Business Case – Capital Expenditure

Pipeline Integrity

Business Case Number 257, 258, 259

1 Project Approvals

TABLE 1: BUSINESS CASE – PROJECT APPROVALS

Prepared By	Anthony Jones, *Pipeline and Asset Management Engineer, APA Group*
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Approved By	Mark Fothergill, *General Manager Infrastructure Strategy and Engineering, APA Group*

2 Project Overview

TABLE 2: BUSINESS CASE – PROJECT OVERVIEW

Description of Issue/Project	The integrity management program for buried transmission pipelines includes: • Inline inspection • Rectification to enable Inline Inspection • Direct Assessment
Options Considered	The following options have been considered: 1. Option 1: Do Nothing Option 2. Option 2: Integrity Management Program
Estimated Cost	$21m (escalated)
Consistency with the National Gas Rules (NGR)	The replacement of these assets complies with the new capital expenditure criteria in Rule 79 of the NGR because: • it is necessary to maintain and improve the safety of services and maintain the integrity of services (Rules 79(2)(c)(i) and (ii)); and • it is such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services (Rule 79(1)(a)).
Stakeholder Engagement	A couple of sentences detailing how our engagement with stakeholders relates to this project. • Gas Market Rules • Landowners effects (noise, visual, third party encroachment etc) • Have we amended the project scope based on feedback received from consumers? • How have consumers been involved in the development of this project?

3 Background

This business case brings together all aspects of buried transmission pipeline integrity management programs. The scope of this document is for all pipelines managed in accordance with AS2885 and excludes station piping.

The Victorian Pipeline Regulations 2007 require under section 21 (2) that “For the purposes of section 109(a) of the Act, a pipeline must be operated in accordance with AS 2885.2-2002 and AS2885.3-2001.”

AS 2885.3:2012 has an entire section dedicated to Pipeline Integrity Management which demands the Licensee to ensure continued pipeline integrity. In addition, section 6.6.1 states “…periodic inspections shall be carried out to identify actual and potential problems that could affect the integrity of the pipeline.”

APA maintains the Victorian pipelines in accordance with a Safety Case approved by Energy Safe Victoria. The Gas Safety Act 1997 section 44 requires "A gas company must comply with the accepted safety case for a facility in relation to the management and operation of the facility."

There are primarily two techniques to inspect an in-service pipeline:

- Direct Assessment (DA)
- Inline Inspection (ILI)

Direct Assessment

The Direct Assessment technique is to excavate the pipeline, remove the coating and perform a non-destructive inspection (NDT) at regular intervals to determine a statistical confidence level as to the condition of the pipeline.

The Direct Assessment technique is acknowledged throughout the pipeline industry as the only means of determining the pipeline integrity where no other inspection technique is viable. There is a Canadian Energy Pipeline Association (CEPA) guidance on direct assessment.

APA utalises Direct Current Voltage Gradient (DCVG) surveys and other means to determine the location of where these DA are most likely to find a pipe wall defect.

APA requires a minimum of one inspection per kilometer of pipeline, with a minimum of two inspections per pipeline where DA is the primary means of integrity inspection.

Inline Inspection

The ILI technique involves advanced X, Y, Z geometry, Magnetic Flux Leakage and Ultrasonic Electromagnetic Acoustic Transducer (EMAT) tools (known as pigs) being inserted into the pipeline and pushed along in the gas stream. As they travel the tools measure the pipe wall thickness around 360 degrees for the total length and can detect geometric features and some tools can find cracks.

All VTS pipelines that are capable of being inspected with an ILI tool that are at least 10 years old, have been inspected with the ILI technique. APA has a Metal Loss Pigging Frequency Policy to determine the ideal re-inspection interval based upon calculation, although it has a default period of 10 years. The calculation is the preferred approach and it considers a number of factors including predicted corrosion growth rate, location class, operating pressure and the remaining pipe wall thickness.

