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CY2017- CY2022

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Gas Heater Strategy

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1.2	18/12/2016	Izzy Shepherd	Update to final draft following full review
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Originated By

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Executive Summary

This document outlines the maintenance and replacement strategy for the Gas Heaters on the Multinet Gas network. This strategy aims to achieve a high level of reliability for the Gas Heaters installed on the network through preventive & corrective maintenance coupled with planned replacement works.

Multinet Gas will complete the following program to maintain its alignment with Network Objectives and remain compliant with its regulatory obligations contained in the Gas Safety Case, Gas Distribution System Code, AS 4645 and AS 2885.

- Vortex Heater Expansion Program.

Capital Expenditure is limited to a single program in 2018. The primary driver for the Vortex Heater Expansion Program to achieve a higher operational efficiency.

Table 0-1 provides the financial summary of the capital expenditure which is 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 (2018-22).

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

Program	CY2017	CY2018	CY2019	CY2020	CY2021	CY2022
Vortex Heater Expansion Program	-	$30	-	-	-	-
Total Direct Expenditure	-	**$30**	-	-	-	-
Overhead	-	$2	-	-	-	-
Subtotal	-	**$32**	-	-	-	-
Real cost escalation	-	-	-	-	-	-
Total Expenditure	-	**$32**	-	-	-	-

Table of Contents

1. Document Overview

1.1. Objectives

This document articulates Multinet Gas' approach to the management of its existing gas heater assets.

It has the following objectives:

- The Strategy articulates the key areas of focus in relation to asset management, key risks, key CAPEX programs, costs and service standard outcomes for the asset group;
- 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

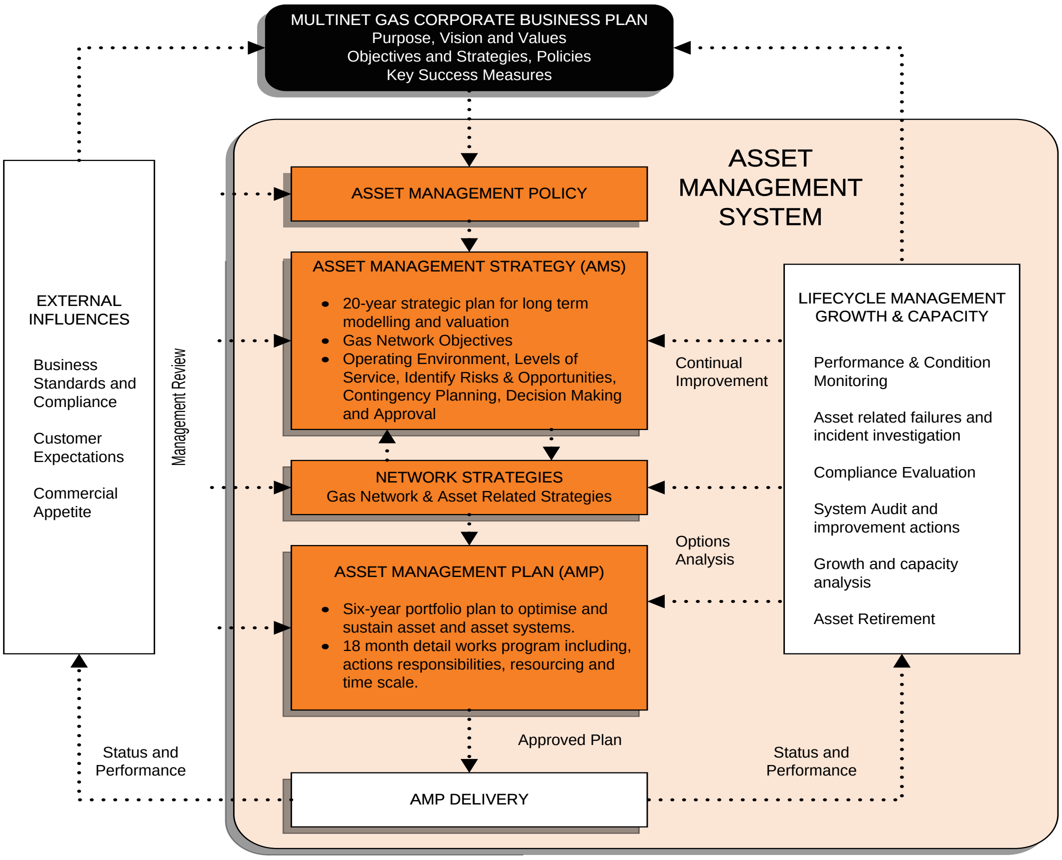
This strategy covers the management of Multinet Gas' existing heater assets:

