwin's power supply and economy.

It is on this basis that APA has concluded that it is necessary to conduct an ILI inspection along the entire length of the pipeline in order to confidently assess the condition of the pipeline and determine what remedial action (if any) is required in the event that significant corrosion is identified. However, due to the configuration of the pipeline, it is currently not piggable.

APA's recent submission to the Australian Energy Regulator (AER) included a bid for capital expenditure to make the Channel Island Spurline piggable so that it can be inspected by an inline inspection tool (ILI).

AER has rejected the submission and proposed an alternative integrity monitoring regime:

- ILI inspection of the onshore section between the Darwin City Gate and the Channel Island Bridge (i.e. this section to be made piggable).
- Visual inspection of the bridge section of the pipeline.
- DCVG surveys, excavations and inspections, and the extrapolation of findings from ILI survey work carried out on pipework upstream of the bridge crossing, for the remaining buried section of the pipeline which cannot be pigged.

The AER decision is based (in part) on its assessment that inline inspection is not mandated by the relevant Australian Standard, and that inline inspection is therefore not the only approach to pipeline integrity management that is consistent with accepted good industry practice. AER asserts that its proposed monitoring regime is "reliable".

In GPA's opinion:

- Long term industry experience shows that ILI is the only proven method for reliably assessing pipeline metal loss features over its entire length.
- On this basis ILI inspection of the onshore section between the Darwin City Gate and the Channel Island Bridge is supported.
- Direct visual assessment is a suitable method for assessing external corrosion on the bridge section of the pipeline.
- The intent of the relevant section of AS 2885 (AS2885.3-2012 Section 6.6.1) is that a pipeline should be made piggable unless there is a valid and compelling reason not to.
- The Standard allows for alternative integrity monitoring regimes in certain circumstances, but it should not be inferred that the Standard considers that the alternatives provide an equivalent level of integrity assessment.
- The method proposed by AER for the remaining buried section of the pipeline does not provide the same level of integrity assessment as can be achieved by ILI, and is unlikely to remove the

uncertainty regarding the condition of the Channel Island Spurline immediately upstream of the Channel Island Power Station.

- The section which AER proposes does not require ILI is immediately upstream of the Channel Island Power Station. A major release (pipeline rupture) in this section is likely to result in more severe consequences than for a release upstream of the Channel Island Bridge due to the proximity of people at the power station (potential fatalities), and the proximity of electricity and gas assets and the access road (damage to which could exacerbate the impact to electricity supply). On this basis it can be argued that the section of the pipeline that demands the highest priority for ILI is this section (i.e. there is a compelling reason to conduct ILI on this section).

GPA interprets "good industry practice" as complying with the requirements of AS 2885. For this case, AS 2885 requires the Licensee, based on its knowledge and assessment of a pipeline's design, construction, maintenance and operations records, and also based on its assessment of the safety and supply risks, to determine an integrity monitoring program which is sufficient to effectively identify, monitor and control pipeline integrity threats. Having done so, implementation of an integrity monitoring program which is not capable of effectively identifying, monitoring and controlling pipeline integrity threats cannot be considered "good industry practice".

Based on the information provided, GPA has no reason to contradict APA's assessment that:

- External corrosion is a credible threat to pipeline integrity
- Failure mode of leak or rupture is credible
- An ignited rupture in the vicinity of the CIPS could result in a "Major" consequence with respect to both safety (fatality) and supply (significant disruption to electricity generation capacity and potential damage to nearby plant and equipment).
- It is good industry practice to conduct an ILI for the entire length of the Channel Island Spurline.

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1 INTRODUCTION

1.1 BACKGROUND

APA's recent submission to the Australian Energy Regulator (AER) included a bid for capital expenditure to make the 12km Channel Island Spurline (from the Darwin City Gate (DCG) to the Channel Island Power Station (CIPS)) piggable so that it can be inspected by an inline inspection tool (ILI). This section has dual diameter pipe, 12" (DN300) and 8" (DN200) and no pigging facilities.

The fact that the pipeline comprises sections with significantly different diameters means that the pipeline is not currently piggable without significant modification. APA group wish to make modifications to make the entire length of the pipeline piggable so that it can effectively assess whether significant metal loss due to external corrosion is present on the pipeline.

Based on advice from Sleeman Consulting, the AER has rejected the submission for the following reasons:

- AER agrees that ILI is accepted good industry practice. However, ILI is not mandated by AS 2885, and therefore ILI is not the only approach to pipeline integrity that is consistent with good industry practice.
- There is no new or existing regulation that requires modifications to permit the ILI of the pipeline regardless of the cost.
- The bridge section of the pipeline can be reliably monitored by visual inspection.
- The onshore section between the Darwin City Gate and the Channel Island Bridge can be made piggable for around 1/10th of the cost of the APA proposal.
- The condition of the remaining buried section which cannot be pigged can be reliably assessed by a combination of Direct Current Voltage Gradient (DCVG) surveys, excavations and inspections, and the extrapolation of findings from ILI survey work carried out on pipework upstream of the bridge crossing.
- The cost of capital works proposed by APA is not necessary to meet a regulatory obligation or to maintain the safety or integrity of services.
- The option proposed by AER is consistent with good industry practice.

