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Corrosion Protection Strategy

CY2017 – CY2022

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1.1	09/09/2016	Daryl Lee	Revised First issue - Draft
1.2	10/12/2016	Troy Praag	Review/QA full document
2.0	19/12/2016	Izzy Shepherd	Final version – issue for use.

Originated By

Title	Name	Signature	Date
Asset Performance Engineer	Daryl Lee		16/12/2016

Reviewed & Approved By

	Title	Name	Signature	Date
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Executive Summary

The corrosion protection (CP) strategy details the lifecycle management of Multinet's corrosion protection system.

It applies to all corrosion protection assets and services located throughout the Multinet Gas distribution system, including corrosion protection units, test points, anodes, and ancillary equipment. The strategy aims to achieve a high level of safety and reliability specific to steel mains on the network via prudent and efficient management of corrosion protection assets.

To remain compliant with its regulatory obligations under the Gas Distribution System Code, AS4645, AS2885 and a number of CP related standards, Multinet undertakes a number of CP related capital programs, including:

- New Impressed Current Cathodic Protection Unit installation;
- Cathodic Protection Unit replacement;
- Impressed Current CPU relocations;
- New and replacement test point installations;
- New and replacement sacrificial anodes;
- Replacement of anode beds at Impressed Current CPU locations; and
- Surge protection works.

Table 0-1 provides the financial summary of the capital expenditure which is expected to be incurred in the calendar year period 2017 to 2022. Table 0-1 includes a breakdown of direct, overheads and real cost escalators for the purpose of reconciliation with that of the overview documentations which support our forthcoming Access Arrangement submission

Table 0-1: Summary of Capital Expenditure ($'000)

Program	CY2017	CY2018	CY2019	CY2020	CY2021	CY2022
CPU Installations	$168	$109	$109	$89	$16	$11
Test Points Installations	$70	$79	$79	$75	$75	$75
Sacrificial Anodes	$39	$24	$24	$24	$24	$24
Anode Beds	$122	$54	$113	$54	$35	$54
Surge Protection	-	$11	$11	$11	$11	$11
Total Direct Expenditure	**$400**	**$278**	**$337**	**$253**	**$161**	**$175**
Overhead	$24	$17	$20	$15	$10	$11
Subtotal	**$424**	**$295**	**$357**	**$268**	**$171**	**$186**
Real cost escalation	-	$2	$2	$2	$2	$2
Total Expenditure	**$424**	**$296**	**$359**	**$270**	**$173**	**$188**

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1. Document Overview

1.1. Purpose

This document articulates Multinet Gas' approach to the lifecycle management of its corrosion protection assets and services applied to the transmission, high pressure, medium pressure and low pressure steel piping systems located throughout the Multinet Gas distribution system.

It has the following objectives:

- Articulate the key areas of focus in relation to asset management, risk, investment, cost and service standard outcomes for the corrosion protection assets and activities; and
- Show alignment of asset management practices with Gas Network Objectives.

The document is intended for use by:

- Multinet Gas staff (and it's contractors); and
- Regulators - Technical, Safety and Economic.

1.2. Scope

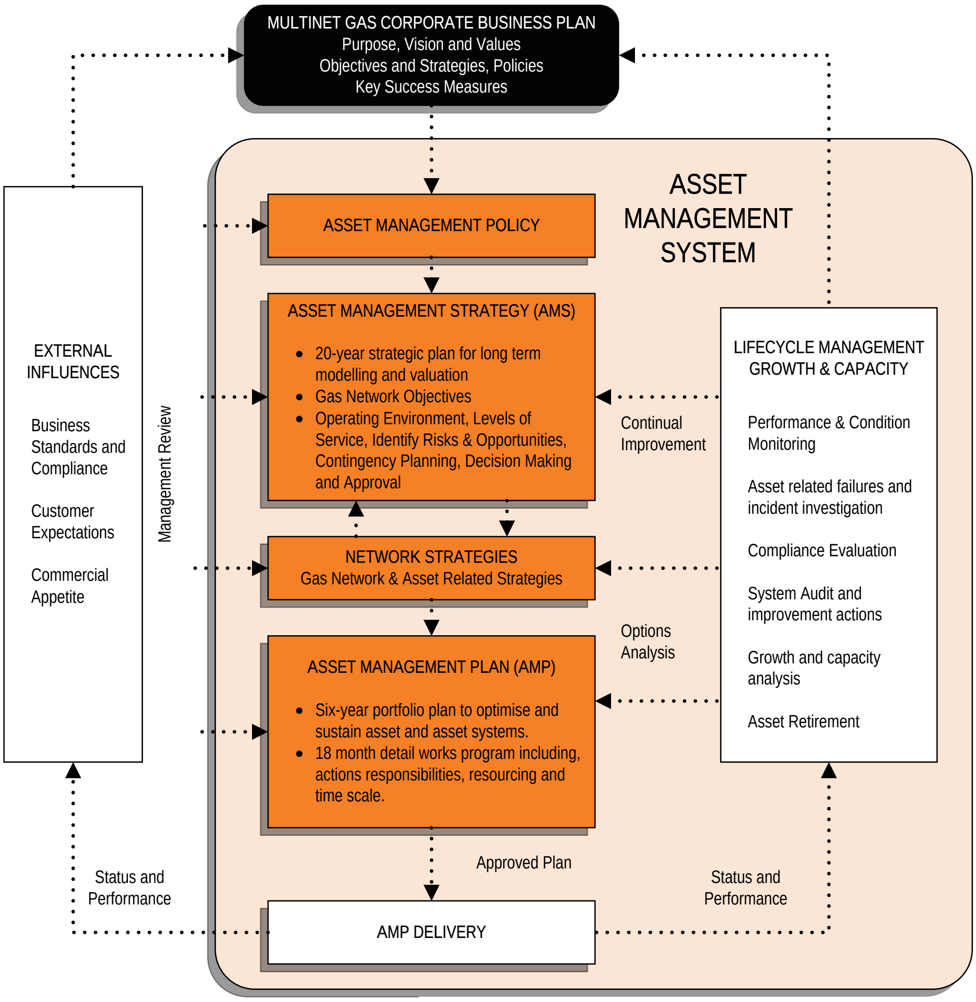
This strategy applies to Multinet Gas' Corrosion Protection assets and services located throughout the Multinet Gas distribution system, including:

- corrosion protection units;
- test points;
- anodes; and
- ancillary equipment.

1.3. Relationship with other Key Asset Management Documents

The Corrosion Protection Strategy is one of a number of key asset management documents developed and published by Multinet Gas in relation to its gas network. As indicated in Figure 1-1, Detailed Network Strategies - including the Corrosion Protection Strategy - informs both the Asset Management Strategy (AMS) and Asset Management Plan (AMP) of the programs needed to achieve the long-term objectives of the gas distribution network.

Figure 1-1: Asset Management Framework



1.4. Phasing and Financial Disclosure

All program defined within the strategy are presented in calendar years consistent with the reporting requirements of the Australian Energy Regulator (AER) and where applicable the Gas Distribution System Code (Version 11).

Where required for conversion to financial year (July to June), dollars and volumes can be estimated using a 50:50 expenditure split.

All financial figures quoted within this document - unless otherwise specifically stated - have the following characteristics:

- Real Expenditure / Cost (reference year = 2017);
- Direct Expenditure only (i.e. excludes overheads and finance costs);
- In units of $1,000 (i.e. '000); and
- All years are denoted in Calendar Year format.
- Total values shown in tables and referred to in the text of this document may not reconcile due to rounding.

Total values shown in tables and referred to in the text of this document may not reconcile due to rounding.

Conversion factors used in the escalation of historic expenditure to real 2017 equivalent expenditure is provided in Table 1-1. Cumulative conversion factors have been provided by the Multinet Gas Regulatory Department.

Table 1-1: Cumulative CPI Conversion Factors

	2012	2013	2014	2015	2016	2017
CPI Index - $2017	1.09619	1.07465	1.05192	1.02819	1.01296	1.00000

1.5. Data Sources

The following data sources have been drawn upon in development of the Corrosion Protection Strategy.

- SAP: [ERP tool used for data collection, analysis and maintenance management of MG assets]

Due to legacy data management and lack of internal resources in managing cathodic protection, corrosion protection has been predominantly managed by service providers. Detailed historical performance and asset data is inaccurate to a certain extent at this point in time.

1.6. References

- Gas Safety Case
- AS 4645 – Gas Distribution Network Management
- AS 4645.2 - Installation and maintenance of steel pipe systems for gas
- ET-CM-2314 Guide – Cathodic Protection Distribution System
- AS 2832.1 – Cathodic Protection of Metals Part 1: Pipes and Cables
- AS 2885 Series – Pipelines Gas and liquid Petroleum
- ESV Code of practice for electrolysis mitigation and cathodic protection.

1.7. Document Review

This document shall be reviewed every two (2) years or earlier if required. The next review is due on or before 31 December 2018.

2. Asset Overview

2.1. Introduction

Cathodic protection (CP) is a system designed to use direct current (DC) to protect metallic structures from corrosion. This can comprise of a galvanic anode cathodic system or an impressed current cathodic protection system. It is the secondary method of reducing the natural corrosion process on exposed steel pipe surfaces; the primary method being the protective coating of the steel pipe itself. CP uses DC current to redirect the flow of electrons that cause oxidation on the metal surface onto a sacrificial anode instead.