- Installed at City Gate (CG) facilities located throughout the Multinet Gas distribution network that are operating at pressures up to 8,700 kPa, providing heating of sales gas prior to pressure reduction; and
- Installed directly within supply regulator facilities, providing heating to the regulator control loop, particularly pilot operated regulators where low inlet temperatures are experienced.

1.3. Relationship with other Key Asset Management Documents

The Gas Heater Strategy is one of a number of key asset management related documents developed and published by Multinet Gas in relation to its gas network. As indicated in Figure 1-1 figure below, detailed network strategies - including the Gas Heater Strategy - informs both the Asset Management Strategy (AMS) and Asset Management Plan (AMP) of the required capital 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 programs defined within this strategy are defined 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.

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 Multinet Gas' Regulatory department.

Table 1-1: 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 Gas Heater Strategy:

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

1.6. References

- AS 4645 series - Gas Distribution Networks;
- AS 2885 series – Gas and Liquid Petroleum; and
- Multinet Gas - System Operations Manual.

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

The purpose of a heater is to heat gas prior to pressure reduction to prevent unacceptably low gas temperature post pressure reduction.

The phenomenon of temperature change within a fluid that occurs during pressure changes is significant. The 'Joule-Thompson effect' summarises the effect on natural gas pressure reduction; 'for every 1,000 kPa drop in pressure there is a 5.4° C drop in temperature'. The higher the mass flow rate of gas, the higher the energy input required to maintain desired outlet gas temperature.

Gas preheat is important to prevent the formation of ice in the pressure regulating facility, and protect steel pipe from being subjected to temperatures below -29°C [where the properties of steel change]. In addition, the fixed factor billing of consumers relies on gas temperature of +15°C at the inlet to the gas meter.

Gas heaters and other heat exchangers are defined by the method of heat generation (gas burners, electric induction) and method of heat exchange (shell and tube water bath, conduction etc.). The design type and ability to meet demand ultimately determines the life of the equipment.

2.1.1. Water Bath Heater

Of the seven gas heaters that Multinet Gas has installed, three are of the water bath type.