1.2 SCOPE

APA Group has asked GPA Engineering to provide an opinion on the following:

- Interpretation of AS 2885.3 Section 6.6.1 "Inspection Activities – General"
- "Good industry practice" with respect to integrity monitoring of pipelines supplying critical infrastructure (including long term integrity management).
- Threat to security of supply from a leak or full bore rupture.
- Threat to the public from a leak or full bore rupture.

GPA Engineering's scope does not include an assessment of the costs of any capital works programs proposed by either APA Group or the AER.

2 REFERENCE DOCUMENTATION

2.1 PIPELINE DOCUMENTS

This review was based on the following documents and information.

DOC. No.	DESCRIPTION
n/a	Peter Tuft and Associates, Report for APA Group, “Pipeline Safety Management Study Review – Victorian Transmission Pipelines”, Rev A, 22 August 2011.
n/a	APA Group, “Amadeus Gas Pipeline, Access Arrangement Revision Proposal, Submission” August 2015
n/a	APA Group, “Pipeline Management System, Pipeline Integrity Management Plan, Northern Territory APA Group Assets”, Rev 0, 15/10/2015
n/a	Sleeman Consulting, “Amadeus Gas Pipeline Access Arrangement 2016/17 – 2020/21, Review of Actual and Forecast Capex for Selected Projects, Report to the Australian Energy Regulator”, 22 September 2015
2016-21	Australian Energy Regulator, “Draft Decision, Amadeus Gas Pipeline Access Arrangement 2016 to 2021, Attachment 6 – Capital Expenditure”, November 2015
AD 1488-1100	Amadeus Basin to Darwin Pipeline Project, Section 11, As-Built Alignment, Rev 10
AD 1506-1013	Amadeus Basin to Darwin Pipeline Project, Channel Island Bridge Crossing General Arrangement, Rev 4

2.2 LIST OF STANDARDS

REFERENCE	DOCUMENT TITLE
AS 2885.0-2008	Pipelines – Gas and liquid petroleum – General Requirements (as amended 2012)
AS 2885.1-2012	Pipelines – Gas and liquid petroleum – Design and construction
AS 2885.3-2012	Pipelines – Gas and liquid petroleum – Operations and Maintenance

2.3 LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
AER	Australian Energy Regulator
AGP	Amadeus Gas Pipeline
ALARP	As Low As Reasonably Practicable
APA	APA Group
AS	Australian Standard
CDL	Critical Defect Length
CIMS	Channel Island Meter Station
CIPS	Channel Island Power Station

ABBREVIATION	DESCRIPTION
CP	Cathodic Protection
DCG	Darwin City Gate
DCVG	Direct Current Voltage Gradient
DN	Nominal Diameter
EIP	External Interference Protection
GRE	Glass Reinforced Epoxy
HDD	Horizontal Directional Drill
HV	High Voltage
ILI	In-Line Inspection
KP	Kilometre Point
kW/m^2	Kilowatts per metre squared (heat radiation flux)
LV	Line Valve
MAOP	Maximum Allowable Operating Pressure
NACE	National Association of Corrosion Engineers
PIMP	Pipeline Integrity Management Plan
SCP	Spoolable Composite Pipe
SMS	Safety Management Study
WT	Wall Thickness

3 PIPELINE DESCRIPTION

3.1 PIPELINE DESIGN AND OPERATING PARAMETERS

The Channel Island Spurline is the 12 kilometre section of the Amadeus Gas Pipeline (AGP) from the Darwin City Gate Scraper Station (DCG) to the Channel Island Meter Station (CIMS). The pipeline supplies gas to the Channel Island Power Station (CIPS) the capacity of which is ~60% of the installed electricity supply capacity to Darwin.

The MAOP of the pipeline is 9.65 MPa, although the normal operating pressure is 5.8 MPa (under certain operating configurations it is possible for the pipeline to operate at 9.65 MPa).

The Channel Island Spurline has dual diameter pipe, 12” (DN300) and 8” (DN200) and no pigging facilities:

- The onshore (buried) sections of the pipeline are DN300, WT = 7.92 mm, API 5L Grade X60
- The Channel Island Bridge section is DN200, WT 12.7 mm API 5L Grade X52 Seamless

The line pipe is coated with HDPE (“yellow jacket”). The construction specification for field joint coating was heat shrink sleeves. However, construction records of coatings used for fittings (branches, bends, reducers, etc) are poor. Field dig-ups reveal that a variety of coatings were used for fittings during construction (heat shrink sleeves, tape wrap, coal tar enamel) but that the choice of coating for any given situation was inconsistently applied.