Multinet's low pressure (LP) and medium pressure (MP) gas networks are mainly constructed from coated mild steel pipe, but there is an increasing amount of plastic mains (e.g. polyethylene) being used in new works or in the upgrading of the existing systems. Cast iron and wrought iron pipes are gradually being replaced. These types of materials are more prevalent in the low-pressure areas.

The majority of the metallic pipework within the Multinet Gas area is subject to stray current from the D.C railway or tramway traction systems making an effective protection system and monitoring program essential to maintain its integrity.

The former Gas and Fuel Corporation of Victoria undertook to implement cathodic protection on their licensed Transmission Pressure pipelines in the 1960's. This successful method was then extended to the high pressure system during the 1970's and then in the 1990's onto the medium pressure. Extensive work was carried out to electrically isolate the cast iron, wrought iron and other uncoated pipework from the various distribution systems. The CP method applied utilises Impressed Current Cathodic Protection (ICCP) and sacrificial galvanic anodes (GA). This method increases the negative potential on a steel structure to mitigate corrosion occurring.

Multinet Gas' transmission, high, medium and low pressure (partial) steel pipelines are catholically protected. The breakdown of the cathodic protected mains length by network pressure is shown in Table 2-1

Table 2-1: CP by Network

Network Pressure	Length of Main Protected (km)
Transmission / High Pressure 2	243
High	2654
Medium	573
Low	329
Total	**3,799**

In total, 3,799km or 38.4% of the total distribution network is cathodically protected. 100% of the transmission pipelines are cathodically protected.

The cathodic protection system has 2,516 Test Points and 213 Cathodic Protection Units (CPU), of which 45 are high output units.

The Gas and Fuel Corporation of Victoria (GFCV) had a specialist Corrosion Mitigation Group responsible for the design, installation, monitoring, and maintenance of the cathodic protection systems and stray current drainage bonds. The pipeline operating divisions of the GFCV generally followed recommendations made by the Corrosion Mitigation Group. This group (later known as Corrosion Protection Services Group) in effect continued to provide these services throughout the desegregation and prioritisation of the GFCV which took place until in year 2000. From there, corrosion mitigation responsibilities were handed over to a Multinet Gas contractor. The same level of service has been maintained under these changes.

The so-called Millennium Drought which started in 2000 and lasted 10 years, progressively dried the Melbourne soil at depths where mains and anode beds are typically laid. This has resulted in a progressively higher soil resistance level, forcing more current to be impressed into steel mains to maintain cathodic protection. The drought ended in 2010 and rainfall has had a positive and progressive effect on soil resistivity.

The dry soil conditions at depth, has masked the effect of corrosion at points of coating defect and inferior CP in recent years. The lack of moisture has resulted in less surface corrosion where there would otherwise be.

The return to average rainfall will have a reverse effect of the drought. The problem is the difficulty in prioritising for augmentation as the data gained is progressive (network to network), but the entire network is changing constantly.

2.2. Asset Age Profile

Due to legacy data and record management, the official age of most sites in undeterminable as details of more granular components were not recorded.

Due to the complexities and variables that can influence the life of the assets there is no definitive age of failure. The physical location and the load impressed on the assets are the greatest contributing factors that affect the life span. In order to overcome this predicament, regular inspection and maintenance is completed on all assets at frequent intervals.

The assets in question consist of but are not limited to, test points, sacrificial anodes & anode beds, CPU (Cathodic Protection Units) Anodes, & Surge protection devices.

2.3. Asset Performance

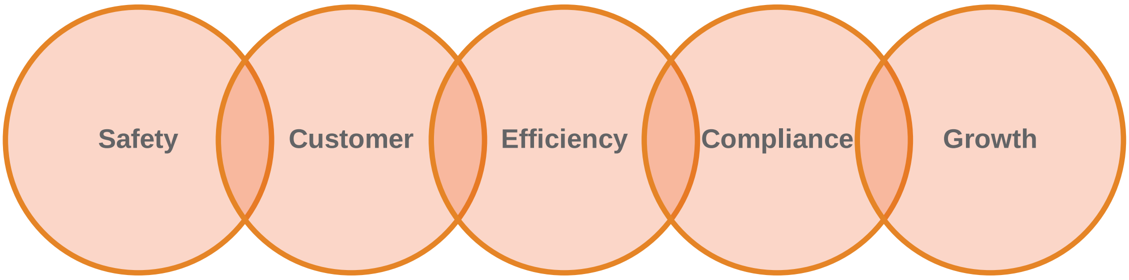
Generally the application of cathodic protection on steel gas mains has been successful in reducing the rate of corrosion on the network. AS 2832.1 states that a fully protected structure should be more negative than -850mV using a saturated copper/copper-sulphate reference electrode. Comdain and ZNX (Multinet's Service Providers) manage and monitor the performance of the network for deficiencies or faults on the corrosion protection systems to AS 2832.1.

