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Asset Management
CY2017- CY2022

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Unaccounted for Gas Strategy

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Title	Name	Signature	Date
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Executive Summary

This document outlines Mutlinet Gas' management strategy for Unaccounted for Gas (UAFG).

In Victoria, UAFG is managed via a benchmark process which aims to incentivise the gas distribution networks to take steps to economically minimise the level of UAFG. Separate benchmarks are applied to Multinet's two independent networks.

- Metropolitan Melbourne, which is supplied by Victoria's Principle Transmission System (PTS); and
- South Gippsland, which is supplied by Bass Gas and not considered part of the PTS (i.e. non-PTS).

UAFG recompilation occurs annually by the Australian Energy Market Operator (AEMO). Since 2005, Multinet's UAFG has been in excess of its benchmarks resulting in significant payments to retailers.

This strategy aims to define UAFG, articulate and quantify its drivers and provide an overview of strategies adopted by Multinet Gas to efficiently reduce UAFG.

Since 2012, Multinet Gas has commissioned independent expert in UAFG, Asset Integrity Australasia Pty Ltd (AIA) to undertake three separate assessments in an effort to quantify and reduce its UAFG. Refer to Section 3 for summarised outcomes of each assessment. In their latest report (2017), AIA concluded:

- *"Multinet has maintained its UAFG at efficient and economically prudent levels over the 2013 to 2017 period given the nature of its network."*
- *"There are no additional cost effective actions available to Multinet that would have effectively reduced the current effective Class B UAFG level below 6.0%"[1].*

The sources of UAFG can be grouped into three categories:

1. ***Measurement*** – e.g. meter reading errors, timing mismatches, pressure and temperature correction, etc.;
2. ***Fugitive Emissions*** – e.g. mains leaks, meter leaks, third party damages, etc.; and
3. ***Systems*** – e.g. system reconciliation, data flows, UAFG calculation model.

Additional details of UAFG sources and their relative contribution to UAFG are detailed in Section 4. Fugitive emissions from Multinet Gas' Low Pressure network was deemed the highest single contributor of UAFG at 22.3% in CY2015.

Section 5 provides details of the strategies and programs adopted by Multinet Gas to efficiently reduce UAFG, grouped by each category – Measurement, Fugitive Emissions and System.

Key programs / Strategies include:

- Continuation of the LP Mains Replacement program (all Cast Iron mains decommissioned by 2033);
- Targeted replacement of all remaining MP Cast Iron mains by end 2021;
- Extending the coverage of pressure and temperature correction to all Tariff D customers by 2022; and
- Replacement of all remaining Turbine Custody Transfer Meters (CTM) by end 2019.

The highlighted programs will reduce UAFG through:

- Reduction of leaks from the cast iron and unprotected steel network;
- Improve gas measurement accuracy at points of highest throughput.

[1] In reference to Class B UAFG levels in CY2015

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1. Document Overview

1.1. Objectives

This document articulates Multinet Gas' approach to management of Unaccounted for Gas (UAFG) on its natural gas distribution network.

The strategy aims to:

1) Define UAFG and articulate its drivers;
2) Quantify the relative weighting of each driver; and
3) Provide an overview of strategies adopted by Multinet to efficiently reduce UAFG.

1.2. Scope

This strategy covers the management of UAFG across all asset classes and systems across Multinet Gas' distribution network. This includes:

- Both transmission and distribution assets, nominally referred within the strategy as 'distribution network';
- Assets located geographically located in inner and outer east metropolitan Melbourne, the Yarra Ranges and South Gippsland; and
- Expenditure associated with reconciliation of UAFG.

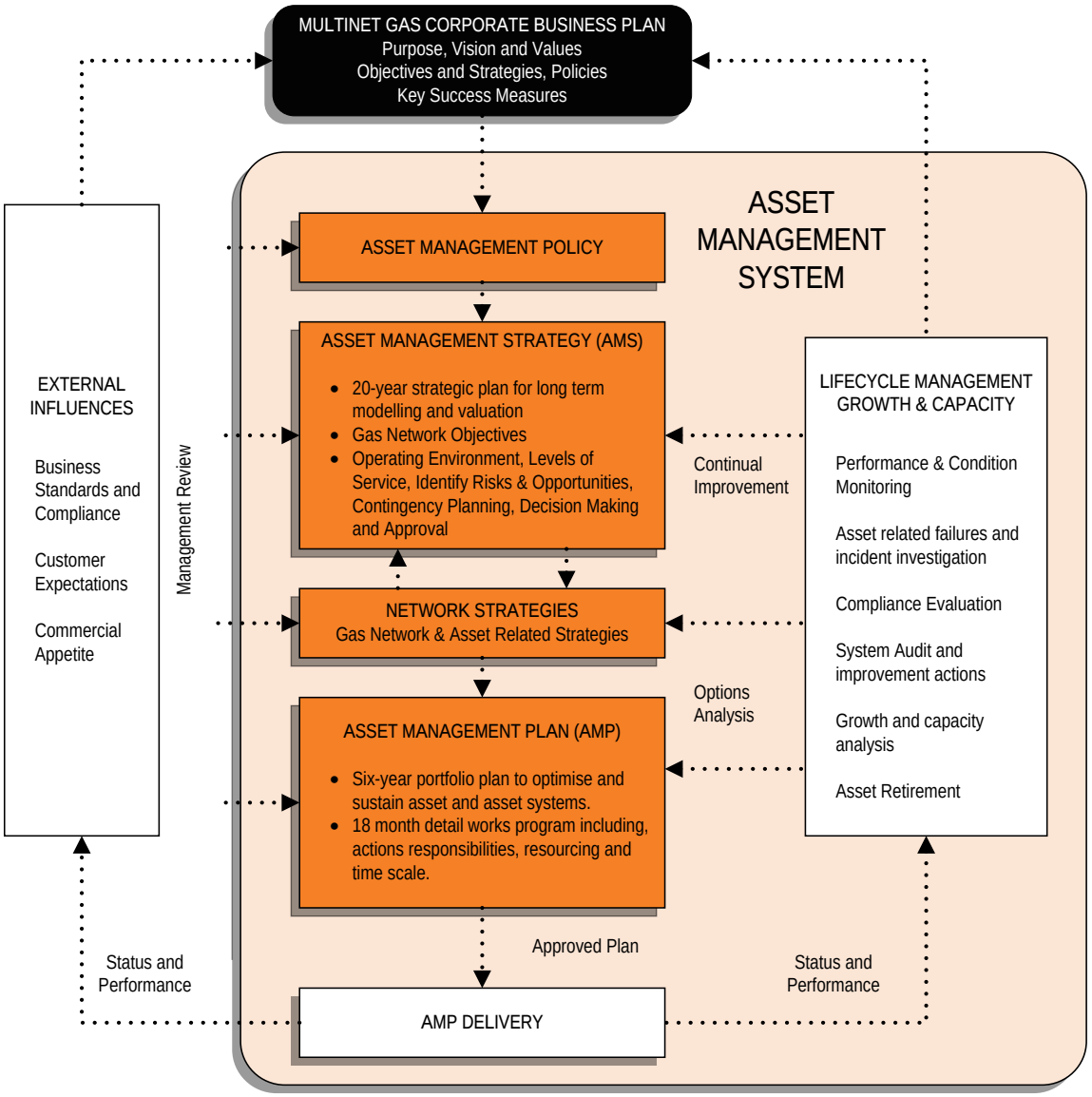
It does not cover:

- A forecast of UAFG for the 2018-22 regulatory period;
- Carbon Emission Reporting; and
- Expenditure, either OPEX or CAPEX associated with strategic initiatives aimed at reducing UAFG.

1.3. Relationship with other Key Asset Management Documents

Multinet's UAFG 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 UAFG 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. Data Sources

The following data sources have been drawn upon in development of the UAFG Strategy:

- SAP: [tool used for data collection, Billing and revenue, and analysis and maintenance management of MG assets]
- AEMO Systems: [Provides market participant with Injection data, Net System Load (NSL), pricing data, and consumption data for input into the UAFG reconciliation model.]

1.5. References

- National Gas Rules 2008
- Gas Distribution System Code Version 11.0
- Wholesale Market Distribution UAFG procedures (Victoria)
- Wholesale Market Metering Uncertainty Limits and Calibration Requirements Procedures (Victoria)
- Retail Market Procedures Version 12.0 (PROJECT-57-30)
- MG-SP-0002 SCADA Strategy v2.0
- MG-SP-0007 Small Meter Strategy v2.0
- MG-SP-0008 Large Meter Strategy v2.0
- MG-SP-0009 Distribution Mains Strategy v2.0
- AIA Report – RPC 0049B UAFG Management Review
- AIA Report – RPC 0056 Audit of the UAFG Calculation Processes
- AIA Report – Review of Multinet Gas UAFG v11
- APA Group Project: Metering Strategy Plan 2015 Multinet Gas Meter Sites
- Business Case: MG-17-062-T and P Correction for Tariff D MIRNs FINAL

1.6. Document Review

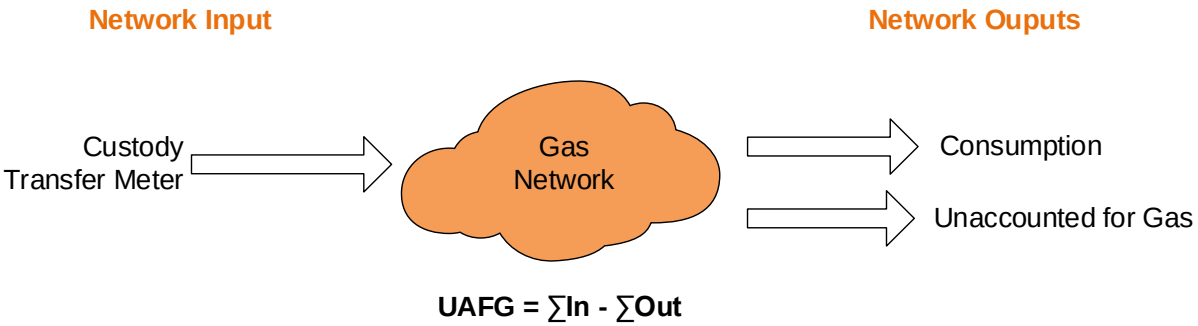
This document shall be reviewed every two (2) years or earlier if required. The next review is due on or before 30/06/2019.

2. Unaccounted for Gas

2.1. Overview

Unaccounted for Gas (UAFG) refers to the difference between the measured quantities of gas entering the gas network (measured by Custody Transfer Meters) and the gas delivered to customers (measured by individual consumer meters). Refer to Figure 2-1.

Figure 2-1: Unaccounted for gas flow diagram



UAFG = ∑In - ∑Out

The difference or unaccounted amount is currently calculated and reconciled on an annual basis from data supplied by Australian Energy Market Operator[2] (AEMO).

UAFG, in Victoria, is managed via a benchmark process which aims to incentivise the gas distribution networks to take steps to economically minimise the level of UAFG. Refer to Section 2.4 for more information regarding regulation and benchmarks.

2.2. Networks Overview

Multinet Gas owns and operates two independent networks; Metropolitan Melbourne and South Gippsland. As such UAFG is reconciled separately for each of these networks.

The Metropolitan Melbourne network is supplied by Victoria's Principle Transmission System (PTS). South Gippsland is supplied by Bass Gas, which is not considered part of the PTS (i.e. non-PTS).

2.2.1. Metropolitan Melbourne (PTS)

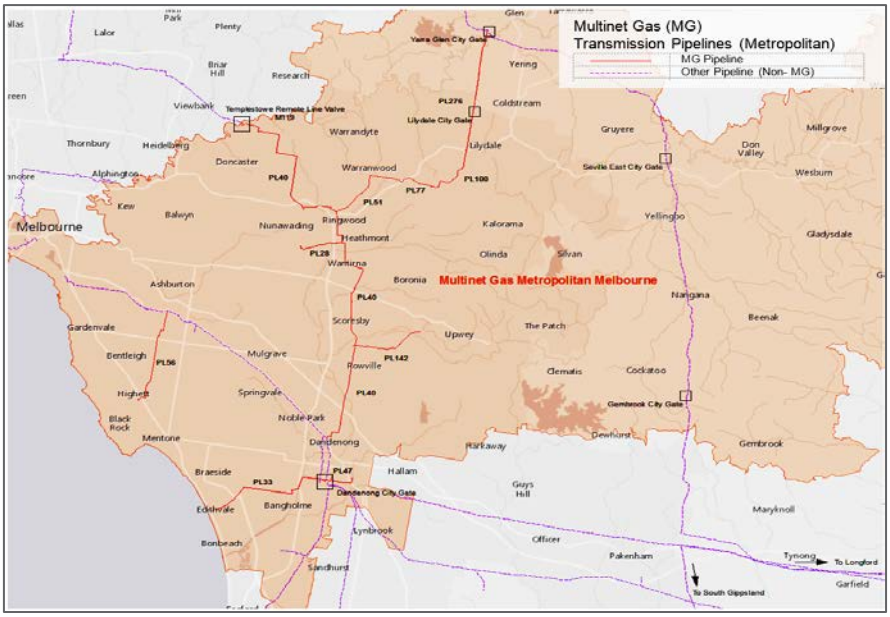
In the Metropolitan Melbourne area, as shown in Figure 2-2, gas is transferred to the Multinet Gas network via 18 custody transfer metering (CTM) stations and consumed by ~700,000 end users. APA Group owns, maintains and operates 17 of these CTMs and associated field equipment including the SCADA (Supervisory Control and Data Acquisition) system. A single CTM located in Templestowe is owned and operated[3] by Multinet. It serves as a network interface between the Multinet metropolitan network and the Australian Gas Networks (AGN) network, which is normally closed.

Refer to Table 7-1 in Section 7.2 for a detailed list of CTM's relating to the Metropolitan Melbourne network.

[2] Formally known as the Victorian Energy Network Corporation (VENCorp) for Energy Distribution Business operating in Victoria.

[3] Calibration and Maintenance carried out by APA Group on behalf of Multinet Gas.