Where the pipeline is installed under road pavement, (the final 4 km of the buried pipeline, excluding the bridge section), it is installed in stabilised backfill (i.e. sand / concrete mixture with compressive strength >10MPa).

3.2 PIPELINE INTEGRITY – CURRENT STATUS

APA advises that the major integrity threat to the pipeline is external corrosion.

The Pipeline Integrity Management Plan (PIMP) is written on the basis that the Channel Island Spurline section will be made piggable. In the interim, the proposed monitoring regime is to excavate all DCVG coating defects >1%IR and at the same time inspect a heat shrink sleeve (PIMP Section 6.3.3.2).

Inspections according to this regime in 2011 identified any corrosion but no mechanical repairs were required.

Since that time, inspections have identified 5 sites on the Channel Island section (downstream of the bridge) where the DCVG coating defects >1%IR. They are not found on every DCVG survey, but each has been found at least twice. These have not been excavated, in anticipation of the project to make the pipeline piggable. There are also two defects on the upstream section between DCG and the bridge that are in a swamp and the ground conditions have never been favourable for excavation.

Excavation for dig-ups in the final section downstream of the bridge is complicated by the following:

- The pipeline is located under the road surface of the access road to the power station.
- The access road is located on a raised embankment closely bordered by mangrove swamp. The access road is quite narrow, so excavation equipment / operations would significantly disrupt access to the power station.
- The pipe is also encased in stabilised sand (i.e. sand mixed with cement) and so excavation is more difficult and time consuming than for a pipeline dig-up in a standard trench.

For these reasons, it has been difficult to investigate the DCVG features.

As detailed in the PIMP Section 6.3.2, the AGP system has a history of corrosion under failed girth weld heat shrink sleeves. Where this occurs, the corrosion site is shielded from CP, so the pipeline is not protected. Further this failure mechanism cannot be detected by DCVG survey. Therefore DCVG cannot be considered a reliable means of identifying this corrosion mechanism. In order to assess corrosion under heat shrink sleeves, the only remaining option, where ILI is not possible, is to dig up all of the joints to undertake visual inspection.

APA advises that there are a number of locations in the final section of the Channel Island Spurline (i.e. downstream of the bridge), that has fittings where coal tar enamel and tape wrap may have been applied and so are therefore subject to the same corrosion condition uncertainty as the heat shrink sleeves.

There are no known external corrosion issues on the bridge section.

- The bridge crosses a sea water channel.
- The pipeline on this section is subject to sea water spray.
- Coating damage via abrasion at the pipeline supports has the potential to become a significant issue in future.
- Corrosion monitoring is by visual inspection, although access to the pipeline for visual inspection makes this difficult.

Based on the foregoing, and also on the fact that two of the three options assessed in the FEED

(Options Assessment) include leaving the pipeline on the bridge, it is concluded that APA is satisfied that the visual inspection regime is sufficient for monitor external corrosion for this section (i.e. the conclusion of the Sleeman Consulting report for this section is reasonable and not contested by APA).

3.3 CHANNEL ISLAND POWER STATION (CIPS)

The 310 MW CIPS supplies the majority of power to the Darwin and Katherine regions (the total installed capacity of the Darwin to Katherine Interconnected System is ~500 MW).

The CIPS was designed to be dual fuel capable (i.e. gas- and diesel-fired generation) however APA advises that in recent gas supply incidents the power station has not switched to diesel leading to load shedding of electricity customers.

The CIPS is regarded as critical infrastructure (as per APA Access Arrangement Submission, page 64), and falls under the definition of critical infrastructure in the *Framework for the Protection of Northern Territory Critical Infrastructure.*

3.4 CONSEQUENCES OF PIPELINE FAILURE

The consequences of loss of containment on the Channel Island Spurline are dependent on a number of factors:

- The size of the hole (from pinhole to full bore rupture)
- The pressure of the pipeline at the time of release
- Whether the release ignites
- The location of the release:
  - whether this causes damage to other plant or infrastructure (including the only access road to the CIPS)
  - site accessibility to assess damage and effect repair
- Whether there are people in the vicinity at the time of release
- With respect to electricity supply:
  - at CIPS the ability to switch to back-up diesel supply, the capacity of the diesel generation system, and the duration for which this can be maintained
  - The availability and capacity of other power stations to meet demand

While the pipeline is located in a relatively remote area, in worst case conditions (pipeline operating at MAOP), an ignited full bore rupture has the potential to cause fatal injuries to persons within 180 m of the release site and hospitalising injuries to persons within 300 m. This a plausible in the vicinity of the CIPS where ignition sources are present (electricity supply infrastructure) and people are present (CIPS site). The other organisations that have operations on Channel Island are the NT Government Department of Primary Industry and Fisheries (Darwin Aquaculture Centre) and the Kleenheat LPG offloading and storage facility. These organisations are more than 300 m away, so access only would be affected.