3. Asset Management Drivers

3.1. Network Objectives

Multinet Gas has established five (5) network objectives that govern how the network is operated and maintained. This is reflected mostly in regulatory obligations and in some cases prudent and responsible behaviour, justifiable on economic grounds. Achievement of these objectives ensures the sustainable and reliable operation of the gas distribution network.

Figure 3-1: Gas Network Objectives



The alignment between network objective and the Cathodic Protection strategy is detailed.

3.1.1. Safety – Achieve Zero Harm, While Maintaining Current Levels of Network Safety.

This strategy aims to achieve a high level of personnel safety, and public safety through the continuous ongoing maintenance of the cathodic protection network. Cathodic protection prolongs the life of steel mains on the network, effectively mitigating the risk of gas escapes and danger to field personnel and surrounding public.

3.1.2. Customer – Effortless Customer Experience

While cathodic protection doesn't play a major role in the delivery of gas to the customer, it is still essential in giving customer confidence of the integrity of the steel network. Furthermore, surge protection measures in place ensure that in the rare chance customers come into contact with their steel service they are protected and safe.

3.1.3. Efficiency – Sustainable and Prudent Network Investment

This strategy aims to concisely outline the cathodic protection capital expenditure programs from 2017 to 2022. Due to the prolonging of asset life, replacement works can be deferred and existing assets can continuously be depreciated.

3.1.4. Compliance – Maintain Regulatory and Technical Compliance

The dangers associated with electrical hazards, stray currents, and other electrical interferences give rise to the importance of cathodic protection. As such, there are a number of standards to adhere to regarding the use of cathodic protection and its individual components. These include (but are not limited to):

- AS 2885-2012 Pipelines - Gas and liquid petroleum - Design and construction;
- AS 4645.1:2008 Gas distribution networks - Network management;
- AS 4645.2:2008 Gas distribution networks – Steel Pipe Systems;
- AS 2832.1-2015 Cathodic protection of metals - Pipes and cables;
- AS 2239-2003 Galvanic (sacrificial) anodes for cathodic protection;
- Electricity Safety (Cathodic Protection) Regulations 2009;
- V/Line, VicTrack and Metro Trains Standards and Clearances; and
- Energy Safe Victoria “Code of Practice for electrolysis mitigation and cathodic protection 2014.

3.1.5. Growth – Seek opportunities for new growth

This driver is not applicable in this strategy. The length of the steel network is steadily reducing in volume as polyethylene mains become the pipe of choice in the industry.

3.2. Lifecycle Management

3.2.1. General

The following maintenance activities have been in use since 1987. Analysis of this strategy and its performance over time has been accepted as giving satisfactory results.

3.2.2. Inspection & Corrective Maintenance

Maintenance of Corrosion Protection Systems.

All buried steel gas distribution pipework shall be adequately monitored to ensure that the level of corrosion protection is satisfactorily maintained. The following criteria are to be applied in determining if effective corrosion protection has been achieved.

Cathodic Protection Criteria

Effectiveness of cathodic protection shall be assessed in accordance with the requirements of AS 2832.1 “Cathodic Protection of Metals Part 1: Pipes and Cables”.

Protection Potential

A steel structure may be considered to be protected when the potential on all parts of its surface is equal to or more negative than -850 mV relative to a saturated copper/copper sulphate reference electrode. Measurement of this potential is only considered valid when not affected by any significant voltage gradients between the reference electrode and the structure.

Fluctuating Potentials

Where structures are subject to fluctuating potentials (such as in stray current electrolysis areas), the structure may be considered to be protected, provided the average potential is more negative than -850 mV, and anodic excursions more positive than -850 mV do not occur for more than 5% of the time in any 24 hour period. Furthermore the anodic excursions should be limited to a few continuous periods, and should be interspersed with frequent excursions more negative than -850 mV.

Testing and control of all stray current effects will be conducted according to the Energy Safe Victoria (ESV) "Code of Practice".

Where deficiencies in protection levels are identified, a thorough technical investigation shall be carried out to determine the cause(s) for the loss in protection and to recommend appropriate corrective action. In some cases the installation of additional equipment may be required to restore effective protection.

Note: Refer ET-CM-2314 Guide - Cathodic Protection Distribution System for more detail.

3.2.3. Reactive Maintenance - Faults & Defects

Fault Investigation

Where an unsatisfactory level of protection is identified from the routine monitoring surveys, the causes and exact location for the loss of protection are be investigated. When assessed as being appropriate, electromagnetic coil surveys will be used for identifying losses of protection caused by faulty electrical insulation or contact with foreign structures. Such surveys are be carried out by officers with the required technical skill, suitable experience and a detailed knowledge of the gas distribution system.