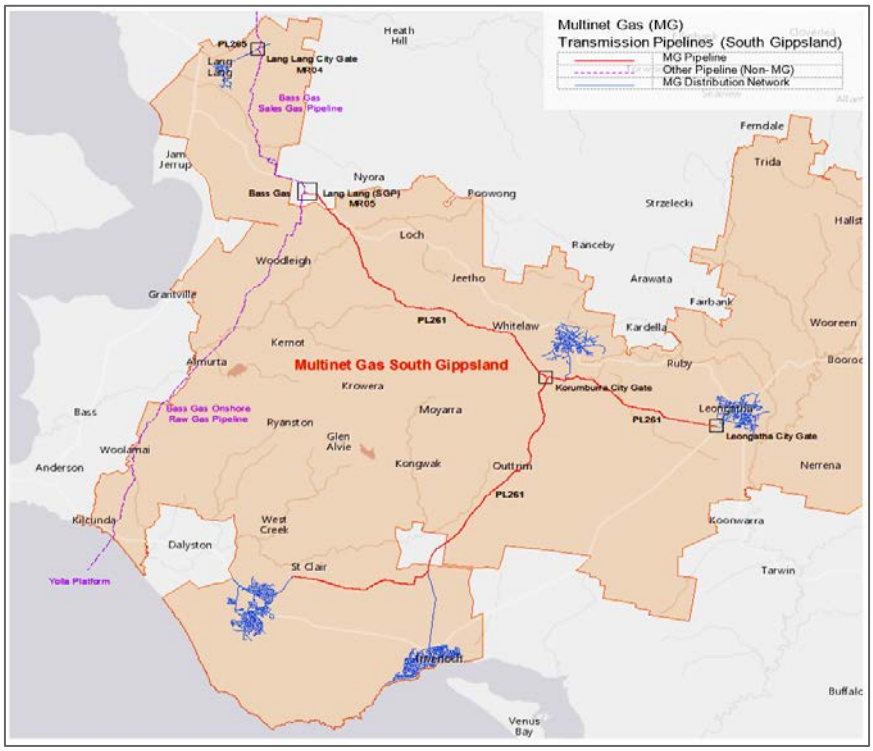
Figure 2-2: Multinet Gas Metropolitan Melbourne Pipelines



2.2.2. South Gippsland (Non–PTS)

Multinet Gas owns, operates and maintains two CTMs in South Gippsland, as depicted in Figure 2-3. The larger of the two, referred to as South Gippsland Pipeline (SGP), measures the supply gas to the townships of Korumburra, Leongatha, Inverloch and Wonthaggi. The smaller, refered to at Lang Lang, measures the supply of gas to the township of Lang Lang. Refer to Table 7-2 in Section 7.2 for a list of CTM's relating to South Gippsland.

Figure 2-3: Multinet Gas South Gippsland Network



2.3. Past Performance

The following sections detail past performance of UAFG for the two networks; Metropolitan Melbourne and South Gippsland.

2.3.1. Metropolitan Melbourne (PTS)

Figure 2-4 provides gas network throughput from 2002 to 2015. It shows throughput has been stable with a slight downward trend over the period. Annual throughput is weather dependent with colder winters increasing end user demand.

Figure 2-4: Metropolitan Melbourne - Gas Network Throughput

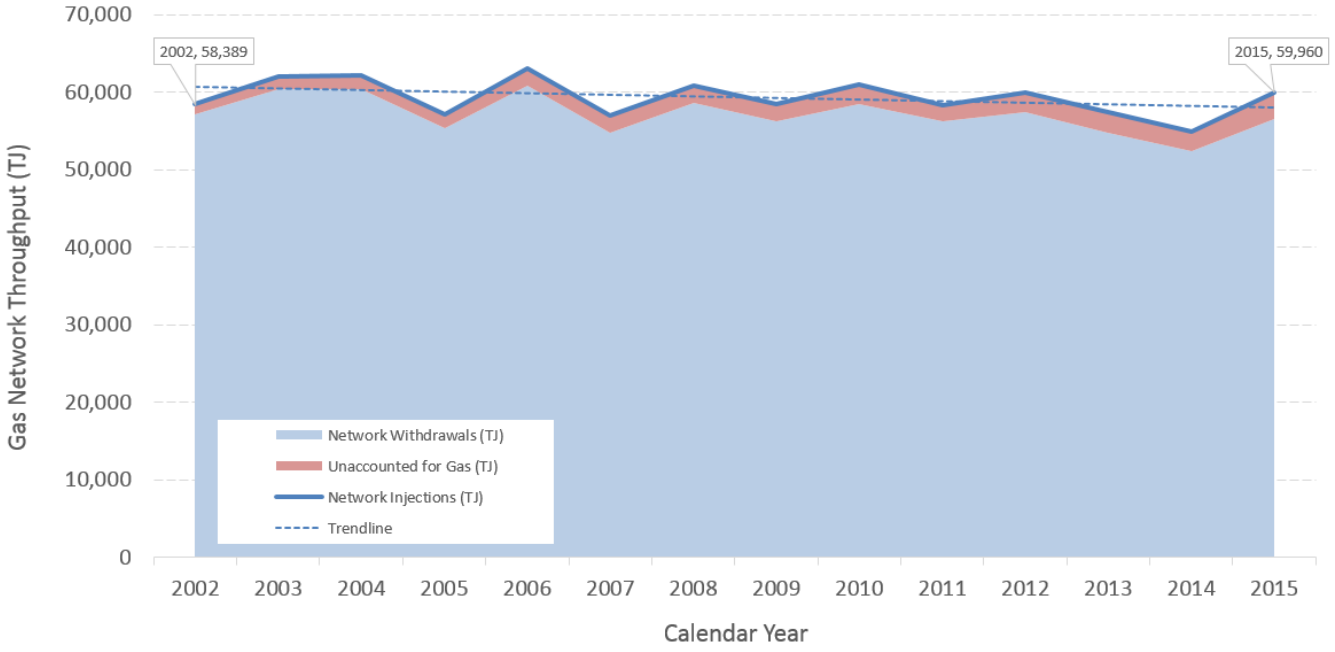


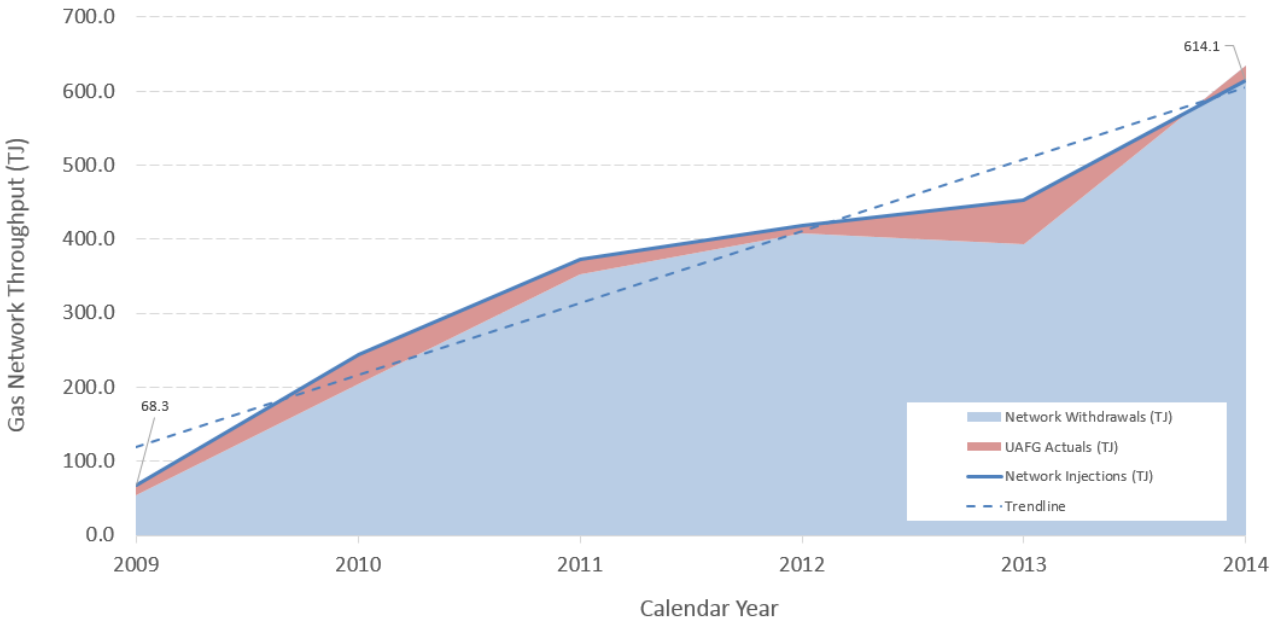
Figure 2-5 provides UAFG over the period 2002 to 2015, measured as a percentage of throughput. It shows an almost linear increasing trend over the period from circa 2% in 2002 to almost 6% in 2015.

Figure 2-5: Metropolitan Melbourne – Actual UAFG[4] since 2002

South Gippsland (Non-PTS)

Throughput in the South Gippsland network, as depicted in Figure 2-6, has steadily been growing since commissioning in 2008. In comparison to the Multinet's metropolitan network, the South Gippsland network contributes approximately 1% of annual throughput.

Figure 2-6: South Gippsland - Gas Network Throughput

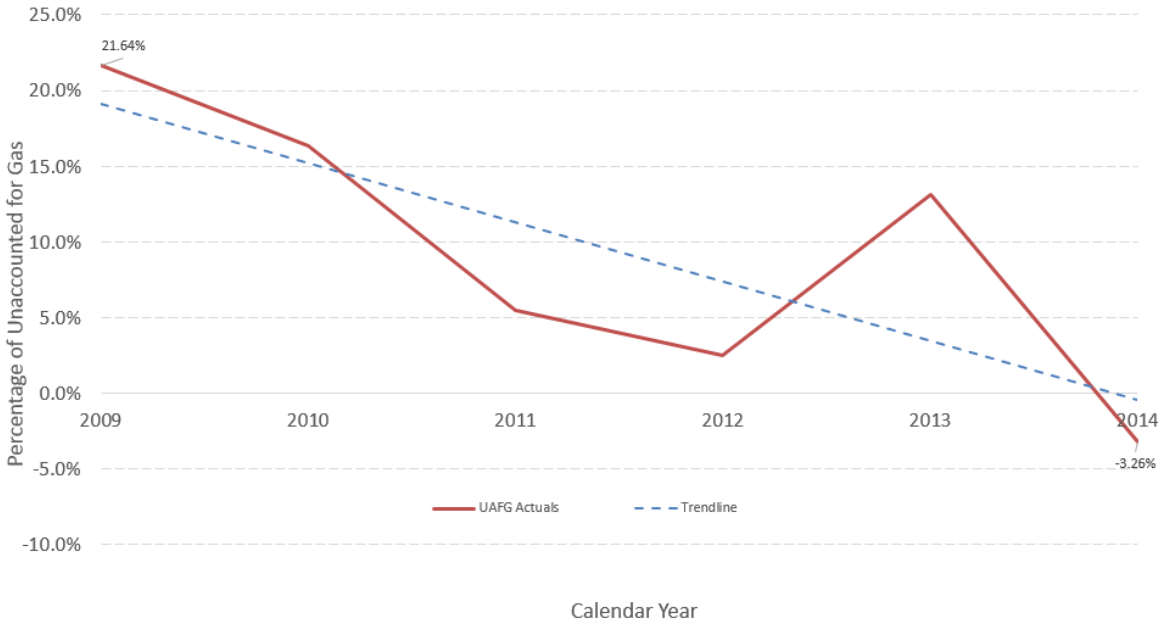


[4] UAFG is weighted average of Class A and B

UAFG for South Gippsland is extremely erratic. UAFG levels, as shown in Figure 2-7, have fluctuated over the period 2009 to 2014, ranging from losses of more than 20% in 2009 to a net gain in 2014 where more gas was withdrawn from the network than injected. Volatility in UAFG in the early years of a new system is to be expected because initial volumes are low, purging and venting is occurring for each new connection and the Coriolis metering may be subject to zero stability issues at low flows. As flows increase we expect the UAFG to become more stable.

Refer to Section 7.3 for detailed tables of UAFG figures for both the Metropolitan Melbourne and South Gippsland Networks.

Figure 2-7: South Gippsland - Actual UAFG[5] since 2009



2.4. Regulation and Benchmarks

In July 1997 the Gas and Fuel Corporation was disaggregated into four divisions: gas distributor and retail companies, a gas transmission company and an independent Market Operator, VENCorp. The distribution, retail and transmission companies were subsequently privatised. The result of this change was that financial accountability for gas losses were no longer absorbed by a single entity. In an effort to incentivise the gas distribution networks to take steps to economically minimise the level of UAFG, UAFG benchmarks were introduced in 2000, however, UAFG reconciliation payments didn't come into effect until 2002[6].

The Gas Distribution System Code (GDSC) sets out UAFG benchmarks, expressed as a percentage of the aggregate quantity of gas injected into the distribution system for each Victorian gas distributor[7]. This is a requirement of the National Gas Rules 2008.3 under Part 19 of the National Gas Rules 2008.

The UAFG benchmarks apply to Class A and Class B customers on the Principal Transmission System (PTS) and non-PTS[8] networks.

- Class A customers use more than 250 Terajoules per annum and are typically serviced by the high pressure and transmission networks.

[5] UAFG is weighted average of Class A and B

[6] Gas distribution System Code, Version 8

[7] Schedule 1, Part C of the Gas Distribution System Code. Version 11.

[8] For non-PTS networks, the Gas Distribution System Code sets out a single benchmark value applicable to both Class A and B customers.

- Class B customers use less than 250 Terajoules per annum and are typically serviced by high, medium and low pressure networks.

The GDSC requires gas distributors to use reasonable endeavours to ensure that UAFG is less than their benchmark. The Australian Energy Market Operator (AEMO) performs an annual reconciliation between gas distributors and retailers based on whether actual UAFG is over or under the benchmark[9]. Refer to AEMO Document (16-DUAFG) *Wholesale Market Distribution UAFG procedures (Victoria)* for more information.

Under the Victorian UAFG model, retailers are required to purchase sufficient gas to cover customer consumption and actual UAFG. If actual UAFG is greater than the benchmark, the gas distributor is required to compensate the retailers for the UAFG in excess of the benchmarks. Where actual UAFG is lower than the benchmark, the retailers make reconciliation payments to the relevant gas distributor.

The current benchmarks for all three Victorian gas distributors along with the reconciliation calculation is outlined in Schedule 1, Part C of the GDSC. Refer to Table 2-1 and Table 2-2 for benchmarks specific to Multinet Gas.

Multinet's current class B benchmarks for the period 2013 to 2017 of 4.1%, were derived based on a three year average of actual Class B UAFG from 2008 to 2010 with a downward adjustment of 0.05 percentage points to recognise Multinet's underspend against the AER's mains replacement allowance for the 2008 to 2012 period. Class A benchmarks remained 0.3% from previous review periods, representing the lower relative losses from the transmission and high pressure networks.

Table 2-1: Multinet Gas UAFG benchmarks – Networks supplied by the Principle Transmission System

Class B benchmarks <250,000 GJ/pa					Class A benchmarks >= 250,000 GJ/pa
2013	**2014**	**2015**	**2016**	**2017**	**2013-2017**
4.1%	4.1%	4.1%	4.1%	4.1%	0.3%

The benchmark for the non-PTS is significantly lower than the benchmark for PTS. The lower benchmark is a direct reflection of a minimal losses associated with a new gas distribution network.

Table 2-2: Multinet Gas UAFG Class A & B benchmarks – Networks supplied by the non-Principle Transmission System

2013	2014	2015	2016	2017
2.0%	2.0%	2.0%	2.0%	2.0%

The Benchmarks are reviewed and updated every five years in line with Victorian gas access arrangement periods. The next access arrangement period commences on 1 January 2018 and the Essential Services Commission (ESC) is responsible for establishing and setting the new UAFG benchmarks for the forthcoming period.