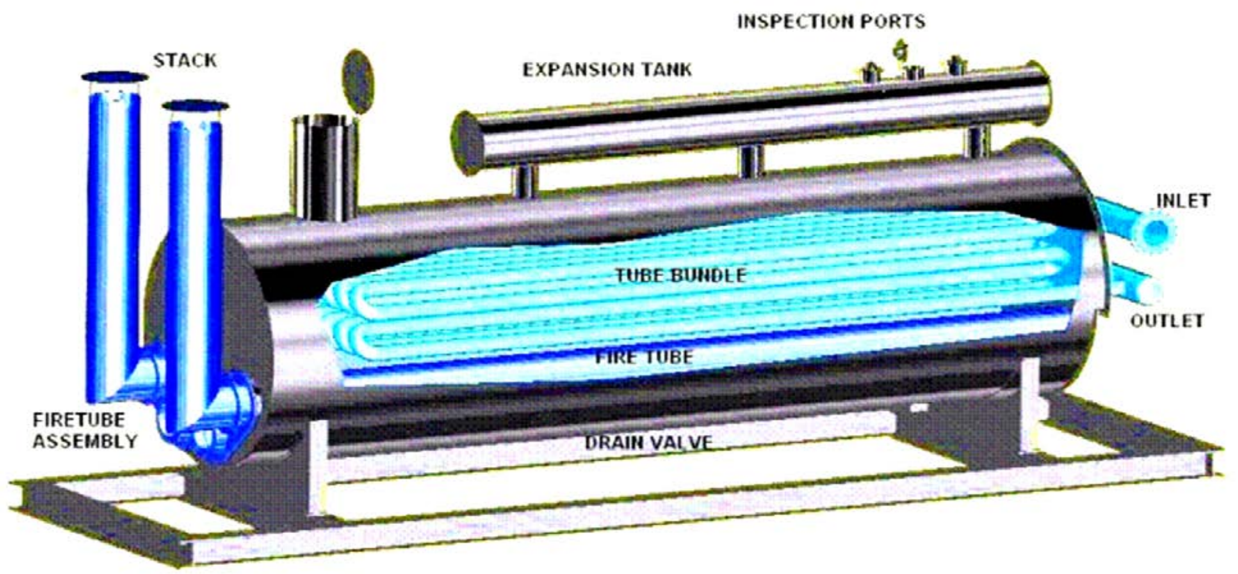
The method of operation is to create a tank filled with water that is heated by fire tubes. Process coils (series of pipes) that carry the high pressure gas are immersed in the heated water. The fire tubes are pipes filled with hot air from the burning of natural gas. Figure 2-1 shows a typical water bath heater.

The desired outlet temperature of the gas is controlled by throttling the burners to heat the water, which in turns heats the gas. Typically the water temperature is approximately 50°C and of a large volume. This large volume of water creates long lag times for heating, thus the water is constantly heated to maintain water temperature.

Figure 2-1: Typical Water Bath Heater

The water in the bath has corrosion inhibitors added, and process coils undergo periodic inspections for corrosion. The water also needs a top-up tank to refill the bath to replace water losses due to evaporation. Figure 2-2 shows a cut away view of a gas hot water bath heater.

Figure 2-2: Schematic of a Water Bath Heater



Checks of flue gas temperature and composition are necessary to prevent the condensing of flue gases in the fire tubes, resulting in standing water within the tube. This water could accelerate corrosion of fire tubes. The composition check indicates the efficiency of the burners to optimise performance.

The moderate quantities of gas burnt requires a volume of air to mix for optimum burning, thus the vent inlets and hot chimney stack are considerations for hazardous area design.

The electricity energy requirements for this type of heater are low and the water bath heater is not considered a pressure vessel. Only the process coils operate at a pressure above atmospheric and are considered station piping, similar to other upstream pipework within a City Gate compound. The burner train must be inspected and maintained in accordance with Australian Standards for Type B appliances[1].

Generally, water bath heaters are skid mounted, erected horizontally, are large, heavy, well integrated equipment and best suited to heat large volumes of gas at a reasonably constant rate.

The following figures show the internal components of a water bath heater.

- Figure 2-3 shows the process coils that carry the gas and is immersed in hot water;
- Figure 2-4 shows the fire tubes to heat the surrounding water; and
- Figure 2-5 shows the water bath heater shell, with fire tubes and process coil installed. The water would fill the empty space.

[1] AS 3814 Industrial and commercial gas-fired appliances

Figure 2-3: Process coils of a Water Bath Heater

Figure 2-4: Fire tubes of a Water Bath Heater

Figure 2-5: End view of a Water Bath Heater

2.1.2. Boiler and Heat Exchanger

Of the seven gas heaters that Multinet Gas has installed, two are of the boiler/heat exchanger type.