APA has provided the following advice with respect to repair times for different failure scenarios due to corrosion and the broader impacts on gas and electricity supply:

> *Leak Repair*
>
> *A leak could occur from a lightning strike or corrosion defect. A temporary repair would be effected by installing a repair clamp. This would require a blowdown of the pipeline section in order to achieve gas free conditions for excavating the pipe. The degree of difficulty excavating the pipe would be location dependent, and could be affected by other buried services, hard ground conditions (rock / stabilised backfill) proximity to other structures (power lines / bridge etc.) and environmental conditions (mangrove swamp, inundation). The clamp would then be*

fitted and the pipeline re-pressured.

The time to effect this repair would be between 24 and 72 hours. We have performed other leak repairs on the AGP within this timeframe.

If the leak occurred in the vicinity of the access road, this might require a partial or complete road closure (refer to additional commentary below).

Rupture Repair

A rupture could occur from a corrosion defect. The repair would be effected by blowing down the spurline and welding in a new pipe length(s). The welds would then be radiographed and the spurline re-pressurised.

The time to effect this repair would be between 72 hours and 7 days, assuming there is no significant damage to surrounding infrastructure. The repair would be under the scrutiny of WorkCover and the technical regulator (Department of Mines and Energy). The recent rupture repair of the Epic Energy Port Pirie Lateral in South Australia (a full bore rupture in an open paddock) took seven days to complete.

If the rupture ignited and caused damage to other assets such as the bridge or the power station, the time taken to effect a repair would be significantly longer.

Gas Supply

An unplanned interruption to the gas supply (from a rupture) would cause almost instant loss of generating capacity at Channel Island with widespread blackouts, as it takes some time to cutover to the diesel backup system. The process of cutting over to diesel and bringing loads back online takes several hours.

The use of alternative fuel (diesel) at the CIPS in combination with other power stations (Berrimah, Weddell, Pine Creek and Katherine) is expected to be insufficient to meet the power requirements of the Darwin-Katherine system at high seasonal loads (wet season) without rolling blackouts.

The prolonged use of diesel would require additional volumes to be transported to the power station over the bridge. A significant repair might result in a partial or complete road closure, making this activity difficult or impossible.

Partial or complete closure of the road could also affect personnel movements to the power station.

4 DISCUSSION

4.1 GENERAL OBLIGATIONS UNDER AS 2885

AS 2885.0-2008 (as amended in 2012) states:

The fundamental principles on which the Standard is based are:

(a) The Standard exists for—

(i) the safety of the general public and pipeline personnel;

(ii) the protection of the environment; and

(iii) security of supply.

(b) The Licensee is responsible for the safety of the pipeline.

(c) All threats to a pipeline are to be identified and either controlled or the associated risks shall be evaluated and managed to an acceptable level.

(d) A pipeline is to be designed and constructed to have sufficient strength, ductility and toughness to withstand all design loads to which it may be subjected during construction, testing and operation.

(e) The design is to be reviewed, assessed and approved.

(f) Before a pipeline is placed into operation it is inspected and tested to prove its integrity.

(g) The integrity and safe operation of the pipeline is to be maintained in accordance with an approved pipeline management system.

(h) Where changes occur in or to a pipeline or its surroundings, which alter the design basis or affect the original integrity, appropriate steps are to be taken to assess the changes and where necessary implement modifications to maintain safe operation of the pipeline.

(i) At the end of its system design life, the pipeline is to be abandoned unless an approved engineering investigation determines that its continued operation is safe.

(j) Before a pipeline is abandoned, an abandonment plan is to be developed and approved

The key elements of this are:

- Safety, environmental protection and security of supply are overriding objectives
- All threats to a pipeline are to be identified and either controlled or the associated risks shall be evaluated and managed to an acceptable level.
- The Licensee is responsible for the safety of the pipeline.
- The integrity and safe operation of the pipeline is to be maintained in accordance with an approved pipeline management system, (where “approved” means by the Licensee).

In this case, the Licensee (APA Group) has determined (based on its assessment of the threats to the pipeline integrity and the controls required to manage them, as documented in the pipeline integrity management plan) that it is necessary to conduct an inline inspection of the Channel Island Spurline to assess the integrity of the pipeline.