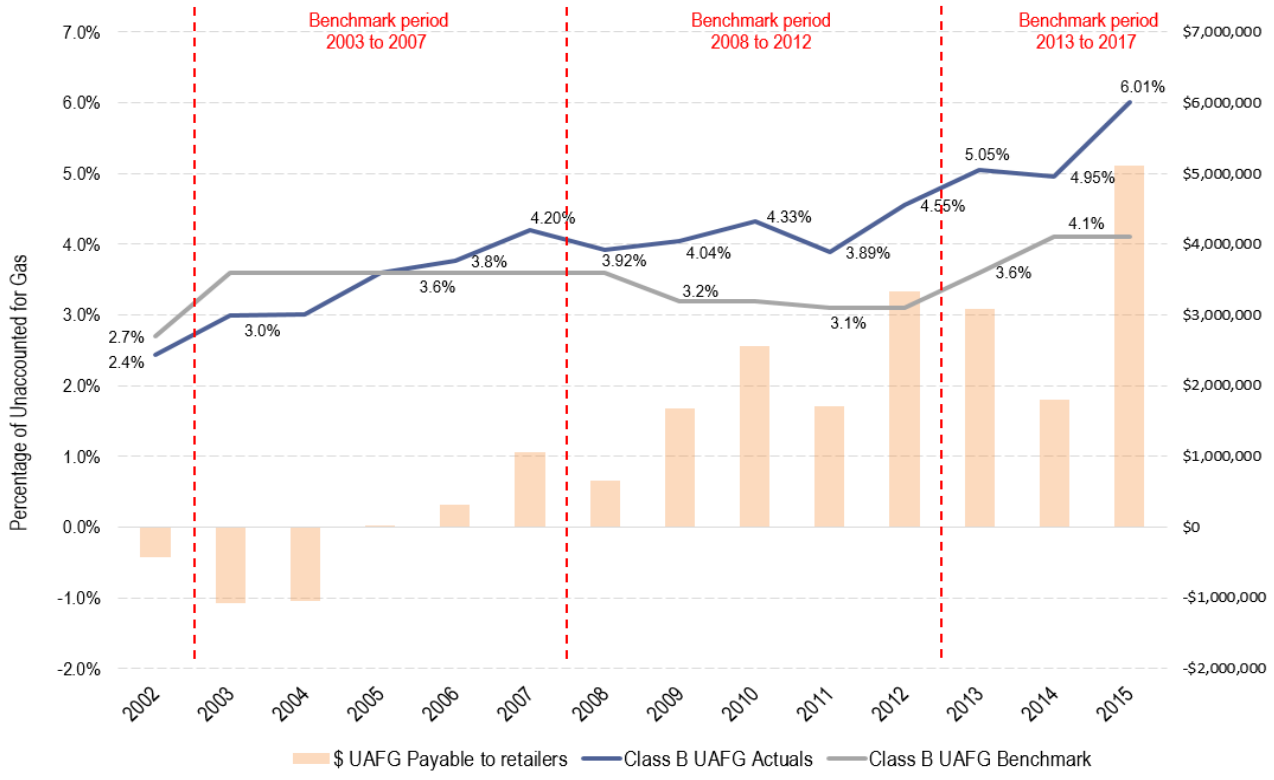
[9] Clause 2.4 of the Gas Distribution System Code, Version 11

2.5. Performance Against Benchmarks

2.5.1. Metropolitan Melbourne

As can be seen in Figure 2-8, since 2005 Multinet's class B actual UAFG has been in excess of the benchmarks, resulting in Multinet compensating retailers consecutively for 10 years. The difference between the benchmark and Multinet's actual UAFG has been steadily increasing. This has resulted in Multinet paying material reconciliation payments to retailers.

Figure 2-8: Metropolitan Melbourne - Class B UAFG Performance against benchmark since 2002[10]

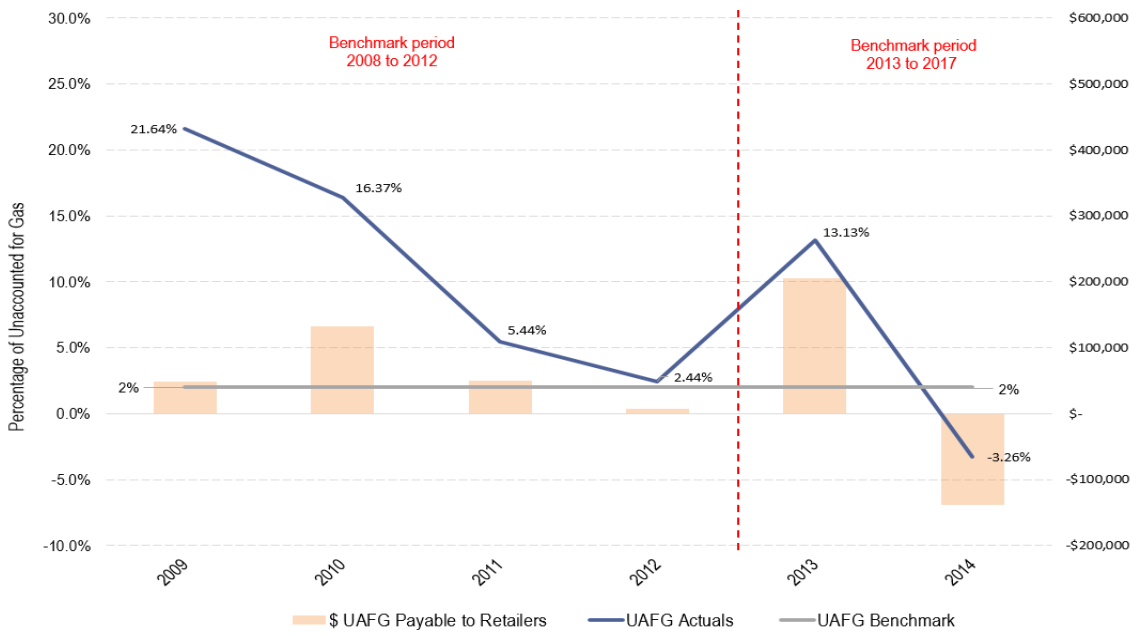


2.5.2. South Gippsland

As can be seen in Figure 2-9 the volatility of UAFG in South Gippsland has not led to large amounts of reconciliation payments due to the small volumes of UAFG involved. However as the size of the townships grow the reconciliation payments are beginning to increase even with a relatively smaller percentage of UAFG than in previous years.

[10] It should be noted that the ESC Class B Benchmark provided for in 2013 and 2014 was 4.1%. However, due to process delays in officially Gazettes a benchmark of 3.6% was applied as shown in Figure 2-8

Figure 2-9: South Gippsland - UAFG Performance against benchmark since 2009



2.5.3. Spot Price Exposure

Under the annual reconciliation between gas distributors and retailers, financial payments to (from) retailers for actual UAFG being greater (lower) than benchmark is calculated using the average volume weighted market price (AVWMP) which takes into account wholesale gas spot market prices.

Given Multinet's UAFG has been in excess of the benchmarks in recent periods, Multinet has been exposed financially due to significant increases in wholesale gas prices (driven by the demand for LNG exports) over which Multinet have no control.

The forecast of wholesale price volatility sits outside the scope of this strategy by does impact the cost / benefit analysis of strategies potentially adopted to efficiently reduce UAFG.

2.6. Comparative Industry performance

Table 2-3 provides an industry comparison of UAFG over the period CY2010 - CY2014. It shows that overall Multinet Gas and AGN (South Australia) have the highest average of UAFG (%) across the 5 year period. and each network has different network characteristics which can have a significant effect on UAFG levels. It also shows that both these networks have the highest population of Cast iron and Unprotected Steel assets in their network both of which contribute significantly to UAFG. Consideration should also be given to the fact that UAFG is reconciled differently in every state.

Table 2-3: Industry Comparison[11]

Network	Market / Region	UAFG Avg.[12]	UAFG Trend	Percentage of Cast Iron/UPS	Network Length (000's km)
ATCO Gas Australia	Western Australia	2.9%	Declining	1.2%	13,137
Actew AGL	Canberra	2.2%	-	-	4,649
Australian Gas Networks (AGN)	Queensland	0.4%	Stable	5.8%	2,797
	South Australia	4.3%	Declining	9.7%	7,832
	Victoria	3.1%	Increasing	3.4%	10,494
AusNet Services	Victoria	3.2%	Declining	6.1%	10,725
Jemena Gas Networks	New South Wales	2.2%	Stable	Material breakdown not available	
Multinet Gas	Victoria	4.3%	Increasing	16%	9,941

Victoria's three (3) distribution networks (AusNet Services, AGN & Multinet Gas) provide the best reference for benchmarking Multinet's UAFG performance given they are all derivatives of the former Gas & Fuel and therefore have common network characteristics, in addition to operating under the same regulator frameworks. Figure 2-10 provides a comparison of UAFG for the three Victorian gas networks since 2006. An increasing trend in UAFG has been seen on both the AGN and MG gas networks over the period. In contrast, AusNet Services has recorded a modest decline in UAFG over the period, stabilising in recent years.

[11] ESAA comparison report

[12] Average UAFG from CY2010-2014

Figure 2-10: UAFG Comparison between Victorian DB's since 2006[13]

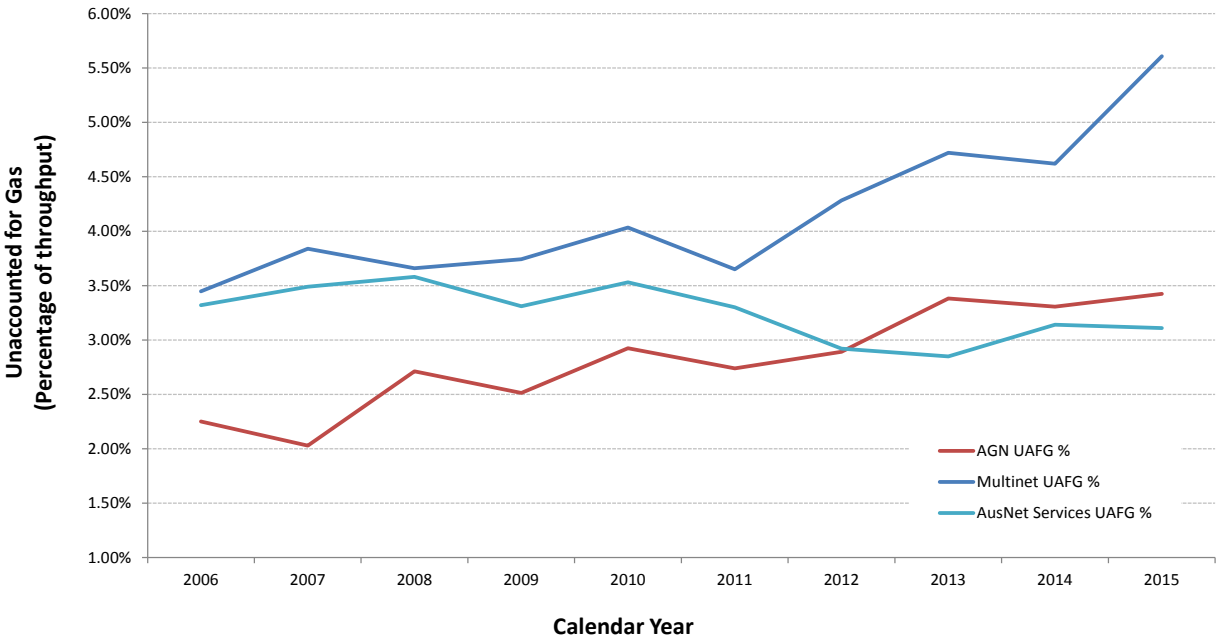
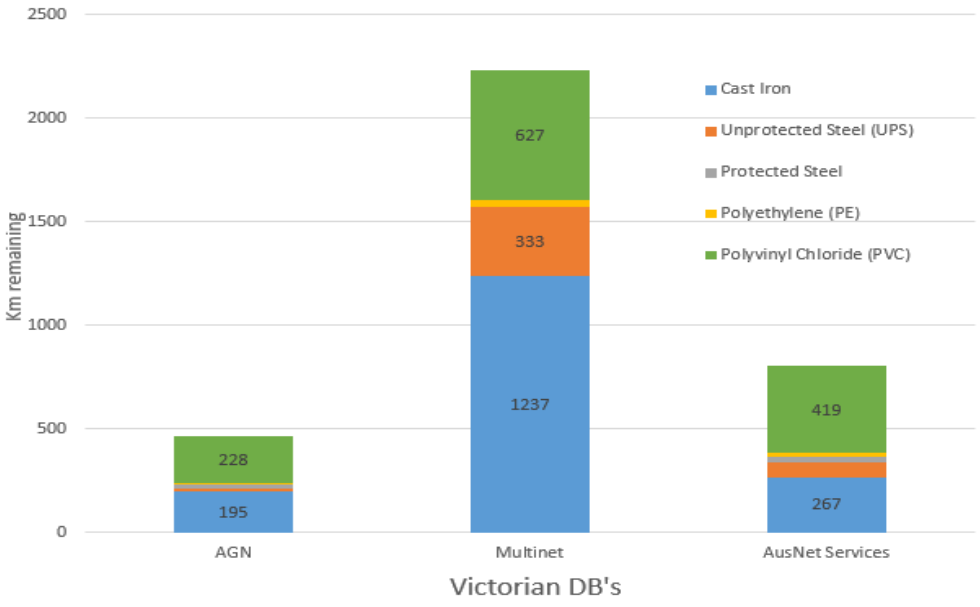


Figure 2-11 provides a comparison of Low Pressure (LP) network characteristics. Compared to the other distributors in Victoria Multinet has a considerably larger population of cast iron and unprotected steel remaining on its LP network. These types of aged assets have historically been known to have higher leakage rates and have a strong correlation to UAFG levels. Cast iron mains are typically the main driver behind replacement programs and both the other Victorian distribution businesses are nearing completion of their LP replacement program. Multinet however is scheduled to finish its replacement program by 2033. Refer to Section 5.3.2 for more information regarding Multinet's Mains Replacement program and its effect on UAFG.

Figure 2-11: LP Network Characteristics for Victorian Db's at the end of CY2015[14]



[13] Values presented are representative of Weight Average UAFG (Class A and B).

[14] Source Victorian RIN (AER) Data

3. Independent Expert

Since 2012, Multinet has commissioned an independent expert in UAFG, Asset Integrity Australasia Pty Ltd (AIA) to undertake three independent assessments in an effort to quantify and reduce its UAFG.

3.1. AIA Report – UAFG Management Review (RPC 0049B)

In 2013 Multinet commissioned Asset Integrity Australasia Pty Ltd (AIA) to:

- Undertake an assessment of the contributory elements of its Unaccounted for Gas (UAFG) in 2010;
- Review the appropriateness, in terms of industry best practice, of the actions and processes undertaken by Multinet to minimise UAFG
- Outline a set of recommendations for further reducing UAFG

3.2. AIA Report - Audit of the UAFG Calculation Processes (RPC 0056)

In 2014, AIA undertook a detailed review of Multinet's UAFG calculations to ensure compliance with AEMO procedures. The procedures and data used for the calculation of UAFG by Multinet was reviewed over a 2-week audit period. This was undertaken in conjunction with the Multinet personnel responsible for calculating UAFG and working through each element of the calculations included in the Multinet UAFG Spread sheet.

Refer to Section 6 of the report for a summary of recommendations.