The difference between a boiler/heat exchanger compared to a water bath heater is the water is heated in a boiler, and then pumped into a heat exchanger. This system is not integrated like a water bath heater. It uses a closed loop of water, with the hot water returning to the boiler after passing through the heat exchanger. The small amount of water required (compared to water bath heaters) reduces lag time, so the concept of operating at idle and throttling to meet demand can be implemented.

The main advantages of the boiler package (compared to a traditional water bath heater) are:

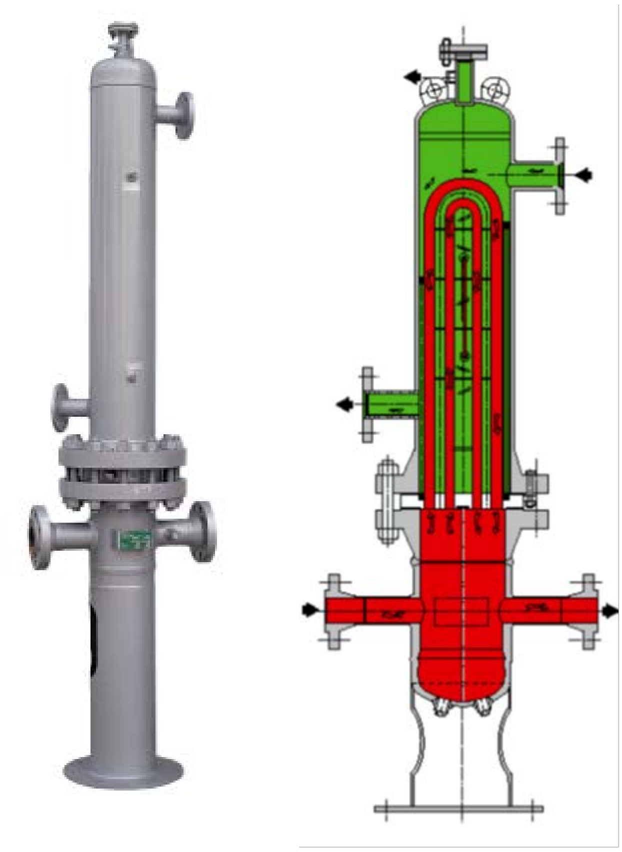
- Closed loop system, minimises water/anti corrosion inhibitor losses and unused heat energy from the heat exchanger is retained, whereas in a water bath heater, water evaporation occurs and hot gases in the fire tubes are expelled;
- Fast acting to changes in demand, and thus higher efficiency;
- Physical size is reduced;
- Noise is reduced; and
- Modular design permits incremental upgrades of each component.

The disadvantages of a boiler & heat exchanger are:

- The boiler must be inspected and maintained in accordance with Australian Standards for boilers (Type B appliance);
- Electric pumps are required, introducing failure consequences and additional precautions for electrical equipment and hazardous zoning; and
- Not yet proven to be cost effective for large continuous demand.

Figure 2-6 shows a typical heat exchanger and cut away in the vertical orientation.

Figure 2-6: Typical Heat Exchanger and Heat Exchanger cut away



2.1.3. Catalytic Heaters

Catalytic gas heaters are excellent for low heat energy outputs and are very efficient.

The Multinet Gas system previously operated catalytic gas heaters to maintain operating temperature of pilots for regulating stations susceptible to large pressure drops. All of these heaters have now been removed and, where heating is still required, replaced with Vortex heaters.

2.1.4. Electric Heaters

Of the seven gas heaters that Multinet Gas has installed, two are of the electric type.

Electric heaters generate their thermal energy from electrical resistance. Generally electricity is more expensive than gas on a per unit basis and thus not cost effective for large loads. However the designs are not as complex as there is no burning process. This eliminates fuel gas, ventilation, flame arrestors, ignition systems and water induced corrosion issues. However, being an electric device, hazardous area design and maintenance is required.

Electric heaters have been successful in other distribution companies for rural towns as a short to medium term solution until the new town's demand increases enough for a water bath heater or alternate.