Equipment Faults and Protection

Faults in corrosion protection equipment and faults causing loss of effective protection are being promptly repaired. Suitably qualified and experienced personnel must undertake such repairs. Qualified electricians are be used for repairs of electrical equipment when appropriate.

3.2.4. Preventative Maintenance

Frequency

Cathodic protection levels within the distribution area are be monitored at six monthly intervals (twice per year). This frequency is in accordance with industry standard practice for high reliability onshore pipelines in populated areas. It provides an acceptable level of surety that the overall level of protection is being maintained, taking into account economic considerations, the reliability of protection systems (frequency of faults), compliance with Standards, and consequences of loss of protection.

Monitoring of Protection Equipment

All impressed current cathodic protection equipment and traction drainage equipment are be monitored at monthly intervals. All identified faults are being repaired, and the equipment returned to service a soon as practicable. All installations and equipment is be maintained in good working order.

3.2.5. Replacement

Replacement of corrosion protection equipment is carried out when corrosion protection monitoring and testing results indicate the stipulated level of protection is no longer able to be provided by the existing installations. This will include items such as ICCP units, anode beds and miscellaneous other equipment.

3.3. Performance Measures

3.3.1. Data Assessment

Cathodic Protection levels within the distribution area are monitored at 6 monthly intervals. A part of this monitoring includes the gathering of sufficient data to allow for the assessment of the effectiveness of both cathodic protection and traction drainage systems. The percentage of test points protected are be used to estimate the length of main in the distribution area, which meets the specified criteria for effective protection.

Test data from sections of main not meeting the required level are further assessed to determine the priority of work required to restore effective protection. Such assessments shall be based on the criticality of the main, the percentage of the 24 hour recordings which meet the required level of protection, or in areas not subject to fluctuating potentials, on spot potential readings.

3.3.2. Data Recording and Reporting and Information to be Recorded

Design and installation details, including correspondence with other authorities and structure owners, results of testing for effects on other structures, required permits and location details shall be recorded and retained.

AS 2832.1 provides requirements for information to be recorded.

Location details of all test points, and monitoring results are maintained for each area, and the data made available in SAP. Faults identified are also recorded in SAP 'Corrosion Protection Notifications'. Output readings of cathodic protection units shall also be recorded in SAP.

3.3.3. Reporting

At the end of each month a report is be prepared summarising the results of all surveys completed, with assessments and comments on areas where protection is identified as inadequate. All faults identified from monitoring and investigations are reported and appropriately referred for repair.

These reports are the property of Multinet Gas and are auditable by Energy Safe Victoria.

4. Capital Program - 2017 to 2022

Multinet aims to complete the following annual programs to maintain consumer safety and remain compliant with its obligations under the GDSC.

- New and replacement of Cathodic Protection Units;
- New and replacement test point installations;
- New and replacement sacrificial anodes;
- New and replacement anodes beds; and
- Surge Protection.

The capital expenditure program is based on historical data and expertise from our service providers. Some of the works scheduled for corrosion protection and related components shall be determined during the annual budgetary processes as they will be reliant on the results of the testing and monitoring regime explained above.

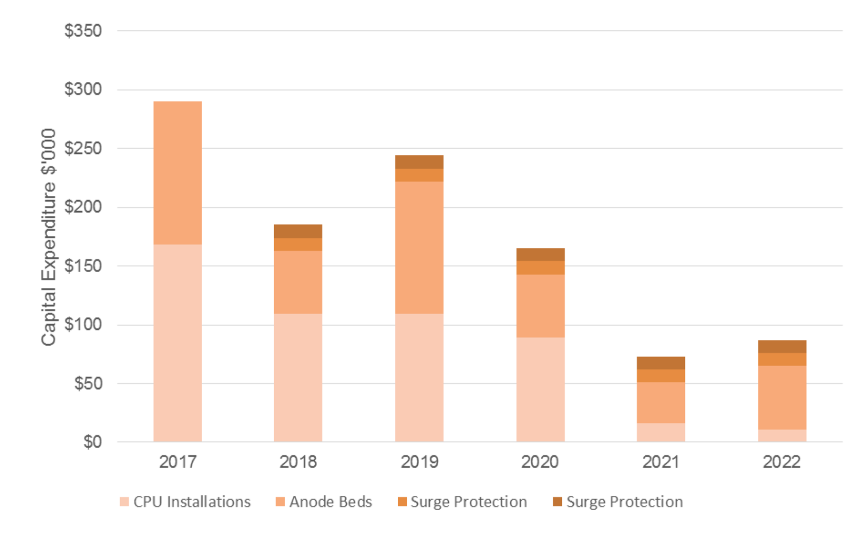
Capex allocation is captured within the AER regulatory accounts 'Other; category.