3.3. AIA Report – Review of Multinet Gas' Unaccounted for Gas (v11.0)

In 2017 Multinet Gas (Multinet) commissioned Asset Integrity Australasia Pty Ltd (AIA) to:

- Undertake an assessment of the contributory elements of its Unaccounted for Gas (UAFG) in 2015;
- Identify any changes in the drivers of UAFG since AIA's last assessment in 2013;
- Review the appropriateness, in terms of industry best practice, of the actions and processes undertaken by Multinet to minimise UAFG including by reviewing how it has actioned the key recommendations in AIA's 2013 report; and
- Recommend a method for calculating the Class B UAFG benchmarks set out in Schedule 1, Part C of the Gas Distribution System Code (Code) for the 2018 to 2022 period.

In its latest report in 2017 AIA found "Multinet's UAFG management practices and policies are in line with industry best practice. AIA considers that Multinet has maintained its UAFG at efficient and economically prudent levels over the 2013 to 2017 period given the nature of its network" and that "There are no additional cost effective actions available to Multinet that would have effectively reduced the current effective Class B UAFG level below 6.0%"[15].

Table 3-1 provides a breakdown of UAFG contributing factors (calculated by AIA) for CY2015.

[15] In reference to 2015 class B UAFG levels

Table 3-1 Summary of UAFG sources[16]

UAFG Classification	UAFG Source	UAFG (GJ)	UAFG (%)
Measurement Based	**Timing Mismatch**	C-I-C	C-I-C
	Administrative / Process Errors	C-I-C	C-I-C
	Purchase Meters (CTM uncertainty)	C-I-C	C-I-C
	Pressure Compensation	C-I-C	C-I-C
	Temperature Compensation	C-I-C	C-I-C
	HHV Compensation	C-I-C	C-I-C
	Meter Accuracy	C-I-C	C-I-C
	Linepack Change	C-I-C	C-I-C
	Company Own Use	C-I-C	C-I-C
	Meter Bypass & Theft	C-I-C	C-I-C
Fugitive Emissions	**Transmission Losses**	C-I-C	C-I-C
	LP Distribution Losses	C-I-C	C-I-C
	MP Distribution Losses	C-I-C	C-I-C
	HP Distribution Losses	C-I-C	C-I-C
	Service Losses	C-I-C	C-I-C
	Meter Losses	C-I-C	C-I-C
	Regulator Leakage	C-I-C	C-I-C
	Third Party Damages	C-I-C	C-I-C
Measurement Based UAFG subtotal		**C-I-C**	**C-I-C**
Fugitive Emissions UAFG subtotal		**C-I-C**	**C-I-C**
UAFG		**C-I-C**	**C-I-C**

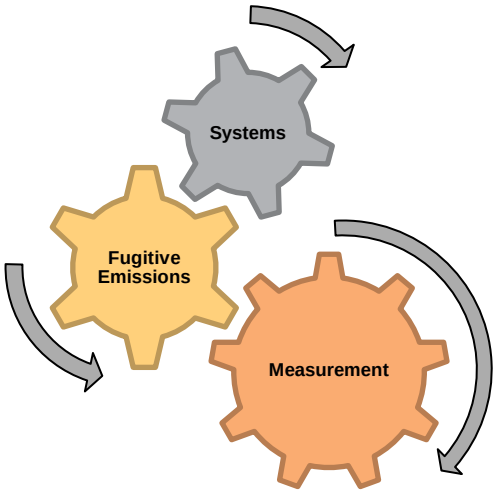
The figures detailed in Table 3-1 are an estimate by an independent expert in the field of UAFG. There is a very high degree of uncertainty on this breakdown on contribution. Some components have lower levels of uncertainty (pressure and temperature compensations, HHV compensation etc) because the parameters that are used to calculate this component can be measured easily. The major components such as fugitive emissions have high levels of uncertainty because it is extremely difficult and costly to measure them directly.

[16] Minor variations exist between the categorisation of sources by AIA and those outlined within the strategy by Multinet Gas.

4. Sources of Unaccounted for Gas

For the purposes of this strategy UAFG can be categorised into three (3) categories:

1. Measurement;
2. Fugitive Emissions;
3. Systems.



Measurement sources of UAFG are due to errors in the way the gas is measured and / or calculated whereas Fugitive emissions are considered physical losses of gas. The sources of UAFG outlined under Measurement and Fugitive emissions in this section are similar, but not the same as that outlined in Section 3.1, Table 3-1.

Systems is defined as errors within the mechanics of the UAFG reconciliation model and errors within the systems that store and process measurement data. The contribution from these system errors is very difficult to quantify due to the complex nature of the system and large amounts of data being processed.

Examples of measurement, fugitive emissions and system sources of UAFG are defined in Sections 4.1 to 4.3, and further defined in Section 5 - Strategies to Minimise UAFG

4.1. Measurement

Table 4-1 provides a summary of measurement sources. Refer to Section 4 in AIA's 2013 report (RPC 0049B) for additional details on Measurement sources of UAFG.

Table 4-1: Measurement Sources

Source	Description
Timing Mismatch	Timing mismatch is caused by the difference in period of measurement between input and output collected meter data over a defined UAFG period.
Linepack Change	Change in the volume of gas within the network (linepack) during the UAFG year.
CTM Uncertainty	Levels of uncertainty in CTM's. Due to the large volumes involved, a small percentage error in CTM readings could contribute a large amount of Multinet's UAFG.
Meter Accuracy	Industrial, Commercial and domestic meter uncertainty.
Meter Index Faults	Meter index does not record gas consumption when meter is passing gas
Pressure & Temperature Compensation for Meters	Gas delivered at variation to Standard Conditions assumed in billing (atmospheric pressure at sea level, temperature 15°C). Gas delivered at variation to standard set pressures or PCF's assumed in billing.
Incorrect PCF	Customer's consumption is calculated using an incorrect PCF.
Higher Heating Value (HHV) Compensation	Difference in the average HHV between Multinet and the declared State-wide value which is used in billing.
Meter Bypass and Theft	Where customers consumption is not recorded through the meter due to the meter bypass being open, service being tapped into prior to the meter etc. or meter being run backwards.
Company's Own Use	The company's own gas consumption from the network is metered but not declared as sales.

4.2. Fugitive Emissions

Table 4-2 provides a summary of fugitive sources. Refer to Section 4 in AIA's 2013 report (RPC 0049B) for additional details on Fugitive emissions sources of UAFG.

Table 4-2: Fugitive Emissions Sources

Source	Description
Transmission Losses	Leakage on the transmission network.
Distribution Losses	Leakage on the distribution networks. This includes leaks on distribution mains & services.
Mains Commissioning/Abandonment	Gas lost due to abandoning and commissioning of transmission pipelines, mains and services
Regulator Venting	In built safety mechanism of regulators to control downstream pressure during normal operation conditions by venting regulated pressure to atmosphere.
Equipment Losses	Leakage from equipment (valves, fittings, meters, etc) and associated joints. This includes meter regulator units, Field and District Regulators, City Gates and CTM stations.
Third Party Damages	Leakage lost on the network as a result of third party damages on mains and services

4.3. Systems

Table 4-3 provides a summary of system sources related to UAFG. These are further defined in Section 5.4.

Table 4-3: Systems Sources

Source	Description
UAFG Data Systems and Reconciliation Model	Errors within the handling of data between systems and errors within the calculation of the reconciliation amount.
Meter Reads	Estimated reads, Incorrect actual reads, reads not accepted by AEMO.
Meters not Installed in SAP	Meters not installed in the SAP billing system correctly

5. Strategies to Minimise UAFG

5.1. Customer definitions and numbers

An overview of different types of customer connections is summarised in Figure 5-1 and further defined in Table 5-1. For the purposes of this strategy, Meter Regulator Type was broken down by Meter Type so that specific strategies can be applied with a focus on the largest consumers first[17].

The following three categories will be referred to throughout the strategy:

1. Interval I&C customers (319)
2. Basic I&C customers (2507)
3. Domestic customers (699,232)

Figure 5-1: Overview of customer connections

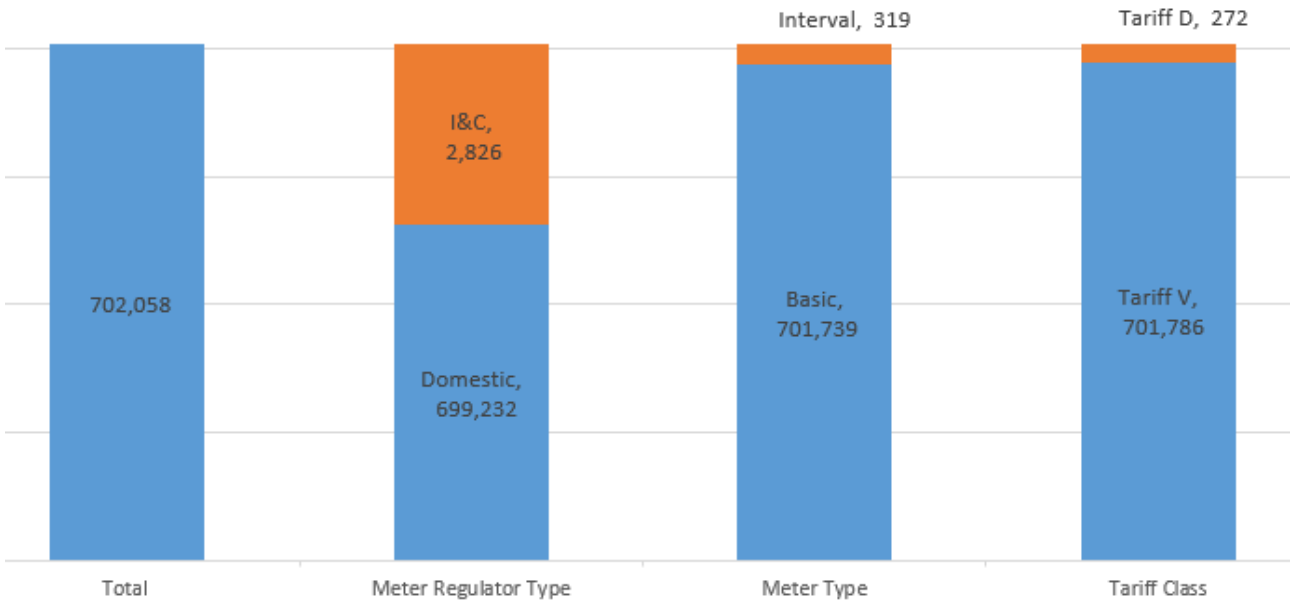


Table 5-1: Customer definitions

	Customer type	Meaning
Meter Regulator Type	Industrial and Commercial (I&C)	Customer that has an industrial and commercial meter regulator setup. These sites are on maintenance plans and the meter and regulator information is stored in SAP ERP
	Domestic	Domestic meter regulator setup that is on reactive maintenance only.

[17] Interval I&C customers make up roughly 20% of the network throughput with Basic I&C customers contributing about 10% of network throughput.

	Customer type	Meaning
Meter Type	Interval or Daily Metered sites[18]	Sites where meter consumption data is to be recorded daily through the use of data logger or flow computer. Reading of these sites is managed by AEMO under a MDA contract.
	Basic	Sites where consumption of data is to be recorded monthly or bi-monthly. Reading of these sites are managed by Multinet. This is the majority of customers in the Multinet network.
Tariff Class	Tariff D[19]	Customers whose consumption is greater than 10 TJ p.a. The customer pays for the metering setup including flow correction. All Tariff D customers are interval
	Tariff V	Customer whose consumption is less than 10 TJ p.a. This is the majority of customers in the Multinet network.

5.2. Measurement

The below sections outline the strategies that will be undertaken to mitigate the measurement sources as defined in Section 4.1

5.2.1. Timing Mismatch

Timing mismatch may affect UAFG by increasing or decreasing levels. Over multiple years the timing error for meter reading mismatches will net out (i.e. balance). Multinet remains compliance with its meter reading obligations as defined by the Retail Market Rules[20].

No further strategies are implemented by Multinet in respect to meter reading timing mismatches.

5.2.2. Linepack Change

Based on pressure data received there is no indication that the pressure between the start and the end of the year in the Multinet transmission system has any significance variance; therefore Linepack related UAFG is considered to be insignificant. Linepack related UAFG may be either positive or negative and will net out unless there is a step change in operating pressures within a pressure system.

No further strategies are implemented by Multinet in respect to Linepack Changes.

5.2.3. CTM Uncertainty

For CTMs a small systematic error can have a large impact on uncertainty on UAFG. In the Metropolitan Melbourne network all of the CTM's (18) in Multinet's network are operated and maintained by APA GasNet[21] who are obligated to carry out testing and calibration in accordance with the Victorian Wholesale Market Rules[22]. In the South Gippsland network both CTM's are owned, operated and maintained by Multinet in accordance with the Victorian Wholesale Market Rules.

APA GasNet look to maintain uncertainty within +/- 1.0%, which is well within the limits governed by the market. When uncertainty is found outside this range remedial action is recommended to bring the uncertainty back to

[18] All Interval customers are Industrial and commercial customers

[19] All Tariff D customers are Interval customers

[20] Retail Market Procedures Version 12.0 (PROJECT-57-30)

[21] APA GasNet (part of the APA Group) are the owners of the Principle Transmission System (PTS) in Victoria.

[22] AEMO Document No. 281528 for Uncertainty Limits and Calibration requirements in Victoria.

within +/- 1.0%. Testing consists of an in situ meter proving tests (carried out annually) and pressure and temperature calibration (carried out every 6 monthly or yearly). Multinet receives and reviews in situ meter proving test results on an annual basis to ensure CTM uncertainty remains with acceptable limits.

In situ meter proving tests however, are only undertaken at the flows prevalent at the time of testing not across the full range of flows experienced by the CTM. CTM volume calibration across the full range of flows is only carried out once throughout the lifecycle of a CTM (prior to installation). When CTM's operate outside their design capacity (over ranging) the risk of damage and level of uncertainty increases as the CTM's are only calibrated to 100% capacity. Sonic nozzles are fitted to turbine meters to reduce the risk of over ranging and meter damage from short duration surges at failsafe events. The alternative is to replace the turbine meter with a Coriolis meter which does not allow for over ranging.

CTM Replacement Program

In 2015, APA Group assessed the current capability of the CTM's operating between APA's transmission network and Multinet Gas' network and the potential for implementing necessary upgrades to these sites. A metering strategy plan[23] was submitted to Multinet indicating that immediate or short term upgrades or replacement are required on 11 of Multinet's CTMs as detailed in Section 7.4.

As a result of these findings, Multinet, in conjunction with APA Group has implemented a program to replace seven Turbine CTMs which were reaching end-of-life. Two meters were replaced in December 2016 (as detailed in Table 5-2) and a further 5 turbine CTM's are scheduled for a meter upgrade and/or life cycle replacement (replaced with a suitably sized Coriolis meter) as listed below in Table 5-3.

Table 5-2 CTM's replaced/upgraded in CY2016

Site ID	Site name	Meter type	Replacement Meter
M015	Noble Park	Turbine	Coriolis
M019	St Kilda East	Turbine	Coriolis

Table 5-3 CTM Upgrade and Life-cycle Replacement Program

Site ID	Site name	Meter type	Scheduled
M007	DTS (Edithvale)	Turbine	2017
M016	Clayton	Turbine	2018
M017	Oakleigh	Turbine	2018
M023	Port Melbourne (Howe Pde)	Turbine	2019
M024	Port Melbourne (Lorimer)	Turbine	2019

Refer to Program ***#1-1 – CTM Upgrade & Lifecycle Replacement*** *in* Table 6-1 for a summary.