Figure 2-7 shows the electric heater installed at [redacted].

Figure 2-7: [redacted] Electric Gas Heater

2.1.5. Vortex Heaters

Vortex heaters have replaced catalytic heaters at a few sites where the winter inlet temperature results in poor operation of the regulator control loop, particularly pilot regulators.

Vortex heaters operate by reducing gas pressure through a vortex nozzle creating high velocity gas that is dumped into the downstream (lower pressure) network. The vortex warms the outer casing of the heater which can heat up small volumes of gas.

These heaters are ideal for heating pilots and require no maintenance as there are no moving components.

2.2. Asset Age Profile

Multinet Gas has seven gas heaters installed at City Gate facilities. The location, commission year, type, condition and replacement value is presented in Table 2-1.

Table 2-1: Heater List

Location	Commissioned	Type	Condition	Replacement Value
[redacted]	2012	Boiler/Exchanger	Excellent	[redacted]
[redacted]	2013	Water Bath Heater	Excellent	[redacted]
[redacted]	2005	Water Bath Heater	Excellent	[redacted]
[redacted]	2007	Water Bath Heater	Excellent	[redacted]
[redacted]	2013	Electric	Excellent	[redacted]
[redacted]	2014	Boiler/Exchanger	Excellent	[redacted]
[redacted]	2016	Electric	Excellent	[redacted]

2.3. Asset Performance

Gas heater performance is measured by the ability to:

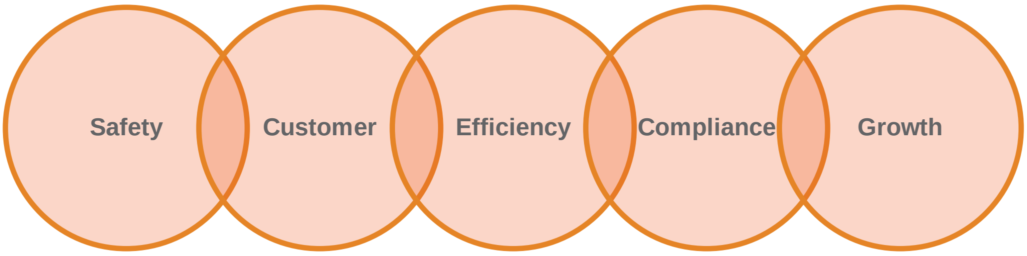
- Heat gas to required specification;
- Heat gas efficiently and cost effectively;
- Maintain low risk profile through high reliability;
- Resistance to corrosion; and
- Exhibit a minimum technical life of 20 years.

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 objectives and the Gas heater strategy is described below.

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

This strategy aims to achieve a high level of reliability and personnel / public safety through inspection, preventive and corrective maintenance, and asset replacement. All planned maintenance activities on gas heaters are underpinned by the need to ensure safety for the field personnel who carry out maintenance activities and the general public.

3.1.2. Customer – Effortless Customer Experience

This strategy aims to achieve a high level of customer satisfaction and experience by providing a reliable means of gas supply to the customer. The planned maintenance activities are designed to cause minimum or no interruption of supply to the end consumer.

3.1.3. Efficiency – Sustainable and prudent network investment

The maintenance strategies outlined in this document are aimed at improving the efficiency of the gas heaters installed in Multinet's network. The vortex heater expansion program aims to achieve increased operational efficiency through better heater control so they only operate when required (as opposed to continuous operation).

3.1.4. Compliance – Maintain regulatory and technical compliance

This strategy aims to achieve a high level of regulatory and technical compliance by ensuring that all maintenance and replacement activities are carried out to meet obligations contained in the Gas Safety Case, Gas Distribution System Code, AS 4645 and AS 2885.

3.1.5. Growth – Seek opportunities for new growth

This strategy also aims to cater for future network growth as new customers are added on to the network. The type of heater installation selected takes future provisioning into account at the design stage thereby allowing for a cost efficient way to cater for future increases in load capacity.