4.2 INTERPRETATION OF AS 2885.3-2012, SECTION 6.6.1

The AER decision is based (in part) on its assessment that inline inspection is not mandated by the relevant Australian Standard, and that inline inspection is therefore not the only approach to pipeline integrity management that is consistent with accepted good industry practice. The AER decision references AS 2885.3-2012 Section 6.6.1 “Inspection Activities – General”.

AS 2885.3-2012 Section 6.6.1 is a new provision (introduced in 2012). In the previous revision (AS2885.3-2001), the only reference to ILI was a note under Pipeline Inspection and Assessment that “Where available, intelligent pigging results should also be considered when assessing pipeline integrity.”

The relevant text of Section 6.6.1 is as follows:

As specified in the PIMP, periodic inspections shall be carried out to identify actual or potential factors that could affect the integrity of the pipeline.

The Licensee shall consider the use of an inline inspection tool capable of detecting the flaws that may exist in the pipeline. Any decision not to use an inline inspection tool shall be consistent with the safety management study and PIMP, and shall be documented.

Where a pipeline (or section of a pipeline) is not capable of being inspected by an inline tool, the Licensee shall consider whether the pipeline needs to be modified to permit inspection by an inline inspection tool. Any decision not to undertake modifications for this purpose shall be consistent with the safety management study and PIMP, and shall be documented.

This section needs to be understood in context. AS 2885 applies to high pressure gas and liquid petroleum pipelines. This covers a broad range of pipelines including:

- large diameter, long distance (100's of kms) high pressure gas transmission pipelines with design lives in excess of 50 years which supply major populations or support critical infrastructure, and may be located in urban environments; and,
- small diameter, short (e.g. less than 100 m), lower pressure oil flowlines with design lives of less than 5 years and deliver oil from a well to a local production facility in remote locations.

While AS 2885 primarily applies to steel pipelines, it permits use of other materials such as glass reinforced epoxy (fibreglass) or spoolable composite pipes (SCP) that are not susceptible to corrosion.

In this context, AS 2885 cannot make a blanket rule that all pipelines are required to be inspected by ILI. The Standard is pragmatic – it recognises that there are circumstances where it is not possible or necessary to do so. Examples include:

- Small diameter pipelines for which there are no ILI tools available that can be run in the pipeline.
- GRE (fibreglass) or spoolable composite pipelines where there is no imperative to run an ILI as they are not susceptible to corrosion, and the available tools for steel pipelines are not able to detect other types of flaws that may occur in these materials.
- Steel and gas flowlines (steel) in remote locations, the corrosion protection (coating, CP) and monitoring techniques are sufficiently effective, when considered in the context of the credible failure mechanism and the associated consequences of a flowline loss of integrity (safety, environment, security of supply).

The section states that any decision not to run an ILI (including a decision to not modify the pipeline to make it piggable) needs to be considered in the context of the requirements of the safety management study and the pipeline integrity management plan, and needs to be documented. Discussion of the safety management study and the pipeline integrity management plan is provided in the following sections.

It seems clear that the general intent of this section is that the pipeline should be made piggable unless there is a valid and compelling reason not to. Alternatives are accepted in certain circumstances for the reasons set out above, but it should not be inferred that the Standard considers that the alternatives provide an equivalent level of integrity assessment.

4.3 SAFETY MANAGEMENT STUDY (SMS)

AS 2885.3, Section 6.6.1 requires that the decision not to make a pipeline piggable must be taken in the context of the SMS.

The SMS considers safety, environment and security of supply consequences of pipeline loss of containment. (For gas pipelines, environmental impacts are generally of lesser concern than safety and supply concerns, while for oil pipelines environmental impacts (oil spill) tend to dominate).

The relevant SMS is "Pipeline Safety Management Study, NT Gas Pipeline System" Rev 0, 12 March 2011. Note that this was conducted prior to the release of AS 2885.3-2012

The SMS was conducted on the basis that the Channel Island Spurline will be made piggable.

Risk assessments for two corrosion related threats were conducted which are applicable to the Channel Island Spurline. The risk assessments use the frequency definitions, consequence definitions and risk assessment matrix provided in Appendix F of AS 2885.1.

Threat ID 1051 Undetected Metal Loss – unpiggable section of pipeline

- The risk assessment covers a number of unpiggable sections including the Channel Island Spurline.
- On the assumption that the Channel Island Spurline is going to be made piggable, the generic consequence assessment does not assess interruption of supply to critical infrastructure (e.g. the CIPS).
- Short term supply interruption to a non-critical customer is determined to be “Minor”. However, as noted in Section 3.4, an extended supply interruption is plausible for the Channel Island Spurline, in which case the consequence could be “Severe” or “Major”.
- The frequency of this event (across all unpiggable sections) was determined to be “Unlikely” (leak only, no ignition).
- The resultant risk ranking is “Low”.