Short Duration Program

The following CTM's are recommended for installation of sonic nozzles to prevent short duration surging due to fail-safe events. M034 Gembrook is currently undergoing a regulator upgrade and network control measures will be revisited at the other 2 sites with the aim of reducing flow spikes above that of the meter capacity.

[23] APA Group Project: Metering Strategy Plan 2015 Multinet Gas Meter Sites.

Table 5-4 CTM's requiring rectification for short duration surging

Site ID	Site name	Meter type
M005	DTS (Lurgi)	Ultrasonic
M018	Malvern	Ultrasonic
M034	Gembrook	Coriolis

Refer to Program ***#1-2 – CTM Short duration surge rectification*** *in* Table 6-1 for a summary.

Note: M148 Yarra Glen is currently undergoing regulator upgrades to 10,000 Scm/h and as such it was decided that flows and any resultant CTM upgrade would be revisited as part of the next revision of the APA Group Metering Strategy Plan.

5.2.4. Meter Accuracy

Meter accuracy limits are maintained by stipulating an initial in-service compliance period. A meters' initial in-service compliance period refers to the "period of time allowed to a meter population or meter type to remain in-service without retesting or replacement".

Table 5-5 outlines the initial in-service compliance periods for meters on Multinet Gas' distribution network. Multinet

Table 5-5: In service Compliance periods[24]

Meter Group	Typical Application	Meter Examples	Initial life
Small Meter (<=10m^3/hr)	Domestic	New /Rep L&G 750/1010 Email 602, RKMR08	15 years
Large Meter (>=12m^3/hr to 28m^3/hr)	Domestic / Commercial	AL425 to AL1000	15 years
Large Meter (30m^3/hr - 100m^3/hr)	Industrial / Commercial	AL1400, AL2300, RK1000 to RK5000	15 years
Large Meter (>100m^3/hr to)	Industrial / Commercial	AL5000, RK10000, Roots 5M to 38M, Romet 140 to 650, GT4M to GT12M	10 years

Through the Field Life Extension (FLE) testing and the annual "Time expired" Meter Replacement program Multinet ensures its best efforts to remain compliant with its obligations to replace meters at the end of their in service compliance periods. There are however a small portion of meters that are not able to be replaced as part of the Time Expired Meter replacement program due to accessibility restrictions. These meters are operating past their in-service compliance period where accuracy limits may be outside the acceptable limits.

Refer to *MG-SP-0007 Small Meter Strategy v2.0* and *MG-SP-0008 Large Meter Strategy v2.0* for more info on FLE testing and the annual "Time expired" Meter Replacement Program.

An ongoing program to gain access to these sites and replace these meters will be put in place. Refer to Program ***#1-3 – Time Expired Replacement program for no access meters*** *in* Table 6-1 for a summary.

5.2.5. Meter Index Faults

Faulty Meter indexes have an adverse impact on Multinet's UAFG as the index may stop recording gas during times of usage. Interval customer's usage is recorded daily and monitored closely so any zero consumption is

[24] Source: MG-SP-0007 & MG-SP-0008 Multinet's Small & Large Meter Strategies.

usually picked up early. Basic I&C customers are of particular concern as they can use up to 10TJ per year and the meters are monthly or bi-monthly read.

A recent investigation (May 2017) on Basic I&C customers showed a total of 15 customers (out of a possible 2,435) had a faulty index, with some not recording for several years. Even though 15 customers is a relatively low number, one faulty index (0.6%), a basic I&C customer has the potential to account for 10 TJ of UAFG per annum. Multinet will continue to investigate faulty indexes on Basic I&C customers on a yearly basis.

The program to review faulty meter indexes has been extended to include domestic connections. Refer to Program ***#1-4 – Faulty Meter Indexes*** *in* Table 6-1 for a summary.

5.2.6. Pressure and Temperature Compensation for Meters

Gas is sold in units of energy, typically Megajoules (MJ) or Gigajoules (GJ) which is based on gas being measured at "Base" or "standard atmospheric conditions" of 101.325 kPa absolute pressure (atmospheric pressure at sea level) and 15°C for temperature. However, since gas is a compressible fluid it is rarely measured at these conditions with meters measuring volumes at the pressure and temperature presented at the meter, which can be significantly different to the aforementioned "standard" conditions.

To compensate for these differences, a Pressure Correction Factor (PCF) is used to convert the metered volume to an equivalent energy that would exist if the measurement was at base conditions. Refer to Section 7.5.1 for conversion from metered volume into energy. AEMO pressure correction factors are detailed in Section 7.6. PCF's only take into consideration variations in metering pressure and do not make allowances for variations in temperature and altitude. Any variation away from these base conditions and set pressure correction factors results in inaccuracies within the customers measured energy and hence results in UAFG. Refer to Section 7.5.2 & 7.5.3 for a detailed calculation on elevation compensation and temperature compensation.

Interval I&C customers

Due to the large volume of gas consumed by Interval customers, as small variation in temperature and pressure could lead to large amounts of UAFG. As a result, some Interval customers have a flow corrector installed on the meter which can record live temperature and pressure, and corrects the measured volume going through the meter accordingly. In 2016, both pressure and temperature flow correction on all Tariff D customers was made mandatory, however there are a number of historic sites which have only pressure correction or no flow correction at all (data logger is installed).

A count of all interval sites across the Multinet Network with their respective equipment is shown in Table 5-6.

Table 5-6 Count of Interval sites by equipment[25]

Equipment	No. of customers
Data logger	221
Pressure corrected only	31
Pressure and temperature corrected	63
Total	**315**

A review of historical interval sites identified a number of sites for proactive replacement (upgrade from data logger to a flow corrector) and the remaining sites were scheduled for reactive replacement at end of life. The following sites will be replaced as part of the proactive replacement program:

- 28 customers with an existing data logger required both temperature and pressure correction to be installed; and
- 16 customers that had existing pressure correction required temperature correction to be installed.

[25] All Tariff D customers are interval customers. Data was taken from early 2017

Multinet is in the process of initiating the above recommendations. Refer to Program ***#1-5 – P&T for Interval Customers*** *in* Table 6-1 for a summary.

Basic I&C customers

All I&C customers including basic and interval are on maintenance plans in SAP and undergo inspections, maintenance and overhauls at regular intervals. During maintenance, the regulators pressure set points are recalibrated to ensure the regulator is operating within acceptable limits. This minimises the amount of regulator creep that occur on the Multinet Network.

Domestic customers

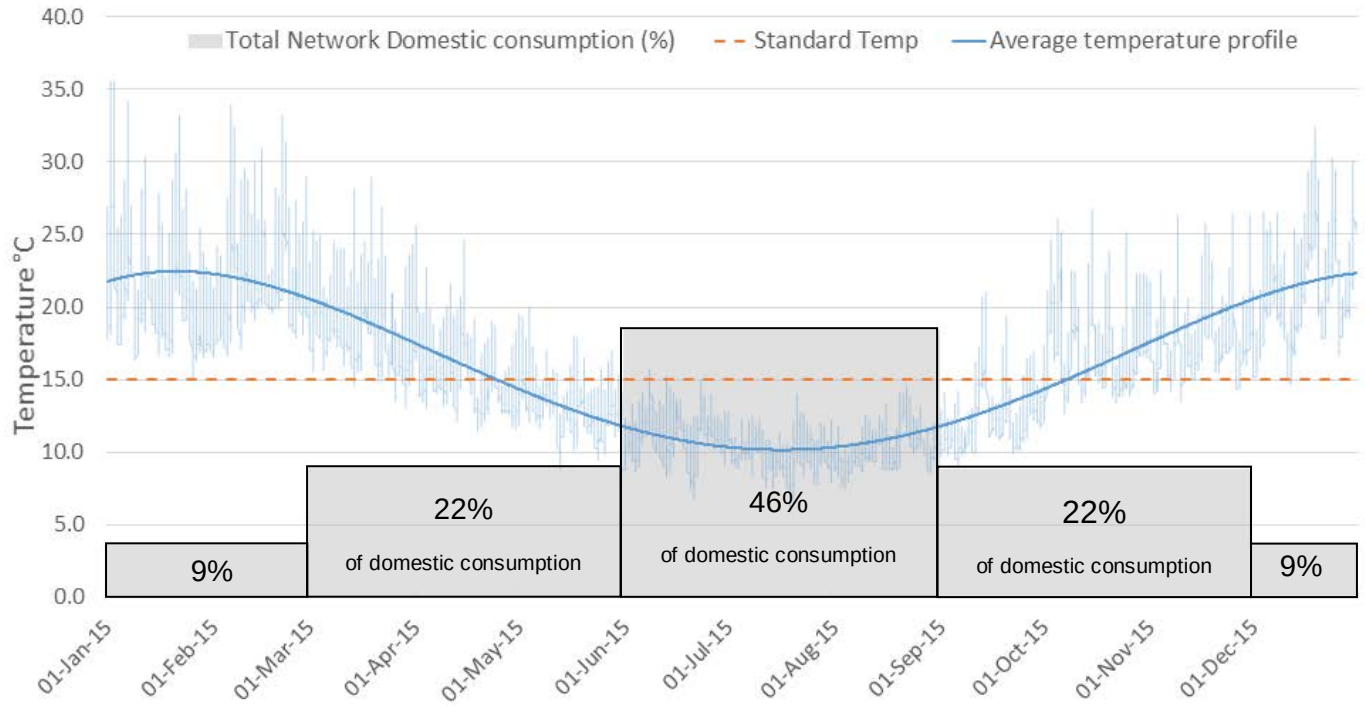
In regards to pressure variation for Domestic customers, *ES-GM-4305 Low and High pressure Domestic Regulators*, sets out the purchase specification for domestic regulators that are approved for use in the Multinet network. These regulators are tested 6 monthly against this standard and the results are reviewed to ensure compliance with this specification.

Temperature variation for domestic customers (contributing 21% of UAFG) is considered by AIA as the second largest source of UAFG on Multinet's network. This is second only to fugitive emissions at 22%. Two factors influence this impact:

1. **Consumption versus gas temperature profiles**

The majority of domestic consumption occurs during the winter months whereby the gas temperature at the meter is well below 15°C (sometimes as low as 5°C). In the warmer months gas temperatures can get as high as 30°C however consumption for domestic customers during this time is significantly lower. This results in an adverse effect on Multinet's UAFG. Previously it has been assumed that ground temperature and the resulting gas temperature at the metering point stays relatively constant, however looking at temperature across several interval I&C customer's with temperature compensation shows variations in average temperatures of 13°C. This profile is provided in Figure 5-2.

Figure 5-2 Average Temp. Profile for 10 I&C sites across various geographical location in Melbourne



2. Increasing Volume of High Pressure Supply Points

UAFG is more pronounced for customers directly supplied from HP networks where a pressure cut (resulting in a reduction in temperature known as the Joules-Thompson effect) is immediately upstream of the meter. Therefore, the ongoing connection of customers to HP networks (from new connections and LP-HP mains replacement) is incrementally increasing temperature related UAFG for all basic sites on an annual basis.

To better understand the effect temperature has on Multinet's UAFG, a project has been implemented to obtain additional real-time data on inlet gas temperature.

Refer to Program ***#1-6 – Temperature variation for domestic customers*** *in* Table 6-1 for a summary.

5.2.7. Incorrect PCF

For all basic customers Pressure Correction Factors (PCF's) are entered against the meter in SAP[26] at the time of installation. This PCF will remain assigned to that customer MIRN[27] for the duration the customer's MIRN remains valid in the system. Once recorded in SAP, the PCF is only altered if a pressure upgrade or downgrade is required. As such any errors in the initial entering of the PCF may remain undetected and result in ongoing incorrect billing.

For interval customers the PCF is registered with AEMO at the time of installation but the same risk exists for sites that do not have ongoing pressure correction.

I&C Customers (Basic and Interval)

The number of PCF errors identified and corrected in SAP since 2014 is shown in Table 5-7.

Table 5-7: PCF errors for I&C customers

Year	2014	2015	2016
No. of PCF errors	98	50	98

An investigation was initiated to review and rectify the causes of PCF errors in Multinet's SAP system. The investigation system identified a number of system improvements aimed at reducing PCF errors. The following was implemented in 2016:

- SAP enhancement that provides a link between Meter Regulator data and Meter data
- SAP enhancement for Meter and regulator upgrade service orders
- SAP Work instructions updated/created to reflect system changes, including:
    - MG-WI-0272 How to change PCF value after meter installation or exchange; and
    - MG-WI-310 Manage Pressure Upgrades and Meter Exchanges for UMS OTH Service Orders.

PCF errors are expected to significantly reduce following the implementation of the above system enhancements. Multinet will continue to monitor PCF errors every 6 months.

Refer to Program ***#1-7 – PCF Review*** *in* Table 6-1 for a summary.

Domestic customers

In 2017 a targeted program was carried out to identify incorrect PCF's for domestic customers and project the extent of the issue using a statistically significant sample testing program. The sample size was of 1,500 domestic installations or ~0.2% of the domestic customer base. The results are shown below in Table 5-8.

[26] SAP is Multinet's asset records repository for Gas Meters.

[27] Meter Identification Reference Number

Table 5-8: Summary of domestic customers with an Incorrect PCF

	Targeted sample				Network Projection	
UAFG Error	No. of Customers with Error	% of targeted Sample	Lost UAFG per customer (GJ/yr)	Lost UAFG (GJ/yr)	Projected Customers	Lost UAFG (GJ/yr)
Customer Under Billed	25	1.8%	0.95	24	6768	6,444
Customer Over Billed	3	0.2%	- 0.97	-3	102	-99
Total	**28**	**2.0%**	**- 0.02**	**21**	**6,870**	**6,345**

Identified errors are likely to be legacy errors, made during the installation of domestic regulator in the field as all known SAP errors causing PCF discrepancies have been addressed. When the potential error is extrapolated to take into consideration all domestic meters, it contributes approximately 0.2% of UAFG in CY2015.

Given its relatively low contribution to UAFG and considering the cost to rectify, from an economic basis no further work is planned for domestic PCF corrections.

5.2.8. HHV Compensation

HHV is defined as the amount of heat released by a specified quantity of gas once combusted. This is essentially the conversion from gas volume to energy. The HHV value takes into consideration the molecular composition of the gas. HHV values used in billing are calculated using a flow weighted state wide average across the three major injection points for Victoria; Bass gas, Iona, and Longford. Any variations in gas composition received at the meter from the declared state-wide average influences UAFG.

Metropolitan Melbourne Network

For the PTS system, the majority of the gas that Multinet receives comes from both Longford and Bass Gas[28]. Table 5-9 shows the relative contribution from each injection point. Figure 5-3 below shows the difference between AEMO declared state-wide average and an estimated Multinet HHV based on receiving 100% of gas from bass gas and Longford. This differential in average HHV between Multinet and the declared State-wide value appears to be fairly stable over the last few years (contrary to what was previously thought) with preliminary results in 2016 showing Multinet receiving a UAFG benefit from this differential in HHV.