Table 4-1 and Figure 4-1 provides a breakdown of expenditure from 2017 to 2022 by program. The requirement for corrosion protection works is expected to ease over the period.

Table 4-1: Corrosion Protection Expenditure Breakdown

Ref	Program	2017	2018	2019	2020	2021	2022
4.1	CPU Installations	$168	$109	$109	$89	$16	$11
4.2	Test Points Installations	$70	$79	$79	$75	$75	$75
4.3	Sacrificial Anodes	$39	$24	$24	$24	$24	$24
4.3	Anode Beds	$122	$54	$113	$54	$35	$54
4.5	Surge Protection	-	$11	$11	$11	$11	$11
	Total Expenditure	**$400**	**$278**	**$337**	**$253**	**$161**	**$175**

Figure 4-1: Corrosion Protection Capital Expenditure



4.1. Impressed Current Cathodic Protection Units

4.1.1. Introduction

Impressed current cathodic protection units are required when the output required to maintain an adequate level of cathodic protection cannot be supplied by a simple connection to a Magnesium anode. These units typically include a cabinet with electrical componentry (e.g., power source, voltmeters/amp meters) and silicone anodes. They can be classified as low output and high output units, with high output units requiring more anodes and a bigger geographical footprint. All cathodic protection installations have to be registered and licensed with ESV, who restrict the output of the unit according to detrimental effects on asset of others.

4.1.2. Scope

The Impressed Current Cathodic Protection Unit program includes:

- New CPU installations;
- Replacement CPU's - High Output;
- Replacement CPU's - Low Output; and
- CPU Relocations.

New units are typically installed when there is a need for an additional area of protection required as a result of potential surveys. Replacement of units are required when there are sites that are expected to no longer be able to provide an adequate level of protection or if there is some failure of componentry or substandard condition of above ground equipment. There are also a number of pole mounted cabinets existing on the network which present a safety hazard for field personnel and are therefore being relocated to ground locations for ease of access.

4.1.3. Works Program

Based on historical works and estimates from service providers, this programs expenditure is estimated as provided in Table 4-2.

Table 4-2: CPU Expenditure

Program		2017	2018	2019	2020	2021	2022
New CPU Installations	Units	[redacted]	[redacted]	[redacted]	[redacted]	-	-
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	-	-
Replacement CPU – High Output	Units	-	[redacted]	[redacted]	[redacted]	-	-
	Exp.	-	[redacted]	[redacted]	[redacted]	-	-
Replacement CPU – Low Output	Units	[redacted]	-	-	-	-	-
	Exp.	[redacted]	-	-	-	-	-
CPU Relocations	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Program Expenditure	**$168**	**$109**	**$109**	**$89**	**$16**	**$11**

4.2. Test point installations

4.2.1. Introduction

Test points are required to ensure cathodic protection can be monitored in smaller geographical footprints. These are typically useful as the Multinet network grows and the replacement of steel mains with polyethylene effectively isolate some parts of the steel network. The installation of new test points is usually dependent on detection of gaps in coverage, however some allowance must be made for replacement of test points due to third party damage or construction activities. In addition to this, test points and cross bonding are also utilised in mitigating the risks from stray current. These test points will be determined by gaps in coverage or other asset/traction drainage requirements as per AS 2832.1.

4.2.2. Scope

The Test Point program covers the installation of new and the replacement of existing test points.

4.2.3. Works Program

Based on historical works and estimates from service providers, the programs expenditure is estimated as provided in Table 4-3.

Table 4-3: Test Point Expenditure

Program		2017	2018	2019	2020	2021	2022
New Testing Point Installations	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replacement of existing Test Points	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Program Expenditure		**$70**	**$79**	**$79**	**$75**	**$75**	**$75**

4.3. Sacrificial Anodes

4.3.1. Introduction

Sacrificial galvanic anodes are typically used where a smaller current and footprint is required to maintain protection levels. Typically the need for new or replacement sacrificial anodes is dependent on gaps in coverage which could be a result of changing electrochemical conditions in the area or an anode in the existing area being corroded or used up. These beds typically consist of 2-4 magnesium or zinc anodes.

Installed on isolated lengths of steel pipework, sometimes after gas network augmentation, anodes are also typically used in order to maintain protection on cased crossings which is essentially having a protective steel casing around a pipe that experiences frequent overhead stress such as railway lines or tram crossings. The steel casing which provides structural protection does not form part of the steel network but it still requires cathodic protection especially if in the vicinity of stray current. .

4.3.2. Scope

This program covers the installation of new and replacement of existing sacrificial anodes.

4.3.3. Works Program

Based on historical works and estimates from service providers, the programs expenditure is estimated as provided in Table 4-4.