In-line inspection is the one of the most important and conclusive activities in a series of integrity management processes that allows pipeline deterioration to be identified and rectified prior to failure.

The EMAT tool is capable of detecting cracking in the pipe. The cost of this tool is significantly higher and will be utalised on a risk basis. The drivers of the risk are similar to the assessment of Stress Corrosion Cracking (SCC) susceptibility:

- Pipeline operating at a stress level of ≥30% of Specified Minimum Yield Stress (SMYS)
- Pipeline traverses High Consequence Areas (HCA)
- Pipeline diameter ≥350mm nominal bore
- Pipeline mainline coating is coal tar enamel or field applied

Pipelines not able to be pigged

There are several pipelines within the VTS that are not able to be inspected with conventional ILI technique. The integrity of these pipelines is currently managed using the DA technique.

The strategy that APA employs on these pipelines is to rectify these to enable ILI on a risk basis. The drivers of the risk are

- Pipeline operating at a stress level of ≥30% of SMYS
- Rectification for ILI is practically possible

The following pipelines are required to be rectified to enable ILI.

- James St
- Tyres – Maryvale
- Truganina to Plumpton

These pipelines have a total length of 15.4km. The VTS is currently 2,200+km of pipeline length. The above pipelines that require rectification to enable conventional ILI represents approximately 0.7% of the VTS.

Pipelines that will continue with Direct Assessment

The following pipelines are currently not able to be ILI and will not be rectified to enable ILI. Thus the technique employed will be to continue with DA and unconventional techniques as they become available.

- Pakenham (both pipelines)
- South Melbourne – Brooklyn (up to start of pig launcher)
- Bay St
- Dandenong-Princes Hwy
- Somerton
- Laverton North
- Regent St

These pipelines have a total length of 10.4km. The VTS is currently 2,200+km of pipeline length. The above pipelines that will not be inspected using conventional ILI represents approximately 0.47% of the VTS.

4 Risk Assessment

The primary risks that could eventuate if the Integrity Management Strategy is not conducted are pipeline failure leading to a loss of containment.

TABLE 3: RISK RATING

Risk Area	Risk Level
Health and Safety	**Low**
Environment	**Low**
Operational	**Moderate**
Customers	**Moderate**
Reputation	**Moderate**

Compliance	**Moderate**
Financial	**Moderate**
Final Untreated Risk Rating	**Moderate**

5 Projects Considered

The following demonstrates the need for each category of capital expenditure required for the Integrity Management Strategy.

5.1 Option 1 – Do Nothing

The Do Nothing option would require in Direct Current Gradient Surveys (DCVG) to assess pipe coating integrity and to perform more frequent leakage survey. The DCVG technique provides a very limited information about pipeline integrity and cannot be certain to detect metal loss in the pipeline. In particular, where the coating is shielding, the DCVG cannot find that location. A shielding coating prevents the cathodic protection from working satisfactorily in that location and metal loss corrosion is highly likely. Examples of this are the corrosion found under failed heat shrink sleeves on the T1 Morwell to Dandenong pipeline (see Appendix A).

5.2 Project 2 – Inline Inspection

In-line inspection is the only certain method to locate external and internal corrosion, dents, gouges, cracks and other defects that affect integrity. It is a proven technology with many decades of successful delivery with increasingly capable tools. This information regarding the pipeline integrity enables condition assessment of the pipe and repairs scheduled as necessary. Alternatives will produce a lower level of condition assessment for a higher cost.