3.2. Risk Management

The risks posed by a gas heater are primarily equipment failure and the consequences of that failure, they are:

- Loss of heating ability causing reduced gas temperature; and
- Damage caused to other equipment, public or environment by failure.

3.2.1. Environment

A gas leak within a heating installation is considered rare, as all water based heaters are inspected every 6 months, and the water has corrosion inhibitors.

The loss of containment of the heated water could present an environmental hazard as the water contains chemicals to prevent corrosion. These chemicals have minor effects on the environment and are of small quantities.

3.2.2. Gas Quality

The consequences of low gas temperature has three main effects:

1. The reduced temperature creates inaccurate billing of gas meters close to the City Gate;
2. The damaged or poor operation of equipment involved with pressure reduction; and
3. The increase in brittleness of downstream pipework.

Consumer metering is fixed factor billing where a reliance on constant temperature at +15°C is required to maintain acceptable accuracy of measurement. If this temperature is greatly lowered, then the billing of consumers will be inaccurate (in the customers favour).

Low temperatures effect pressure regulation equipment, the immediate downstream pipe and distribution mains. Pressure regulation equipment, including over pressure protection equipment has decreased performance or inability to operate when moisture in the surrounding air is able to freeze on surfaces causing rubber components to perform in a different manner. This risk is the most likely to occur at City Gates and Field Regulators due to the large pressure differential.

Polyethylene distribution mains should not operate for extended periods of time at temperatures less than -20°C and steel mains down to -29°C. This has been taken into consideration at a number of high inlet pressure sites in the Multinet Gas network with special low temperature resistant steel installed immediately downstream of all South Gippsland City Gate stations.

3.2.3. Gas Leak

The fuel gas and process coil contain natural gas and any leak due to corrosion or third party damage has the potential for explosive consequences. These consequences are less than other areas of the Multinet Gas network as all heaters are above ground in secure compounds, preventing public access and utilising prevailing wind conditions to reduce gas accumulation. Gas detectors are installed at the majority of above ground stations. The likelihood of an explosion is considered extremely rare, as all heaters are inspected every 6 months and compounds are designed to minimise hazardous area effects.

3.3. Lifecycle Management

3.3.1. General

Planned replacement depends on the results of the six-yearly detailed inspections for water bath heater and the annual boiler inspection for boilers. Unplanned or ad-hoc replacements only occur due to failure of individual parts requiring immediate replacement after a breakdown; these are rare and usually confined to auxiliary services such as fuel gas regulators or temperature and pressure sensors.

The three types of gas heater present three different maintenance schedules.

The water bath heaters incur:

- Six monthly checks;
- Six yearly burner train scheduled maintenance on all water bath heaters; and
- Four year initial inspection and then based on an assessment, six to eight years for subsequent inspection.

The boiler and heat exchanger incur:

- Six monthly checks;
- Annual check by a boiler inspector; and
- Four yearly internal inspections and then based on an assessment, six to eight years for subsequent inspection.

The electric heaters incur a six monthly check which is aligned to the routine SCADA maintenance.

3.3.2. Inspection and Preventive Maintenance

Water bath heater operational check – winter and summer

1. Regulators are to be checked for correct operation and settings.
2. Strainers and instrument filters are to be removed, inspected and cleaned.
3. All pipework and joints are to be checked for leaks with the site being leak free on exit.
4. Relief Valves are to be checked for correct operation and settings.
5. Water bath temperature is to be checked using a suitable thermometer and adjusted if necessary.
6. Flue gases are to be analysed using a suitable gas analyser before and after conducting operational check.
7. Fluid contained in water bath is to be circulated.
8. Confirmation of receipt of alarms by the control room must be carried out and logged. Shut down alarms to be checked.
9. The spark arrester is to be removed and thoroughly cleaned.
10. Visually inspect fire tube for scale and rust.