Table 4-4: Sacrificial Anode Expenditure

Program		2017	2018	2019	2020	2021	2022
New Sacrificial Anodes	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replacement of Existing Sacrificial Anodes	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Program Expenditure		**$39**	**$24**	**$24**	**$24**	**$24**	**$24**

4.4. CPU Anode Beds

Anode beds are typically utilised with impressed current systems. The higher the output required the more anodes required for the system to maintain it's potential. Typically involving the use of silicon iron anodes, the low output beds consist of 1-2 anodes whereas the high output beds use around 10 anodes. These anodes need to be replaced as time goes by as they are continuously consumed to protect the pipe. These anodes also have a longer lifespan compared to the lower cost magnesium anodes due to the impressed current

4.4.1. Scope

This program covers the replacement of existing high and low output anode beds.

4.4.2. Works Program

Based on historical works and estimates from service providers, the programs expenditure is estimated as provided in Table 4-5.

Table 4-5: CPU Anode Bed Expenditure

Program		2017	2018	2019	2020	2021	2022
High Output – Replacement	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Low Output – Replacement	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Program Expenditure		**$122**	**$54**	**$113**	**$54**	**$35**	**$54**

4.5. Surge protection

4.5.1. Introduction

There are a number of electrical sources that may create a hazard on a pipeline using a number of different mechanisms to transfer electrical current to the pipeline. Such currents may originate from lightning, earth fault currents on adjacent power transmission structures, or from induced voltages due to both fault and load currents in high voltage power lines, cables or DC and AC traction systems.

Electrical surges on the network may cause the following but are not limited to:

- Electrical arcing which may be an ignition source for escaping gas;
- Damage to insulating fittings such as isolating flanges, coupling, unions and monolithic joints;
- Electrocution of field crew working on pipe;
- Coating damage on pipes; and
- Usage of one-off insulating equipment such as spark gaps.

4.5.2. Scope

Installation and replacement of varistor / spark gap combination at a number of regulator pits, cathodic protection units and insulating flanges on the Multinet Network.

4.5.3. Works Program

Based on historical works and estimates from service providers, the programs expenditure is estimated as provided in Table 4-6**.**

Table 4-6: Surge Protection Expenditure

Program		2017	2018	2019	2020	2021	2022
Surge Protection	Unit	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Program Expenditure	**-**	**$11**	**$11**	**$11**	**$11**	**$11**

4.6. Telemetry on Cathodic Protection Units

All of Multinet's CPUs and test points are measured on a monthly basis across the whole network. While still an effective method, it still poses an element of risk as isolated incidents could occur before or after the time of measurement. As such, Multinet would not be aware of any incidents until the subsequent CP reading the following month. Furthermore, field crew could be at the risk of electrical faults happening in the area at the time of reading. This is due to the fact that a majority of the CPUs and test points are within close proximity of power poles.

Due to these reasons, it is prudent and safe to implement data-loggers on cathodic protection units to take remote potential readings for reporting purposes, a continuous monitoring system and remote area testing can also be potentially implemented. The data recorded would also allow Multinet to view any unusual spikes in DC Traction systems that could potentially affect our network.

The costs associated with this project are captured in the SCADA strategy MG-SP-0002 as the project is considered a data acquisition tool.

5. Appendix

5.1. Glossary & Definitions

Term	Definition
Cathodic Protection	Prevention of corrosion by application of direct electric current to the surface of a metal.
Cathodic Protection Unit (CPU)	A device providing cathodic protection current, powered from an external energy source. Such energy sources include mains power, solar, etc. Cathodic protection units require permits and registration in accord with the Electricity Safety (Cathodic Protection) Regulations 2009
Cathodically Protected (Distribution) Area	An electrically isolated area within the distribution system, of size convenient and practicable for assessing and maintaining the effectiveness of corrosion protection
Corrosion	The deterioration of metal caused by its electrochemical reaction with its environment
Coating Quality Survey	A survey conducted by traversing directly above a coated main along its length using equipment and techniques designed to identify any defects in the coating. Methods in common use include “Pearson” and Direct Current Voltage Gradient (DCVG)
Coil (Electromagnetic coil) Survey	An electromagnetic tracing technique for locating points of failed insulation or electrical contact to other metallic structures.
Direct Current Voltage Gradient (DCVG) Survey	A type of coating quality assessment survey conducted by traversing above the pipeline using equipment that applies pulsating DC electrical signals to identify coating defects.
Drainage Bond	An electrical connection via cable from a point in the distribution system to tram or train substations to prevent adverse effects from stray currents. These installations include equipment to control the direction and magnitude of current flowing.
Electrical Isolation	The electrical separation of structures to be protected from other structures and/or electrical systems. This is achieved by the installation of insulating flanges, monolithic insulating joints and insulating couplings
Galvanic (Sacrificial) Anode	A block of metal which provides protection by preferentially sacrificing itself instead of allowing the steel to corrode. **Note**: Magnesium is commonly used for underground service, although sometimes zinc is preferred. Refer to AS 2239-2003 Galvanic (sacrificial) anodes for cathodic protection
GFCV	The Gas and Fuel Corporation of Victoria
Spot Potential Reading	A measurement of pipe-to-soil potential taken at a given location at a particular point in time. Such readings can be used to assess protection status where potentials do not vary with time. However, in circumstances where potentials fluctuate due to telluric or stray current influences, recordings of potential over a period of time (usually 24 hours) are necessary
Stray Current Electrolysis	Is the effect of stray currents on buried metallic structures
Test Point	A conveniently located termination point for electrical cables connecting to a buried pipeline. This allows measurement of the pipeline potential, and is the principal method of assessing the effectiveness of corrosion protection. Test points are also required for coating quality surveys and electromagnetic coil surveys to investigate losses in protection