Threat ID 1113 Undetected Metal Loss – ILI limitations

- The risk assessment covers all sections of the AGP.
- While not explicitly stated, the risk assessment applies to the Channel Island Spurline once it is made piggable.
- The risk assessment addresses general interruption of supply to critical infrastructure, but does not explicitly address loss of supply to the CIPS due to a failure of the Channel Island Spurline.
- The risk assessment assumed the failure modes to be a leak or rupture. APA considers that a long corrosion defect sufficient to cause rupture is credible (refer Section 3.4 above).
- For the leak case:
    - The consequence is “Minor” (assume 1-2 days interruption)
    - The frequency is “Unlikely”
    - The resultant risk rank is “Low”
- For the rupture case:
    - The consequence is “Major” (assume several days, up to 1 week). As discussed in Section 3.4, this is a credible consequence in some scenarios
    - The frequency is “Remote”
    - The resultant risk rank is “Intermediate”

On the basis of the foregoing (including the discussion in Section 3.4), these assessments can be applied to the Channel Island Spurline as follows:

- For the leak case:
    - The period of gas supply outage to CIPS of 1-3 days would result in disruption to the Darwin Electricity supply which in APA’s judgement is equivalent to a “Severe” consequence.
    - The frequency of a leak event is considered “Unlikely”
    - The resultant risk ranking is “Intermediate”.
- For the rupture case:
    - For an ignited release in the vicinity of the CIPS, at least one fatality is a plausible outcome (a “Major” consequence).
    - The period of gas supply outage to CIPS of at least one week (assuming damage to other plant and infrastructure) would result in disruption to the Darwin Electricity supply which in APA’s judgement is equivalent to a “Major” consequence.
    - The frequency of a rupture event is considered “Remote” (there is currently insufficient

certainty regarding the pipeline condition to assign a “Hypothetical” frequency to this event.
- The resultant risk ranking is “Intermediate”.

In both of these cases AS 2885 requires the Licensee to implement actions to reduce risk to “Low” or “Negligible”. If this cannot be achieved, action is required to remove threats, reduce frequencies and/or severity of the consequences to the extent practicable and demonstrate ALARP.

The considered position of APA is that to minimise any uncertainty regarding the frequency of a loss of containment due to external corrosion, and to identify any actions required to reduce the frequency and consequence of such an event, it is necessary to run an ILI over the full length of the pipeline.

The most significant consequence will occur if there is a major release (pipeline rupture) immediately upstream of the Channel Island Power Station (in addition to loss of supply, fatalities, damage to electricity and gas assets). On this basis it can be argued that the section of the pipeline that demands the highest priority for ILI is this section.

Further, if this section is made piggable so that an ILI can be run, the uncertainties regarding the corrosion condition of the pipeline can be largely removed, so that all assessed risks are likely to be revised to be “Low” or demonstrated to be ALARP.

Note: The foregoing assessment has not been subject to a formal validation review workshop as required by AS 2885 for an SMS, but is inferred from the information presented in the 2011 SMS report (which was subject to a formal validation review workshop) and subsequent advice from APA. The next formal review of the SMS as required by AS 2885 is scheduled for the first half of 2016.

4.4 PIPELINE INTEGRITY MANAGEMENT PLAN (PIMP)

AS 2885.3, Section 6.6.1 requires that the decision not to make a pipeline piggable must be taken in the context of the PIMP.

The PIMP takes into account the pipeline design, condition assessment, and any particular features of the pipeline (such as coating types and piping configurations which mean that specific locations are susceptible to corrosion).

It follows from this that the pipeline integrity monitoring regime is specific to the pipeline – the regime for one pipeline is not necessarily sufficient for another. As discussed above, there is uncertainty with regard to coating types and coating condition (and their location) on the Channel Island Spurline. In particular coatings for which CP shielding is an increased risk are not necessarily detectable by DCVG. It is on this basis that APA has concluded that it is necessary to conduct an ILI inspection along the entire length of the pipeline. The PIMP for the Northern Territory APA Group Assets is based on the assumption that the entire Channel Island Spurline will be made piggable.

4.5 OTHER REQUIREMENTS OF AS 2885

The 2012 revision to AS 2885.3 introduced requirements for integrity and remaining life review assessments at intervals not exceeding 10 years (refer AS 2885.3-2012 Section 10.3 “Remaining Life Review”). The review period is to be based on anticipated corrosion rates.

This section lists recommended data requirements for remaining life review. For reasons discussed above, the data requirements are not mandatory. Notwithstanding this, the item at the top of the list is “Pipeline integrity degradation data from inline inspection (ILI) surveys or metal loss defect assessments.”