This business case is for a program of work as described in the below table, the costs are escalated to match the year of inspection

TABLE 4: PIPELINES TO BE PIGGED

Pipeline	Length (km)	Diameter (mm)	Cost	Year of ILI
T57 Ballan – Ballarat	22	150	$595,474	2018/19
T61 Pakenham – Wollert	93	750	$703,691	2019/20
T62 Derrimut – Sunbury	24	150	$448,950	2017/18
T66-70 Mt Franklin -Kyneton - Bendigo	91	300	$635,887	2019/20
T75 Wandong - Kyneton	84	300	$564,103	2019/2020

T108 Newport	1	450	$499,655	2018
T65 Dandenong - Princes Highway	6	750	$604,309	2018
T24 Brooklyn - Corio	51	350	$1,575,868	2021
T16 Dandenong – West Melbourne	36	750	$1,572,705	2021
T60 Longford - Dandenong	109	750	$2,790,438	2022
T70 Ballan – Bendigo	91	150	$618,062	2020
T33 South Melbourne – Brooklyn	13	750	$1,168,590	2021
T60 Longford – Tyers	65	750	$877,433	2022
T63 Tyers - Morwell	16	500	$697,668	2021
T96 & T98 Chiltern-Rutherglen – Koonoomoo	104	200	$598,493	2022
James Street - Laverton Pipeline (253)	2	350	$484,827	Immediately after trap installation
T37 Tyres - Maryvale	5	150	$404,030	Immediately after trap installation
T118 Truganninna-Plumpton	8	500	$600,694	2022
T01 Morwell – Dandenong (post inspection program)	127	450	$1,159,321	2018

Post Inspection Repairs

The last pipeline in the table is the T01 Morwell – Dandenong pipeline. This pipeline is the oldest and in the poorest condition of all VTS pipelines. The pipeline was inspected with ILI for the first time in its life 10 years ago, immediately after the pipeline was rectified to allow an ILI tool to be used. The ILI found many defects.

A majority of the defects were caused by cathodic protection shielding, mainly from incorrectly applied heat shrink sleeves. This practise was conducted in the 1970's through to the early 1990's. Therefore, the defects detected in 2006 ILI had been in existence for approximately 15-30 years.

The threshold for defects requiring repair is approximately 30% depth of metal loss, depending on length and width. Thus the defects that were detected with greater than 15% wall loss in 2006 are likely to reach 30% threshold in 2017 when the next ILI will be conducted.

The data from 2006 ILI shows approximately 70 defects with metal loss between 20-39% from external corrosion that were not repaired. A reasonable prediction is that after 11 years, 50 of these defects will require repair. These repairs will be undertaken in 2018.

There is no provision for pipeline repairs post ILI for any other pipeline in the VTS.

Crack Detection

The integrity information provided by intelligent tools can be loosely categorized as; metal loss detection, geometry and crack detection. No single tool is capable of assessing the pipeline for all three categories.

The metal loss and geometry detection tools do not identify pipeline cracking. The contemporary tool is the metal loss detection and geometry tools and all of the pipelines listed in the table will be inspected using a metal loss and geometry tools. The crack detection tool is the most technically advanced inspection method available in the pipeline industry.

The purpose of using the crack detection tool is to identify any circumferential cracking, longitudinal cracking, weld seam cracking, crack clusters and interaction with existing or other forms of corrosion.

The following pipelines will be inspected with a crack detection tool and thus their cost estimates differ when comparing on a cost per unit (length and diameter) rate:

- T24 Brooklyn – Corio (DN350)
- T16 Dandenong – West Melbourne (DN750)
- T33 South Melbourne – Brooklyn (DN750)
- T60 Longford – Dandenong (DN750)

5.2.1 Cost/Benefit Analysis

The benefits to this option is that ILI is the most comprehensive technique to managing integrity for inservice pipelines.

The only alternative to ILI is the DA technique. The cost of this option would be to perform at least 2,000 individual inspections of the pipelines. The cost of these inspections could be reasonably averaged at $28,000 per inspection. This would create a total inspection program cost of over $56,000,000. Given the results of these inspections are less than ideal, whereas the preferred option of ILI is a conclusive result the cost/benefit fails the most basic of assessments.