11. Water and corrosion inhibitor are replaced during the summer operational check.

3.3.3. Scheduled Full Maintenance

This activity consists of the same activities as an operational check as well as replacing all 'soft spares' (gas burner regulator train).

In addition, a wall thickness test is conducted as part of the six to eight yearly inspection to check for signs of corrosion or damage. Some designs of water bath heater suffer from rubbing of fire tubes caused by thermal expansion and contraction.

3.3.4. Corrective Maintenance - Faults and Defects

Reactive maintenance on heaters is driven by failure alarms. All heaters are connected to SCADA and these alarms are detected by the control room. Usually these alarms are for flame blow outs or depleted water levels. These call outs are occasional and not frequent for heaters with automatic relight capability.

3.3.5. Replacement

The assumption made during design and selection of a gas heater is that the economic life will be driven by the ability of the heater to meet load. Typically, heaters will operate for at least 15 years; however the load may increase to a level where the heater can no longer maintain gas heating requirements. This either demands a replacement or installation of secondary heating. Generally, it is not cost effective to install a heater designed for greater than 15 year expected load, as the capital cost is high and the heater would operate at less than ideal efficiency at low loads for many years.

Replacement is therefore driven by current performance. All the heaters in the Multinet Gas network are performing well within requirements and therefore replacement or augmentation is unlikely in the next 5-10 years.

3.4. Performance Measures

The performance of a water bath, boiler or electric type gas heater is measured by maintaining the desired outlet gas temperature. For heaters with long lead time (water bath and electric type) the peak demand (maximum gas flow) needs to be predicted and then a control setting activated to schedule full heating load prior to the peak demand. Vortex heater performance is not measured other than during installation or maintenance when the heater can be physically viewed or monitored.

Based on the heater design and maintenance regimes Multinet Gas expects that all heaters will deliver an outlet gas temperature above $0^{o}C$ at all times.

4. Capital Program – 2017 to 2022

4.1. Overview

Planned capital expenditure of gas heaters is usually driven by their inability to meet current demand or that the condition of the equipment is likely to be deemed unserviceable in the near future.

Five of the seven heaters have been installed over the last 6 years and further replacements are not expected in the next 6 year period to 2022.

Multinet Gas has planned to complete the following annual program to maintain its alignment with the Network Objectives (refer section 3.1) and remain compliant with its regulatory obligations contained in the Gas Safety Case, Gas Distribution System Code, AS 4645 and AS 2885.

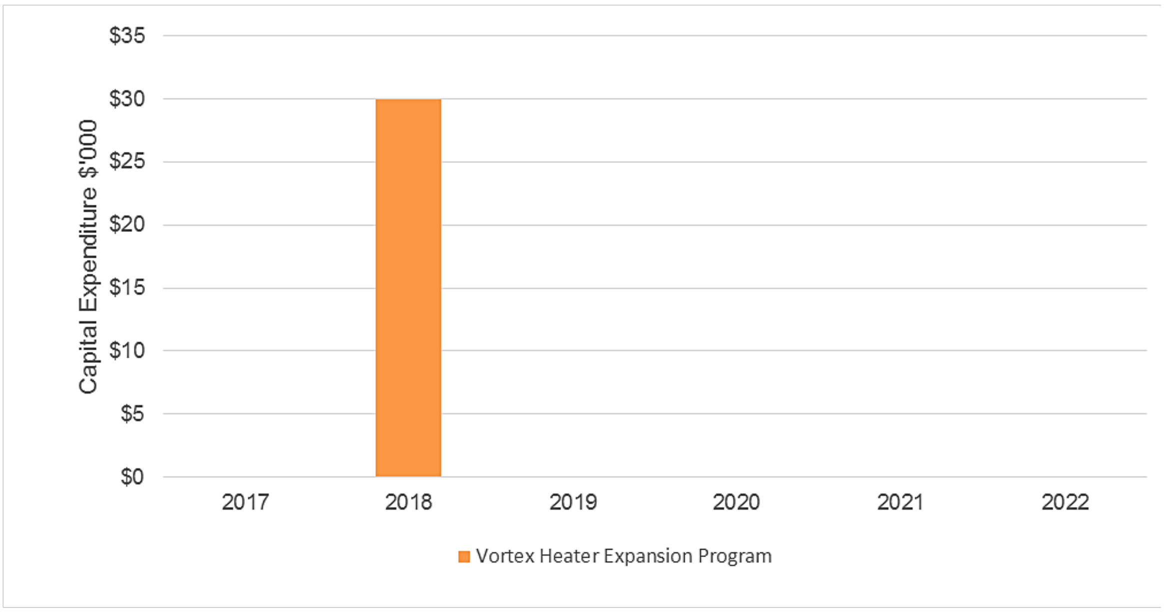
- Vortex heater expansion program.