Where a pipeline is not able to be inspected by ILI, remaining life review becomes increasingly difficult as degradation mechanisms for the coating and pipeline become more significant with the passage of time. In the absence of such data it becomes increasingly difficult to justify life extension beyond the design life and / or the next remaining life review period.

4.6 "RELIABILITY" OF INTEGRITY MONITORING PROPOSED BY AER

The AER draft decision is based on its position that the integrity monitoring regime proposed by AER is "reliable". The regime proposed by the AER is as follows:

- ILI inspection of the onshore section between the Darwin City Gate and the Channel Island Bridge (i.e. this section to be made piggable).
- Visual inspection of the bridge section of the pipeline.
- DCVG surveys, excavations and inspections, and the extrapolation of findings from ILI survey work carried out on pipework upstream of the bridge crossing, for the remaining buried section of the pipeline which cannot be pigged.

The regime proposed for the piggable section (ILI inspection) and the bridge section (visual inspection) is reliable.

At issue is whether the regime proposed for the remaining buried section of the pipeline which cannot be pigged is reliable.

DCVG is a method for detecting coating defects utilising the cathodic protection system. While this provides an indication of some coating defects, it does not provide an indication that metal loss due to corrosion is occurring. Where DCVG is used as a primary means of corrosion monitoring, the following uncertainties need to be recognised:

- There is limited correlation between %IR and defect size. Many factors can influence the %IR reading that is obtained from a given defect. Furthermore, there is little correlation between defect size and the probability of corrosion occurring. Therefore, a dig-up regime based on %IR cannot be relied on to identify coating defects which are more likely to be subject to corrosion.
- The DCVG technique may not detect significant causes of corrosion such as beneath coating damage from rocks or other debris that allows moisture to permeate but shields cathodic protection current flow. Shielding can also occur under coating that is susceptible to disbondment such as tape wrap, heat shrink sleeves and coal tar enamel (all of which are used on the AGP).

An effective integrity monitoring regime requires dig-up and visual inspection regime to confirm whether corrosion is occurring at any given location. However, it is limited by the reliability of the techniques used to determine the dig-up location.

As discussed above DCVG does not necessarily detect all locations where active corrosion may be occurring, and therefore cannot be relied upon for locating sites for visual inspection. Inspections from DCVG indications together with other data such as from cathodic protection potential surveys, corrosion coupon or electric resistance probe data, dig-ups at locations not associated with DCVG, CP current demand and trending, can provide assurance that significant corrosion is unlikely (although none of these techniques can determine the extent of corrosion under shielded coating defects). However these techniques, which can be regarded as aligning with the NACE external corrosion direct assessment (ECDA) process (ref NACE SP0502), should only be considered as indicative of the level of risk of corrosion occurring. In line inspection (ILI) provides a substantially higher level of assurance.

As noted in Section 3.2, APA's experience using DCVG on the AGP is that coating defects identified on previous surveys may not be detected by subsequent surveys.

Extrapolation of findings from results upstream of the Channel Island Bridge does not remove uncertainties regarding the pipeline condition downstream of the bridge:

- The corrosive environment (soil conditions) on either side of the bridge are not necessarily the same.
- The construction techniques and particularly the application of field applied coating on fittings may not be consistent.
- In the absence of ILI data, the location of targeted dig-up sites cannot be reliably determined.

ILI directly measures metal wall thickness. Industry experience is that it is by far the most effective method for detecting metal loss locations for subsequent dig-up and visual inspection. In the absence of an ILI, there remains uncertainty regarding the external corrosion condition of the pipeline.

For these reasons, while AS 2885 permits use of an alternative pipeline integrity monitoring program in certain circumstances (as discussed in Section 4.2), it should not be inferred that AS 2885 considers alternative pipeline integrity monitoring techniques provide equivalent integrity monitoring.

4.7 "GOOD INDUSTRY PRACTICE"

GPA interprets "good industry practice" as, at a minimum, complying with the requirements of AS 2885. For this case, AS 2885 requires the Licensee, based on its knowledge and assessment of a pipeline's design, construction, maintenance and operations records, and also based on its assessment of the safety and supply risks, to determine an integrity monitoring program which is sufficient to effectively identify, monitor and control pipeline integrity threats. Having done so, implementation of an integrity monitoring program which is not capable of effectively identifying, monitoring and controlling pipeline integrity threats cannot be considered "good industry practice".

5 SUMMARY AND CONCLUSIONS

The Channel Island Spurline provides gas to the 310 MW Channel Island Power Station, which supplies the majority of Darwin's power (the total installed capacity of the Darwin to Katherine Interconnected System is ~500 MW).