Term	Definition
Thyristor Drainage Unit (TDU)	Electrical equipment, usually installed in tram or train substations, to provide sufficient negative voltage for drainage bonds to be effective. The output voltage of TDUs is normally controlled so as to vary in accord with substation load
Variable Conductance Drainage Bond (VCDB)	Electronic equipment used to control the current in a drainage bond. The output current of VCDBs is normally controlled to maintain a set level of protection on a structure
Victorian Electrolysis Committee (VEC)	The Victorian Electrolysis Committee comprises membership of all parties affected by or causing stray current electrolysis. It is responsible for co-ordination of testing and adjustment required to maintain effective protection from stray currents and to control interference between adjacent cathodic protection systems. It is also responsible for administration of cathodic protection permits and regulations under the authority of Energy Safe Victoria.

5.2. Monitoring Requirements

The material provided in this Appendix should be regarded as purely informative. Details may vary according to individual circumstances for each structure or protection system. The rationale provides only an outline of typical major reasons for a particular activity. Other factors may become of critical relevance in various situations.

AS 2832.1 Provides further guidance on monitoring requirements for catholically protected structures.

Item	Survey Interval	Features/Checks	Rationale
Distribution Areas Potential Survey, (including - isolated sections, supply mains and extensions)	6-Monthly	• 24 hour (nominal) recordings at test points significantly affected by traction or telluric currents • Spot readings at stable test points • Anode or CPU current • Compare with previous readings • Access, test point boxes and cables	Frequency of testing depends on safety, economic and environmental factors, including cost of monitoring, safety and reliability of system, effect of faults on protection and implications of resulting corrosion or gas escapes. Testing at 6-monthly intervals follows standard industry practice for gas pipelines in populated areas.
Transmission Pipelines Potential Survey	6-Monthly	• 24 hour (nominal) recordings at test points significantly affected by traction or telluric currents • Spot readings at stable test points • Anode or CPU current • Compare with previous readings • Access, test point boxes and cables • Submit a report to the asset owner and every second report is to be forwarded to the ESV for compliance to standards.	Frequency of testing depends on safety, economic and environmental factors, including cost of monitoring, safety and reliability of system, effect of faults on protection and implications of resulting corrosion or gas escapes. Testing at 6-monthly intervals follows standard industry practice for gas pipelines in populated areas.
New Steel Mains	Initial	• Coating quality survey within 12 months of completion. • Commission protection system.	To ensure mainlaying contractor complies with required standards. Ensure protection complies with AS 2832.1
Meter Regulators and Pits	6-Monthly	• Access, boxes and cables • Condition of risers • Condition of paint work • Bonding lugs • Surge protection	As for distribution areas, to maintain effective protection.
Cased Crossings	6-Monthly	• Potential of carrier and casing • Access, boxes, cables • Vents	To ensure casing is not in contact with carrier pipe. Such contact will cause loss of protection within the casing.

Item	Survey Interval	Features/Checks	Rationale
Cathodic Protection Units	Monthly	• Operation • Read current and voltage • Minor repairs • Access, test point boxes, cables etc.	
Drainage Bonds	Monthly	• Operation • Diode and resistance • Equipment OK • Minor repairs • Note: - the VEC conduct a monthly DB inspection.	
Surge Protection	6-Monthly	• Visual inspection of varistors, spark gaps, NiCd battery electrolyte level. • Access, boxes, cables	
Surge Protection	5-Yearly	• Lab check on characteristics of NiCd batteries • Electrical test of varistors and spark gaps. • Measure resistance to earth of earthing beds	
Consumer Installations	Fault Based	• Condition of risers • Meter regulator pipework • Electrical Isolation • Surge protection • Earthing.	
Coating Surveys	As Req'd TP pipelines 10 yearly	• Pearson test survey • DCVG survey	
Mains Location	As Req'd	• Electromagnetic Coil survey	

5.3. List of Tables

5.4. List of Figures