Heater capex allocation is captured within the AER regulatory accounts ‘Other’ category (RJA sub-category).

Table 4-1: Financial Summary of Capital Expenditure

Ref	Program	2017	2018	2019	2020	2021	2022
4.2	Vortex Heater Expansion Program	-	$30	-	-	-	-
	Total Expenditure	**-**	**$30**	**-**	**-**	**-**	**-**

Figure 4-1: Capital Program - Gas Heaters



4.2. Vortex Heater Expansion Program

4.2.1. Introduction

Vortex heaters have replaced catalytic heaters at a number of sites where the winter inlet temperature results in poor operation of the regulator control loop, particularly pilot regulators.

Vortex heaters operate by reducing gas pressure through a vortex nozzle creating high velocity gas that is dumped into the downstream (lower pressure) network. The vortex warms the outer casing of the heater which can heat up small volumes of gas.

These heaters are ideal for heating pilots and require no maintenance as there are no moving components.

4.2.2. Scope

The Vortex Heater Expansion Program targets the heaters installed at the below Field Regulator sites:

[redacted]

4.2.3. Business Drivers and Strategic Alignment

The primary drivers for this program are:

- To achieve alignment with gas network objective of efficiency.

The vortex heater expansion program aims to achieve a higher operational efficiency by modifying the control loop to ensure that the heater is only working based on the temperature drop at the intermediate pressure reduction stage. The vortex heaters were previously working continuously irrespective of the outlet temperature.

4.2.4. Works Program

Multinet Gas plans to modify the [redacted] existing vortex heaters in 2018. Unit costs used in forecasting future expenditure estimates for the works have been based on the historical costs previously incurred in completing similar projects.

The summarised works program is shown in Table 4-2, and includes the expenditure and volumes associated with the program.

Table 4-2: Vortex Heater Expansion Program - Capital Expenditure & Volumes

Program		2017	2018	2019	2020	2021	2022
Vortex Heater Expansion Program	Units	-	[redacted]	-	-	-	-
	Unit/Rate	-	[redacted]	-	-	-	-
	Total Expenditure	-	**$30**	-	-	-	-

5. Appendix

5.1. Glossary & Definitions

Term	Meaning
AER	Australian Energy Regulator
City Gate	A City Gate Regulator can supply gas at an outlet pressure greater than 7 kPa and is supplied from a Class 600 Pipeline.
Field Regulator	A Field Regulator can supply gas at an outlet pressure greater than 7 kPa and is not supplied from a Class 600 Pipeline.
Gas Meter	Mechanical device (usually) used to measure the volumetric flow rate of gas that passes the device. The volume of energy that passes through the meter is dependent on both gas pressure and temperature when the volume is measured
GDSC	Gas Distribution System Code Version 11
kPa	Kilopascals
MG	Multinet Gas
SAP	Systems Applications and Products is an Enterprise Resource Planning tool which used at Multinet Gas for recording asset data and maintenance management.

5.2. List of Tables

5.3. List of Figures