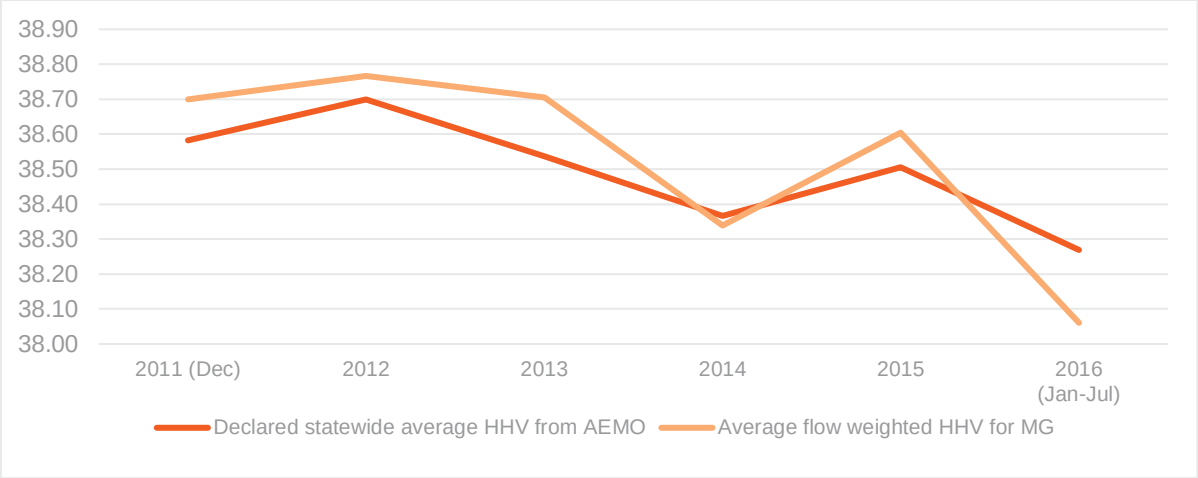
Multinet will continue to monitor HHV values in Victoria to ensure that this differential in HHV does not increase significantly.

Table 5-9 Relative contribution from the injection points into the PTS

Injection point	Energy Percentage (Dec 2011 – Jul 2016)
Iona	15%
Bass Gas	7%
Longford	78%

[28] Any gas produced from Iona would likely to be used up in the west of Victoria by AusNet Services before reaching Multinet's region

Figure 5-3 HHV values comparison between AEMO declared values and Multinet Gas estimated



Note: Average flow weighted for MG assumes 100% contribution from Longford and Bass gas

South Gippsland Network

For the non-PTS system, Gas quality is measured by AEMO at Pakenham and as there is only one input into the system (Bass Gas) there is minimal variation in actual HHV values at the meter to the calculated HHV value declared by AEMO.

No further strategies are implemented by Multinet in respect to HHV Compensation.

5.2.9. Meter Bypass and Theft

Although uncommon, theft of gas can occur. Examples of theft include:

- I&C customers opening the bypasses around a meter to reduce the metered consumption; or
- Domestic customers installing plumbing lines to bypass their meter.

All I&C customers are on regular maintenance where the bypass valve is checked to ensure that it is tagged and locked. There is less than 5 of these cases reported each year and as such there is no evidence to suggest that these are a significant contributor to UAFG.

Domestic customers are all on manual meter reading cycles which also services to identify modified metering installations.

5.2.10. Company's Own Use

As detailed in Table 5-10 Multinet has five (5) City Gate heating facilities which consume gas from the Multinet Network; three water bath heaters and two shell and tube heat exchangers.

Table 5-10 Multinet Gas City Gate Heating facilities

Location	Commissioned	Type
Lilydale CG	2012	Boiler/Exchanger
Gembrook CG	2013	Water Bath Heater
Seville East CG	2005	Water Bath Heater

Location	Commissioned	Type
Korumburra CG	2007	Water Bath Heater
Leongatha CG	2014	Boiler/Exchanger

All five sites are metered, however two meters do not have an account setup with a retailer and hence their consumption is not included in the UAFG calculation. The consumption of these two meters need to be accounted for in the UAFG settlement.

Refer to Program ***#1-8 – Consumption at City Gate Facilities*** *in* Table 6-1 for a summary.

5.3. Fugitive Emissions

The below sections outline the strategies that will be undertaken to mitigate the sources of fugitive emissions as defined in Section 4.2

5.3.1. Transmission Losses

Leakage on the transmission network is minimal if not negligible. Most leaks on the transmission network occur through valve stem seals. Refer to Section 5.3.5 for information on managing equipment leakage.

5.3.2. Distribution Losses

The largest individual contributor of UAFG is distribution losses on LP Mains due to the relatively large population of cast iron and unprotected steel (UPS) assets left on the network. Refer to Figure 5-4 for leakage incident rates by material and pressure. As detailed in Table 5-11 there is also still a small population of large diameter cast iron left on the MP network, which are the largest contributor of UAFG per km length due to the increased pressure that these mains operate. These large diameter MP mains are often supply mains to the LP networks so they cannot be decommissioned until all LP has been upgraded to HP.

Figure 5-4: Leak Incident Rates by Material and Network Pressure - CY2015

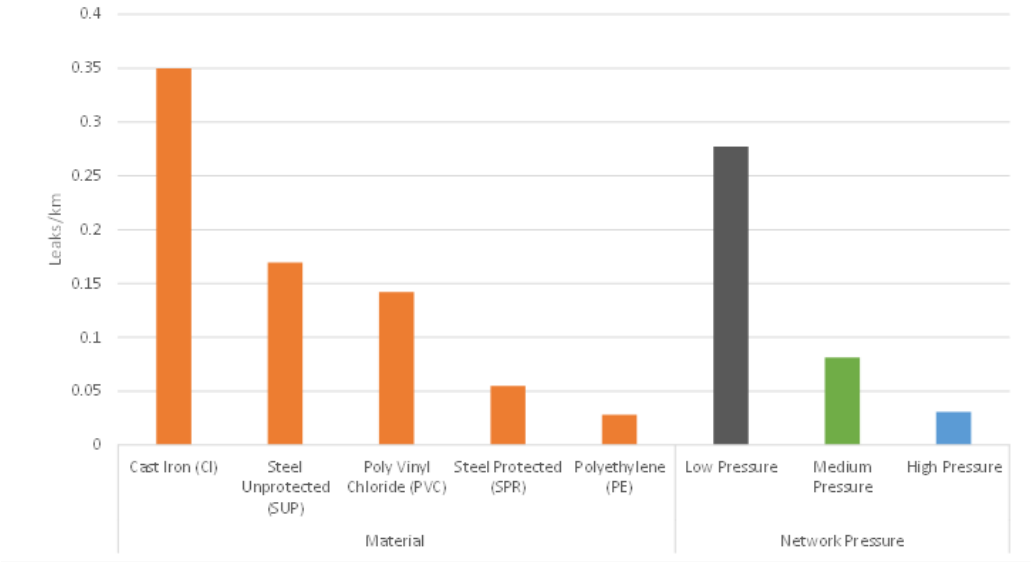


Table 5-11: Percentage of Distribution Main by Pressure and Material Classification

Pressure Tier	Cast Iron (CI)	Poly Vinyl Chloride (PVC)	Steel Un-Protected (SUP)[29]	Steel Protected (SPR)[29]	Polyethylene (PE)	Total
Low Pressure (LP)[30]	12.41%	6.29%	2.18%	1.17%	0.32%	22.37%
Medium Pressure (MP)	0.37%	0.00%	0.71%	5.06%	2.89%	9.03%
High Pressure (HP)[31]	0.00%	0.00%	0.97%	25.69%	41.19%	67.85%
High Pressure 2 (HP2)[32]	0.00%	0.00%	0.00%	0.76%	0.00%	0.76%
Total	**12.78%**	**6.29%**	**3.86%**	**32.68%**	**44.40%**	**100.0%**

Mains Replacement Program

A 30 year Mains Replacement Program was introduced by Multinet Gas in 2003 to address the 'societal risk' posed from failure of cast iron mains and resulting risk of incidents leading to loss of life or significant property damage. The objective is to decommission all cast iron (CI) mains on Multinet's low pressure network by 2033 (i.e. within 30 years).

Multinet Gas remains committed to the 30 year program and through continual review of network performance has extended mains replacement to include other materials and pressures that also pose an unacceptable 'societal risk'.

The following key programs are delivered by Multinet Gas to maintain alignment with Network Objectives and compliance with regulatory obligations contained in the Gas Safety Case, Gas Distribution System Code and AS 4645:

- Continuation of the 30 year program for the decommissioning of all low pressure cast iron mains by 2033;
- Targeted replacement of all remaining medium pressure cast iron mains by end 2021; and
- Targeted replacement of earliest 31 kilometres (km) of first generation high density polyethylene (HDPE) mains by end 2022.

The primary drivers for the above mentioned programs are:

- Reduction of public and maintenance personnel risk associated with gas main fractures and leaks from the cast iron and unprotected steel network;
- Reduction of public and maintenance personnel risk associated with squeeze–off failures, resulting from brittle cracking of early first generation high density polyethylene mains;
- Improve network reliability and capacity;
- Maintain and Improve Operational, Safety and Regulatory requirements; and
- Reduce environment impacts from methane emissions associated with Un-Accounted for Gas (UAFG).

Figure 5-5 below provides an overview of the historical replacement volumes up to and including 2016 along with the forecasted volumes for the remaining period from 2017 to 2033. Historically (from 2003) annual replacement rates have varied from a low of 21 km in 2010 to a high of 168 km in 2006. The average replacement rate over the 14 year period was 83 km per annum.

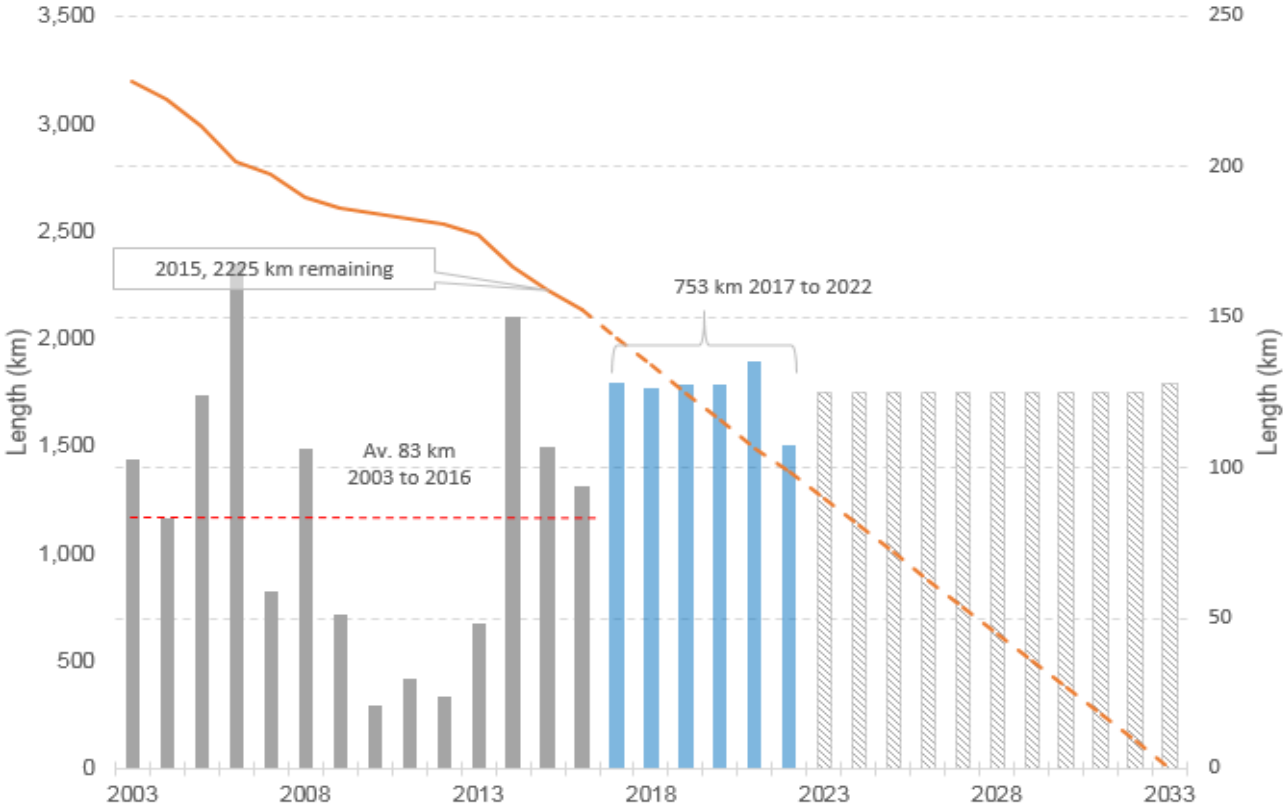
[29] For the purposes of classification, unprotected steel is considered mains which are uncoated and for protected steel mains are considered externally coated.

[30] Low pressure normal operating maximum is 3.5 kPa as per Multinet Gas Engineering Standard EP-PL-7600.

[31] High Pressure 1 has historically been referred to as High Pressure.

[32] High Pressure 2 is provided as a pressure category in the Gas Distribution Code Schedule 1.

Figure 5-5: Low Pressure Mains Replacement Volumes



Refer to Program ***#2-1 – Mains Replacement Strategy*** *in* Table 6-2 for a summary.

Leakage survey

Multinet Gas currently carries out annual leakage survey on areas of their network that have a high population and building density. Refer to EC-LS-5201 Leakage Survey – Gas Distribution and Transmission pipelines for more information regarding Leakage Survey. In an effort to reduce UAFG Multinet carried out a Special leakage survey (ad-hoc) on its MP cast Iron network in 2017. Refer to Table 7-9 for leakage survey results on Medium Pressure Cast Iron.

Multinet will continue to carry out an annual leakage survey as well conduct a yearly special leakage survey on its MP cast Iron network until the replacement program is completed in 2021.

Refer to Program ***#2-2 – Leakage Survey*** *in* Table 6-2 for a summary.

SCADA Control/monitor of Field and District Regulators

Multinet gas currently monitors and controls particular areas of its gas network in real-time using the SCADA system. Refer to Table 5-12 for an overview on SCADA on the Multinet Network.

Table 5-12 Overview of SCADA Control/Monitor on the Multinet Network

Supply Regulator Description	LP	MP	HP	HP2
SCADA Controlled (Variable)	0	0	45	0
SCADA Controlled (Step)	0	0	8	3
SCADA Monitored	120	24	9	0
No SCADA	12	28	4	0
Total	**132**	**52**	**66**	**3**

For the HP networks, by utilising real-time pressure data at various fringe points, the outlet pressure can be continually controlled (i.e. minimised) while still maintaining minimum required fringe pressures. By optimising the pressure in the network at all times, the volume of UAFG due to leakage is reduced, whilst ensuring customers are supplied at pressures in accordance with the Gas Distribution Code. As such a program of works for installing SCADA Variable control on Step Controlled HP Field Regulators is scheduled for the next regulatory period (2018-2022). Refer to program of works ***#2-3 – SCADA HP Variable Control*** a summary.