5.3 Project 3 – Rectification of pipelines to enable ILI

Some of APA's pipelines were not designed and constructed to enable the ILI tool to pass through the pipeline, and/or the necessary start and end of line valve arrangements to enable temporary pig launchers and receivers. This project is for the rectification of those pipelines to enable ILI.

TABLE 5: PIPELINES TO BE RECTIFIED

	Pipeline	Year Installed	Operating Stress % of SMYS	Failure Consequence	Coating Type	Joint Coating	Length (km)
1	Tyers to Maryvale	1971	38%	Major	Coal Tar	Enamel	5.4
2	James St	2005	36-49%	Major	Trilaminate	Heat Shrink	1.6
3	Truganina to Plumpton	2012	<72%	Major	FBE	Epoxy	8.4

The Australian Standard for operating pipelines AS2885.3:2012 states in section 6.5; "The Licensee shall implement processes and procedures to monitor and assess pipe wall integrity to maintain the required wall thickness." To achieve this prescriptive requirement, the wall thickness must be measured. The most accurate technique is undoubtedly ILI.

The Truganina to Plumpton pipeline has the launching pig traps installed but not the receivers. The reason for this was the pipeline was expected to be extended as part of the Western Outer Ring Main (WORM) project and thus the receivers not required at that location. The WORM will not be extended prior to 2022 when the Truganina to Plumpton pipeline will be required to be inspected. Thus the project to install ILI receiving station at Plumpton.

Heat shrink sleeves were used by the Gas and Fuel Corporation (G&F) for weld joint coating and to repair coating defects discovered by Direct Current Gradient Surveys (DCVG) for many years. Many of these were applied incorrectly by todays' standards and have led to disbondment and cathodic protection shielding. Pipelines with coal tar enamel coating that were not able to be pigged are likely to have many heat shrink sleeves applied from DCVG surveys. Once applied, DCVG is unlikely to detect the heat shrink sleeve failure where the coating is shielding the cathodic protection. The pipeline Tyres to Maryvale pipeline would have undergone a DCVG survey every 10 years in accordance with G&F standards. For many years the G&F repaired every coating defect detected, until statistical standard was applied which varied the quantity of repairs depending on the number of defects detected but as a minimum two defects would be repaired per pipeline section. This pipeline would have many coating repairs applied in the decades of operation and their exact location is unknown.

The disbonded heat shrink sleeves on the Tyres to Maryvale pipeline will shield the cathodic protection. That means that DCVG will not detect the coating failure. The only practical means of locating defects under shielding coating is with ILI.

5.3.1 Cost/Benefit Analysis

This project is to enable the passage of an intelligent inspection tool, without this work, the above pipelines are subjected to suboptimal integrity management strategies. The result is the inability to detect corrosion that is almost certainly occurring on the Tyres to Maryvale pipeline and indeterminate on the other two. Eventually this corrosion could result in a loss of containment. The significance of the loss of containment is dependent on the location, volume of gas released, ability for the gas to accumulate before ignition, the consequences to customers of pipeline shutdown during recovery and the loss of life or injury to people.

The James St and Trugannina pipelines are physically capable of rupture and traverse HCA. The consequence of a rupture in these areas is likely to be Major or Catastrophic. The Tyres to Maryvale pipeline supplies Victoria's largest gas consumer, the consequences of a rupture would be Major.

5.4 Project 4 – Direct Assessment

Some of APA's pipelines were not designed and constructed to enable the ILI tool to pass through the pipeline, and/or the necessary start and end of line valve arrangements to enable temporary pig launchers and receivers. There is a small quantity of pipelines in the VTS where it is not technically feasible to rectify the pipelines to permit ILI. In addition conventional ILI for small pipe diameters (less than 150mm nominal bore) is unlikely to be successful. In other cases, the operating stress level is lower enough where rupture is not a credible failure mode, so the largest loss of containment event from corrosion would be a pin hole leak.