The CIPS is regarded as critical infrastructure (as per APA Access Arrangement Submission, page 64), and falls under the definition of critical infrastructure in the *Framework for the Protection of Northern Territory Critical Infrastructure.*

APA has determined that the most significant threat to pipeline integrity is external corrosion. APA is concerned that the current inspection and monitoring regime (based on DCVG survey and targeted dig-up) does not provide sufficient confidence that it can locate and assess whether corrosion is occurring and the extent to which it may have occurred. Depending on location, a gas release due to corrosion has the potential to cause fatal injuries to persons close by, and cause significant disruption to Darwin's power supply and economy.

It is on this basis that APA has concluded that it is necessary to conduct an ILI inspection along the entire length of the pipeline in order to confidently assess the condition of the pipeline and determine what remedial action (if any) is required in the event that significant corrosion is identified. However, due to the configuration of the pipeline, it is currently not piggable.

APA's recent submission to the Australian Energy Regulator (AER) included a forecast capital expenditure to make the Channel Island Spurline piggable so that it can be inspected by an inline inspection tool (ILI).

AER has rejected the submission and proposed an alternative integrity monitoring regime:

- ILI inspection of the onshore section between the Darwin City Gate and the Channel Island Bridge (i.e. this section to be made piggable).
- Visual inspection of the bridge section of the pipeline.

- DCVG surveys, excavations and inspections, and the extrapolation of findings from ILI survey work carried out on pipework upstream of the bridge crossing, for the remaining buried section of the pipeline which cannot be pigged.

The AER decision is based (in part) on its assessment that inline inspection is not mandated by the relevant Australian Standard, and that inline inspection is therefore not the only approach to pipeline integrity management that is consistent with accepted good industry practice. AER asserts that its proposed monitoring regime is "reliable".

In GPA's opinion:

- Long term industry experience shows that ILI is the only proven method for reliably assessing pipeline metal loss features over its entire length.
- On this basis ILI inspection of the onshore section between the Darwin City Gate and the Channel Island Bridge is supported.
- Direct visual assessment is a suitable method for assessing external corrosion on the bridge section of the pipeline.
- The intent of the relevant section of AS 2885 (AS2885.3-2012 Section 6.6.1) is that a pipeline should be made piggable unless there is a valid and compelling reason not to.
- The Standard allows for alternative integrity monitoring regimes in certain circumstances, but it should not be inferred that the Standard considers that the alternatives provide an equivalent level of integrity assessment.
- The method proposed by AER for the remaining buried section of the pipeline does not provide the same level of integrity assessment as can be achieved by ILI and is unlikely to remove the uncertainty regarding the condition of the Channel Island Spurline immediately upstream of the Channel Island Power Station:
    - DCVG is a method for detecting coating defects. While this provides an indication of where corrosion may be occurring, it does not provide an indication that metal loss due to corrosion is indeed occurring.
    - There is limited correlation between %IR and defects size. Many factors can influence the %IR reading that is obtained from a given defect. Furthermore, there is little correlation between defect size and the probability of corrosion occurring. Therefore, a dig-up regime based on %IR cannot be relied on to identify coating defects which are more likely to be subject to corrosion.
    - The DCVG technique may not detect significant causes of corrosion such as beneath damage from rocks or other debris that allows moisture to permeate but shields cathodic protection current flow. Shielding can also occur under coating that is susceptible to disbondment such as tape wrap, heat shrink sleeves and coal tar enamel (all of which are used on the AGP).
    - ILI directly measures pipe wall thickness and therefore is not subject to these limitations.
- The section which AER proposes does not require ILI is immediately upstream of the Channel Island Power Station. A major release (pipeline rupture) in this section is likely to result in more severe consequences than for a release upstream of the Channel Island Bridge due to the proximity of people at the power station (potential fatalities), and the proximity of electricity and gas assets and the access road (damage to which could exacerbate the impact to electricity supply). On this basis it can be argued that the section of the pipeline that demands the highest priority for ILI is this section (i.e. there is a compelling reason to conduct ILI on this section).

GPA interprets "good industry practice" as complying with the requirements of AS 2885. For this case, AS 2885 requires the Licensee, based on its knowledge and assessment of a pipeline's design, construction, maintenance and operations records, and also based on its assessment of the safety and supply risks, to determine an integrity monitoring program which is sufficient to effectively identify, monitor and control pipeline integrity threats. Having done so, implementation of an integrity monitoring program which is not capable of effectively identifying, monitoring and controlling pipeline integrity threats cannot be considered "good industry practice".

Based on the information provided, GPA has no reason to contradict APA's assessment that:

- External corrosion is a credible threat to pipeline integrity
- Failure mode of leak or rupture is credible
- An ignited rupture in the vicinity of the CIPS could result in a "Major" consequence with respect to both safety (fatality) and supply (significant disruption to electricity generation capacity and potential damage to nearby plant and equipment).
- It is good industry practice to conduct an ILI for the entire length of the Channel Island Spurline.