As can be seen in Table 5-10 there is no SCADA control over the LP and MP networks. As such Multinet proposes to install basic Step control on 26 MP Field regulators and 25 LP District regulators over the next regulatory period (2018-2022). Refer to Program ***#2-4 – SCADA Control on LP and MP Networks*** *in* Table 6-2 for a summary.

Field and district regulator pressure settings are reviewed yearly and consequently a regulator schedule is published in an effort to optimise the pressure in the network at all times. In known areas of high leakage, particularly on MP networks, Multinet will look to reduce regulator pressure settings where possible to minimise leakage volumes throughout the network. Refer to Program ***#2-5 – Network Pressure Schedule*** *in* Table 6-2 for a summary.

Managing leakage on the LP network during overnight periods is of particular importance as there is minimal usage in the system during this time. As such a program has been put in place to better monitor District regulator settings against the scheduled pressure. Refer to Program ***#2-6 – District Regulator Performance monitoring in PI*** *in* Table 6-2 for a summary.

5.3.3. Mains Commissioning/Abandonment

Any quantity of gas used to commission any new asset is not metered and directly contributes to UAFG. In 2015, AIA quantified the amount of gas used as 132 (GJ.pa) or 0.004%[33] of total UAFG. This calculation was based around a total of 160km of new HP mains laid. Refer to Section 7.8 for an example calculation.

No further strategies are implemented by Multinet in respect to lost gas during commissioning / abandonment activities.

5.3.4. Regulator Venting

All regulators (with the exception of LP customer regulators) have a built in safety mechanism which vents gas to atmosphere to prevent over pressurisation of downstream fitting lines. Venting of small volumes of gas may occur during normal operating conditions. Regulators that are found to be venting more than normal are considered defective and are replaced.

[33] Calculation based on 2007 annual total UAFG amount of 2,507,247 (GJ.pa). Refer to Appendix B for totals (i.e. 71,833,005 (GJ) – 69,325,758 (GJ))

Mutlinet Engineering Standard *ES-GM-4305 - Low and High pressure Domestic Regulators* sets out the purchase specification for domestic regulators. These regulators are tested 6 monthly against this standard and the results are reviewed to ensure compliance with this specification.

As the inlet pressure to the regulator increases the regulator outlet pressure begins to creep until the internal relief mechanism engages to relieve regulator downstream pressure. As such by optimising pressures in the network Multinet can reduce the amount of gas lost due to venting under normal operating conditions. A program of works for installing SCADA Variable control on Step controlled HP Field Regulators is scheduled for the next regulatory period (2018-2022). Refer to program of works ***#2-3 – SCADA HP Variable Control for*** a summary.

5.3.5. Equipment Losses

Leakage can occur anywhere there is a connection to a piece of equipment (valves, meters, regulators, upstands, filters etc). The following equipment is on regular maintenance and any leaks occurring on the equipment will be identified and rectified during planned maintenance:

- I&C meter regulator units;
- TP valves;
- Distribution Valves[34];
- Field and District regulators;
- HP Fringe Points;
- City Gate facilities
- CTM facilities

The majority of equipment leaks occur on domestic meter regulator units as they are exposed to atmospheric conditions and are not subject to scheduled maintenance. Scheduled maintenance of domestic regulators is not economically justified. These are often reported as public escapes and are rectified according to the priority given.

5.3.6. Third Party Damages

Third party damages are a common occurrence on gas distribution assets. The damage can be superficial without any detrimental long term damage to the asset, while other damages can result in leakage of gas which results in UAFG. While a third party damages can occur on any part of the network, the majority are related to service damages by consumers and contractors (i.e. fencing contractors) working without proper knowledge of the location of the buried gas assets.

Investigation in to the feasibility of installing marker warning tape onto new services in order to reduce the number of damages will be carried out. Refer to Program ***#2-7 – Marker warning tape for services*** *in* Table 6-2 for a summary.

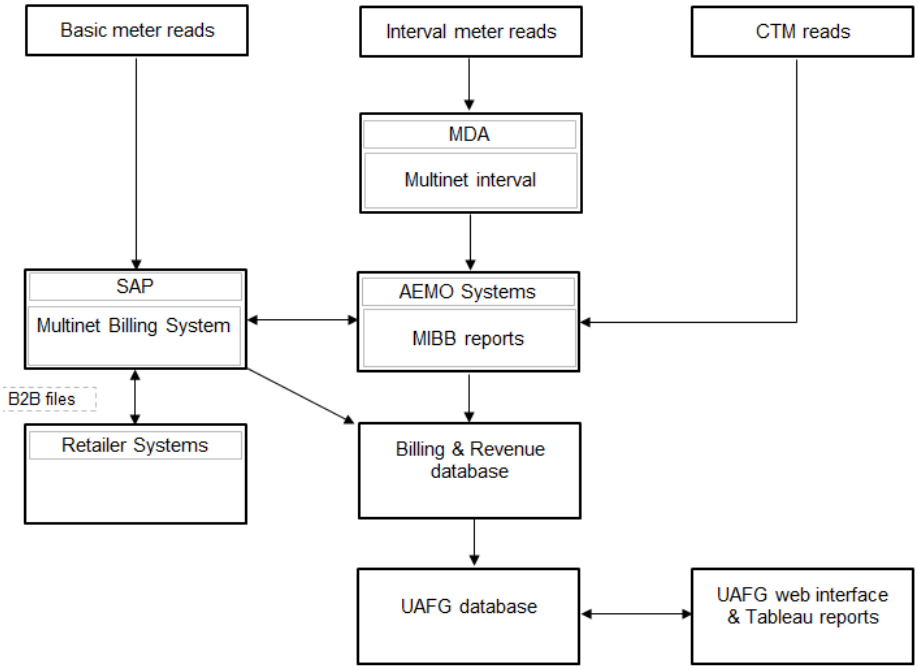
[34] Refer to MG-SP-0011 Distribution Valves Strategy v2.0

5.4. Systems

5.4.1. UAFG Data Systems and Reconciliation Model

From the initial meter readings (and estimations) through to the UAFG reconciliation, a large amount of data is handled and passed between a number of systems. Figure 5-6 highlights the main systems and data flows used in calculating UAFG and generating gas transportation charges.

Figure 5-6: Schematic of key UAFG data systems



As mentioned in Section 3.2 Multinet commissioned AIA in 2014 to undertake an audit of the UAFG Reconciliation model to ensure compliance with AEMO procedures. The report found that the Multinet calculation of UAFG was being undertaken in compliance with the AEMO procedures. Refer to AIA Report – RPC 0056 Audit of the UAFG Calculation Processes for detailed findings and recommendations.

Due to increasing levels of UAFG since 2014, in 2017 Multinet engaged Accenture to undertake another audit of the Reconciliation model, whilst also extending the scope to cover the systems and data that feed into the model. These audits are covered in the following programs of works and the preliminary findings of these audits can be found in Section 7.9

- ***#3-1 – Systems & Data flow audit***
- ***#3-2 – Reconciliation model audit***

Based on these findings a number of recommendations will be proposed and assessed and the most cost effective solutions will be implemented. Refer to Table 6-3 for a summary.

5.4.2. Meter Reads

As defined in Table 5-1, interval meter read data is managed by AEMO, however all basic meter read data is managed by Multinet. As such all basic meter reads are sent to AEMO for acceptance and inclusion into the UAFG settlement for the calendar year. If an actual read cannot be obtained the system estimates a read based on historic data. These estimate reads are revised once an actual read is obtained again. For the purposes of UAFG

settlement AEMO will not accept any reads 6 months after the date of that read. Hence any revisions that occur outside the 6 month period due to an actual read being obtained will not be included in the UAFG settlement.

Where this contributes to UAFG is when Multinet are unable to obtain an actual read within any rolling 6 month period. Reads are estimated for a number of reasons, including

- No Access;
- Invalid read;
- Dirty index.

Refer to Section 7.10 for a list of reason codes.

Table 5-13 below shows the number of estimated reads on Basic I&C customers across CY 2016.

Table 5-13 Estimated reads on Basic I&C customers

No. of customers	Total No. of reads	No. of reads Estimated	Percentage of reads Estimated
2435	12452	2326	19%

Sites with an estimated read percentage of 75% and greater were site visited and found that the majority of sites had an estimated read due to no access.

In order to reduce the number of estimates as a result of "no access' the following programs have been put in place.

- ***#3-3 – Skilltech contract renegotiation***
- ***#3-4 – Customer/retailer scheduled read day***
- ***#3-5 – Smart meter trial***

One particular issue that was identified as part of this investigation was the meter dial issue in SAP, whereby meters are entered into the system as having 5 dials when they require 6 digits for a meter read. This results in the read being out by a factor 10 and has adverse impacts on Multinet's UAFG. This issue has since been rectified, however all historic errors will still remain in the system. A strategy to identify these sites has been developed.

Refer to Program ***#3-6 – Meter Dial Issue*** *in* Table 6-3 for a summary.

UAFG settlement data (consumption for the CY) is received from AEMO and almost never reconciles to consumption data in Multinet's SAP system. This is largely due to the fact that revised reads outside 6 months are not accepted by AEMO, but is also due to various other read validations that AEMO have in their system. As a result of this, a program of works is in place to investigate any system issues that result in reads not being accepted by AEMO.

Refer to Program ***#3-7 – BMP Reporting*** *in* Table 6-3 for a summary.

5.4.3. Meters not Installed in SAP

When a meter is installed or exchanged in the field, the meter must also be installed or exchanged in the SAP meter billing system. If a meter is not properly installed or exchanged in the system no meter reads will be obtained for that customer. Where this is of concern to UAFG is when this issue is not rectified within 6 months as AEMO will not accept any consumption data outside of this period. As such meter management is critical in the process of managing UAFG.

A recent review of our meter management showed that there were opportunities for improvement in our process, as such the following process improvements have been implemented to ensure that going forward all meters are being installed in SAP:

- Gas fitters are now only allowed to access meters during Meter Store operating hours, 7.30a.m to 3.30p.m
- All physical meter deliveries will be validated in SAP
- Gas fitters to return all meters within 5 days of removal from the field and meter store personnel to check SAP and physical meter

Multinet have a program in place to identify any legacy meters that are not installed on the network. Refer to Program ***#3-8 – Legacy meter not installed*** *in* Table 6-3 for a summary.

6. Programs of Works Summary

The following programs will be undertaken in the forthcoming regulatory period (2018-2022).

6.1. Measurement

Table 6-1: Works Program for Measurement category

#	Title	Overview	UAFG Source	Timeframe	Status[35]
1-1	CTM Upgrade and life-cycle replacement program	Planned replacement of the following five Turbine CTMs. • M007 - DTS (Edithvale) • M016 - Clayton • M017 - Oakleigh • M023 - Port Melbourne (Howe Pde) • M024 - Port Melbourne (Lorimer)	CTM Uncertainty	CY17-19	In progress
1-2	CTM short duration surging rectification	Rectification works on short duration surging to address the following CTM locations: • M005 - DTS (Iurgi) – Network control measures • M018 - Malvern – Network control measures • M034 - Gembrook – undergoing regulator upgrade	CTM Uncertainty	CY18	Not Started
1-3	Time Expired Meter Replacement – “no access” meters	Dedicated program to address “no access” meters encountered as part of the annual time expired meter replacement program (Domestic & I&C).	Meter accuracy	Ongoing	Ongoing
1-4	Faulty meter indexes	The following activities will be carried to out to manage faulty indexes:	Faulty Meter Indexes	Ongoing	Ongoing

[35] June 2017

#	Title	Overview	UAFG Source	Timeframe	Status[35]
		• Continue to run zero consumption reports on a yearly basis. Report to be expanded to cover domestic customers. • Review current process for updating meter status in IT Systems (SAP IS-U). • Site visit meters with a particular type of index to ensure correct operation.			
1-5	P&T for Interval Customers	Installation of Pressure (P) & Temperature (T) correction as per defined program / criteria: • Proactive o *28 sites for T&P correction, refer to Table 7-6* o *16 sites for Temperature correction, refer to Table 7-7* • Reactive – all remaining tariff D customers	P & T compensation	CY17-18	In progress
1-6	Temperature variation for domestic customers	Investigate the effect of temperature variation (i.e. variance from 15°C) for domestic customers	P & T compensation	CY18	Not started
1-7	PCF review	Ongoing review of Pressure Correction Factors (PCF) for I&C customers at 6 month intervals.	Incorrect PCF	Ongoing	Ongoing
1-8	Consumption at City Gate Facilities	Review metering and retailer relationships for heater installations at City Gates to ensure consumption is included in UAFG calculation.	Company own consumption	CY18	Not started

6.2. Fugitive Emissions

Table 6-2 Works Program for Fugitive Emissions category

#	Title	Overview	UAFG Source	Timeframe	Status[36]
2-1	Mains replacement strategy	Efficient delivery of Multinet's Mains Replacement Program. Refer to *MG-SP-0009 Distribution Mains Strategy v2.0* for more information	Distribution losses	Ongoing	Ongoing
2-2	Leakage Survey	Ongoing compliance to Multinet Gas' leakage Management Strategy Refer to *EC-LS-5201 Leakage Survey - Gas Distribution and Transmission pipelines* for more information	Distribution losses	Ongoing	Ongoing
2-3	SCADA HP Variable control	Five regulators across the following three networks will undergo a SCADA upgrade to Variable control by 2022. Networks include: • Vermont Network • Keysborough Network • Lorimer St Regulator Refer to Section 4.2.3 *MG-SP-0002 SCADA Strategy v2.0 for more details*	Distribution losses/Regulator Venting	FY18-FY22	Not started
2-4	SCADA Step Control on LP and MP Networks	Install step control on the LP and MP (by 2022) as per SCADA Strategy • 26 x MP Field regulators • 25 x LP District regulators Refer to Section 4.2.4 and 4.2.5 in *MG-SP-0002 SCADA Strategy v2.0* for more details	Distribution losses	FY18-FY22	Not started
2-5	Network Regulator Schedule	Annual review and implementation of Network Pressure Schedule. Refer to *Multinet Gas – 2017 Regulator Schedule* for detailed settings.	Distribution losses	Ongoing	Ongoing

[36] June 2017

#	Title	Overview	UAFG Source	Timeframe	Status[36]
		2018 review to provide additional focus on high leakage areas in MP networks to reduce pressures (hence network losses) where possible.			
2-6	District Regulator performance monitoring in PI	Establish automatic alarms for district regulators when outlet pressures vary (within tolerance) from set point.	Distribution losses	FY17-18	In progress
2-7	Marker warning tape on services	Investigate the feasibility of installing marker warning tape onto new services.	Third Party damages	FY18-20	Not started

6.3. Systems

Table 6-3 Works Program for Systems category

#	Title	Overview	UAFG Source	Timeframe	Status[37]
3-1	Systems & Data flow audit	Finalise and implement remedial actions from System & Data Flow audit.	UAFG Data systems and Reconciliation Model	FY17-18	In progress
3-2	Reconciliation model audit	Finalise and implement remedial actions from UAFG Reconciliation model audit	UAFG Data systems and Reconciliation Model	FY17-18	In progress
3-3	Meter reading contract renegotiation	Renegotiate Meter Reading contract with external provider to increase incentives to obtain increased frequency of actual reads for I&C Customers	Meter Reads	FY17-18	In progress
3-4	Customer/retailer scheduled read day	Liaise with retailers and I&C customers on a preferred scheduled read time for difficult to access sites.	Meter Reads	FY18	Not started
3-5	Smart meter trial	Implementation of Multinet's Smart Gas Meter Trial. Refer to *MG-SP-0007 Small Meter Strategy v2.0* for additional information.	Meter Reads	FY18	Not started
3-6	Meter Dial issue	All new and repaired meters are checked to confirm SAP meter dial numbers aligns with the actual dials. The following actions will be carried out to identify all historic errors: • Educate meter readers to identify system mismatches, and • Develop reporting to identify system errors.	Meter Reads	Ongoing	Ongoing