The DA technique is to excavate the pipeline, remove the coating and perform a non-destructive inspection (NDT) at regular intervals to determine a statistical confidence level as to the condition of the pipeline. This approach is the only satisfactory method of achieving compliance with AS2885.3 section 6.6.1 "…periodic inspections shall be carried out to identify actual and potential problems that could affect the integrity of the pipeline."

TABLE 6: UNPIGGABLE PIPELINES

Pipeline Section	Diameter	Length	DA quantity
Pakenham (T38)	DN80&150	2,400m	4
South Melbourne – Brooklyn (T33) up to start of pig launcher	DN750	1,700m	4
Bay St (T89)	DN100 & DN150	450m	2
Dandenong-Princes Hwy (T65)	DN500	40m	2
Somerton	DN250	3,400m	3
Laverton North	DN150	1,600m	2
Regent St	DN200	800m	2

5.5 Summary of Projects

The section should include a general overview of how the options compare and identify any options are not technically feasible.

TABLE 7: SUMMARY OF COST/BENEFIT ANALYSIS

Option	Description	Costs (escalated)
Project 1	Do Nothing	Indeterminate
Project 2	Inline Inspection	$14,052,365
Project 3	Rectification for ILI	$6,683,901
Project 4	Direct Assessment	$640,394
	Integrity Management Program total	$21,376,660

5.5.1 Consistency with the National Gas Rules

Consistent with the requirements of Rule 79 of the National Gas Rules, APA considers that the capital expenditure is:

- Prudent – The expenditure is necessary in order to maintain and improve the safety of services and maintain the integrity of services to customers and personnel and is of a nature that a prudent service provider would incur.
- Efficient – The field work will be carried out by the external contractor that has been used to date, who has demonstrated specific expertise in completing the installation of the facilities in a safe and cost effective manner. APA tenders the provision of ILI services on a competitive basis. The expenditure can therefore be considered consistent with the expenditure that a prudent service provider acting efficiently would incur

- Consistent with accepted and good industry practice – ILI is a proven technology used worldwide for demonstrating pipeline integrity. Direct Assessment is accepted as good industry practice where ILI is not practical.
- To achieve the lowest sustainable cost of delivering pipeline services – ILI is the most cost effective solution and has been approved by the AER for many other pipeline assets.

5.5.2 Forecast Cost Breakdown

Inline Inspection

The costs of ILI are dependent on pipeline length, diameter, exchange rate, some fixed costs and need to relocate launch and receiving facilities. APA has a contract with a provider of ILI services where the cost is calculated by length, diameter and tool type per run.

The cost of crack detection tools is greatly influenced by the data processing costs which are depend on the number of features detected by the tool (the number of defects on the pipeline). This is impossible to estimate accurately.

Rectification for ILI

The costs for rectifying pipelines to enable ILI are heavily dependent on the original design, diameter and field bending techniques during original construction and not dominated by pipeline length. In most cases there is a need to alter the pipeline with live welding, stopples and bypasses to enable the inline valve arrangement and bends to be built. Each rectification project has been estimated from the bottom up.

Direct Assessment

The cost of DA depends greatly on the cost of excavation, reinstatement and recoating. All of these costs are dependent on pipe diameter, depth, surface conditions such as roads, pavement, grass or other. The exact locations of each DA has not yet been determined as a DCVG is required to be undertaken.

Appendix A – Photographic Evidence of Heat Shrink Sleeve Failure

The following images were taken from the Morwell to Dandenong Pipeline constructed with coal tar enamel (black), with enamel joint coatings (black). The heat shrink sleeves (yellow) were used as coating repair sleeves for many years.

The disbanded coating is shielding the cathodic protection from working. This phenomenon is undetectable by DCVG as the shielding prevents any indication of coating failure.

Image 1: Transition from original coal tar to the yellow heat shrink sleeve applied by the G&F Corporation.

Image 2: The disbanded heat shrink sleeve is clearly evident on visual inspection

Image 3: Extensive disbondment