[37] June 2017

#	Title	Overview	UAFG Source	Timeframe	Status[37]
3-7	BMP reporting	Investigate reads that are not accepted by AEMO in an effort to understand the following: • No. of reads not accepted • Reasons for non-acceptance • Any system wide issues that may be contributing to non-acceptance	Meter reads	FY18	Not started
3-8	Legacy meters not installed in SAP	• Meter reader incentives to identify meters not on meter reading route • Reconciliation between I&C customers and meter billing system • Meter room checks	Meters not installed in SAP	FY17-18	In progress

7. Appendix

7.1. Glossary & Definitions

Term	Meaning
AIA	Asset Integrity Australasia
AEMO	Australian Energy Market Operator
AVWMP	Average Volume Weighted Market Price
Basic Customer	Customer whose consumption of data is to be recorded monthly or bi-monthly. Reading of these sites are managed by Multinet. This is the majority of customers in the Multinet network.
CAPEX	Capital Expenditure
CY	Calendar Year
DB's	Distributors
Domestic customer	Domestic meter regulator setup that is on reactive maintenance only.
FLE	Field Life Extension
FY	Financial Year
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
GFC	Gas and Fuel Corporation
GJ	Gigajoules
HHV	Higher Heating Value
HP	High Pressure (Pressure Range: 140 to 515 kPa)
HP2	High Pressure 2 (Pressure Range: 515 to 1050 kPa)
I&C	Industrial & Commercial
Industrial and commercial customer	Customer that has an industrial and commercial meter regulator setup. These sites are on maintenance plans and the meter and regulator information is stored in SAP ERP
Interval customer	Sites where meter consumption data is to be recorded daily through the use of data logger Reading of these sites is managed by AEMO.
LP	Low Pressure (Pressure Range: Up to 7 kPa)

Term	Meaning
MG	Multinet Gas
MIRN	Meter Identification Number
MP	Medium Pressure (Pressure Range: 35 to 210 kPa)
Non-PTS	Non - Principal transmission System
OPEX	Operational Expenditure
PE	Polyethylene
PCF	Pressure Correction Factor
PTS	Principal Transmission System
PVC	Polyvinyl Chloride
RTU	Remote Terminal Units
SAP	Systems Applications and Products is an Enterprise Resource Planning tool which used at Multinet Gas for recording asset data and maintenance management.
SCADA	Supervisory Control And Data Acquisition
Tariff D customer	Customers who consumption is greater than 10TJ p.a. The customer pays for the metering setup including flow correction.
Tariff V customer	Customer who consumption is less than 10 TJ p.a. This is the majority of customers in the Multinet network.
TJ	Terajoules
UAFG	Unaccounted for Gas

7.2. List of CTM's

Table 7-1: Custody Transfer Meter Stations Metropolitan Melbourne

Reference. No	Suburb or Town/City	Meter Type	Category
M003	Dandenong North 450 mm	Ultrasonic	B
M004	Murrumbeena 300 mm To Highett	Ultrasonic	B
M005	DTS - Lurgi/150 mm GMH	Ultrasonic	B
M006	Dandenong (BOC Let Down)	Ultrasonic	B
M007	DTS - Edithvale	Turbine	C
M012	St Kilda	Ultrasonic	B
M015	Noble Park	Coriolis	C
M016	Clayton	Turbine	C
M017	Oakleigh	Turbine	C
M018	Malvern 2,800	Ultrasonic	B
M019	St Kilda East	Coriolis	C
M023	Port Melbourne	Turbine	C
M024	Port Melbourne	Turbine	C
M034	Gembrook	Coriolis	C
M119	Templestowe Remote Line Valve (closed)	Ultrasonic (MG owned)	B
M147	Seville East	Coriolis	C
M148	Yarra Glen	Coriolis	C
M162	Yarra Glen – Lilydale off-take	Ultrasonic	B

Table 7-2: Custody Transfer Meter Stations – South Gippsland

Reference. No	Suburb or Town/City	Meter Type	Category
MR05	Lang Lang (SGP)	Coriolis	C
MR04	Lang Lang	Coriolis	C

7.3. UAFG Past performance since 2002

Table 7-3: PTS Past Performance – UAFG since 2005

Year	Network Injections (TJ)	Network Withdrawals (TJ)	Unaccounted for Gas (TJ)	Percentage of UAFG (%)
2002	58,389	57,089	1,300	2.23%
2003	62,016	60,317	1,699	2.74%
2004	62,109	60,401	1,708	2.75%
2005	57,170	55,301	1,869	3.27%
2006	63,060	60,886	2,174	3.45%
2007	56,967	54,780	2,187	3.84%
2008	60,764	58,540	2,224	3.66%
2009	58,433	56,247	2,186	3.74%
2010	60,895	58,439	2,456	4.03%
2011	58,304	56,212	2,092	3.59%
2012	59,976	57,403	2,573	4.29%
2013	57,441	54,730	2,711	4.72%
2014	54,884	52,348	2,536	4.62%
2015	59,960	56,567	3,393	5.66%

Table 7-4: Non-PTS Past Performance - UAFG since 2009

Year	Network Injections (TJ)	Network Withdrawals (TJ)	Unaccounted for Gas (TJ)	Percentage of UAFG (%)
2009	68,336	53,550	14,786	21.64%
2010	243,990	204,052	39,938	16.37%
2011	372,798	352,526	20,272	5.44%
2012	418,854	408,620	10,234	2.44%
2013	452,817	393,347	59,470	13.13%
2014	614,077	634,115	-20,038	-3.26%

Table 7-5: Past performance reconciliation payments

Year	Class B Actual UAFG (%)	Class B Benchmark (%)	UAFG Variance (TJ)	Cost of UAFG ($/GJ)	Reconciliation payment to retailers ($)
2002	2.4%	2.7%	-144	$ 2.94	-$ 423,525
2003	3.0%	3.6%	-353	$ 3.04	-$ 1,072,595
2004	3.0%	3.6%	-341	$ 3.06	-$ 1,044,569
2005	3.6%	3.6%	0.7	-	$ 1,205
2006	3.8%	3.6%	100	$ 3.14	$ 312,998
2007	4.2%	3.6%	322	$ 3.29	$ 1,060,889
2008	3.9%	3.6%	187	$ 3.54	$ 662,007
2009	4.0%	3.2%	467	$ 3.59	$ 1,678,357
2010	4.3%	3.2%	657	$ 3.90	$ 2,565,865
2011	3.9%	3.1%	407	$ 4.19	$ 1,707,182
2012	4.5%	3.1%	841	$ 3.96	$ 3,330,534
2013	5.0%	3.6%	767	$ 4.03	$ 3,090,292
2014	4.9%	4.1%	452	$ 3.99	$ 1,805,062
2015	6.0%	4.1%	1088	$ 4.69	$ 5,110,037

7.4. APA Group Project: Metering Strategy Plan 2015 (extract from Summary)

Site	Site Name	Upgrade Required	Urgency	Date Required
M005	DTS (Lurgi)	Multinet to limit flow to 100% of meter capcaity	Critical	Immediately
	AND	100% Nozzle Upgrade	Critical	Immediately
	OR	Installation of 300NB USM	Risk Dependent	Immediately
M007	DTS (Edithvale)	Life Cycle Replacement	Medium	2017+
M015	Noble Park	Fix Fail Open Regulators / add ramping function	Critical	Immediately
M015	AND	100% Nozzle Upgrade (If meter not upgraded)	Critical	Immediately
M015	AND	Life Cycle Replacement	Medium	2017+
M015	OR	Upgrade to a CMF300 (If regulators not fixed)	Medium	2016+
M016	Clayton	Fix Fail Open Regulators	Critical	Immediately
M016	Clayton	100% Nozzle Upgrade	Critical	Immediately
M016	Clayton	Life Cycle Replacement	Medium	2017+
M016	**OR**	Upgrade to a CMF300	Risk Dependent	2016+
M017	Oakleigh	Fix Fail Open Regulators	Critical	Immediately
M017	Oakleigh	100% Nozzle Upgrade	Medium	Immediately
M017	Oakleigh	Life Cycle Replacement	Medium	2017+
M017	**OR**	Meter Upgrade (New site req)	Risk Dependent	Immediately
M018	Malvern	Meter Upgrade (forecast shows no growth)	Risk Dependent	2016+
M019	St Kilda East	Life Cycle Replacement	Medium	2017+
M023	Port Melbourne (Howe Pde)	100% Nozzle Upgrade	Critical	Immediately
M023	Port Melbourne	Life Cycle Replacement	Medium	2017+
M023	OR	Upgrade to a CMF200	Critical	Immediately
M024	Port Melbourne (Lorimer St)	Life Cycle Replacement	Medium	2017+
M034	Gembrook	Fix Fail Open Regulators	High	Immediately
M148	Yarra Glen	Upgrade to a CMF100	Critical	2016+

Refer to APA Group Project: *Metering Strategy Plan 2015 Multinet Gas Meter Sites* for more details

7.5. Pressure and Temperature compensation

7.5.1. Volume to energy conversion

A customer metered volume of gas is converted to energy using the following relationship.

$$E = V_m \, x \, PCF \, x \, HHV \, x \, 1000 \, (GJ)$$

Where:

$E = Energy \, in \, GJ$

$V_m = Metered \, volume \, in \, m^3$

$PCF = Pressure \, Correction \, Factor$

$HHV = Higher \, Heating \, Value \, in \, MJ/m^3$

7.5.2. Elevation Compensation calculation

To compensate for the change in atmospheric pressure based on ground elevation, the following calculation could be performed to correct the values for UAFG volume:

$$UAFG_{atm} = V_m \left[\frac{(P_a - P)}{1013.25} - 1 \right]$$

$UAFG_{atm}$ = UAFG due to variation in atmospheric pressure at elevation

V_m = volume of gas metered

P_a = atmospheric pressure at sea level (mB)

P = pressure correction at elevation (mB)

Assuming the average ground elevation of Melbourne is 70m above sea level, a pressure correction of 8.24mB in atmospheric pressure is applied. Modelling of the elevation at the meter locations where UAFG readings are taken, could be performed to further refine this estimate.

7.5.3. Temperature Compensation calculation

To compensate for the change in temperature away from standard conditions, the following calculation can be used:

$$UAFG_{temp} = V_m \left[\frac{288.15}{(T_m + 273.15)} - 1 \right]$$

$UAFG_{temp}$ = UAFG due to temperature variation of gas

V_m = volume of gas metered

T_m = temperature of gas metered (deg.C)

7.5.4. Sites listed for pressure and/or temperature correction

Table 7-6 Sites with existing data logger that require both Pressure and temperature correction

MIRN:	Business:	Address:	Suburb:	Post Code:	2015 Consumption:	Revised Consumption:	Difference: (GJ)	% Lost
C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C

MIRN:	Business:	Address:	Suburb:	Post Code:	2015 Consumption:	Revised Consumption:	Difference: (GJ)	% Lost

Refer to business case *MG-17-062-T and P Correction for Tariff D MIRNs FINAL* for more information

Table 7-7 Sites with existing pressure correction that require temperature correction

MIRN	Company	Street	Suburb	Post code	Old Consumption.	New Consumption.	Difference in consumption (GJ)	% Lost
C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C	C-I-C

Refer to business case *MG-17-062-T and P Correction for Tariff D MIRNs FINAL* for more information

7.6. AEMO Pressure Correction Factors

Table 7-8 PCF's in use in the Victorian Gas Market, published on 28 August 2015.

Pressure Correction Factor	kPa
1.0109	1.1
1.0123	1.25
1.0148	1.5
1.0247	2.5
1.0257	2.60
1.0272	2.75
1.0396	4
1.0495	5
1.0692	7
1.0742	7.5
1.0989	10
1.1188	12
1.1484	15
1.1781	18
1.1979	20
1.2970	30
1.3960	40
1.5942	60
1.6934	70
1.7927	80
1.9913	100
2.0907	110
2.1901	120
2.3891	140
2.6879	170
2.8873	190
2.9872	200
3.0870	210
3.4866	250
3.9873	300
4.4890	350
4.9922	400
5.4961	450

7.7. Leakage survey results on Medium Pressure Cast Iron in 2017

Table 7-9: Leakage Survey results on MP Cast Iron 2017

Area	Length (km)	Leak Indications	Leakage Rate (leaks/km)	Size of mains
Bulleen	4.83	71	14.7	300/450mm
Hawthorn	0.89	11	12.4	225mm
Glen Iris	3.09	47	15.2	225/300mm
Clayton South & Clayton South Detail A	6.2	15	2.4	100mm/150mm
St Kilda	5.9	38	6.4	450m/600mm
Port Melbourne	8.4	18	2.1	150mm
Brighton East	1.7	2	1.2	
Highett	0.8	0	0.0	
Blackburn (Miscellaneous #1)	1.06	0	0.0	
Blackburn Sth (Miscellaneous #2)	0.61	3	4.9	100mm
Burwood East (Miscellaneous #3)	0.56	0	0.0	
Burwood East (Miscellaneous #4)	1	5	5.0	50/100mm
Burwood (Miscellaneous #5)	0.17	0	0.0	
Ashwood (Miscellaneous #6)	0.42	5	11.9	50mm
Doncaster (Miscellaneous #7)	0.12	0	0.0	
Mount Waverley (Miscellaneous #1)	1.3	1	0.8	50mm
Monomeith Cr, Mount Waverley (Miscellaneous #2)	0.131	2	15.3	100mm
Gyton Ave, Glen Waverley (Miscellaneous #3)	0.4	5	12.5	150mm
Blue Hills Ave, Mount Waverley (Miscellaneous #4)	0.9	0	0.0	
Mount Pleasant Dr, Mount Waverley (Miscellaneous #5)	0.08	1	12.5	50mm
Morrison St, Oakleigh (Miscellaneous #6)	0.114	0	0.0	
Totals	**38.7**	**224**	**5.8**	

Note: These are leak indications as the leaks have not been pinpointed.

7.8. Gas lost during mains commissioning/abandonment formula

It has been documented that a small percentage of UAFG is attributed to purging and filling of mains, during commissioning and related maintenance activities. This quantity of gas can be estimated using the following equation:

$$UAFG_{com} = V\left(\frac{P_{avg}+101}{101}\right)\times\frac{1}{Z}\times HV\times 10^{-6}$$

UAFG= quantity of gas used to commission main (TJ)

V = internal volume of the main (m^3)

P_{avg} = average operating pressure of the main (kPa)

Z = supercompressibility of gas at average pressure, P_{avg}

HV = heating value of gas = 38.7 MJ/m^3

7.9. Preliminary findings of Systems audits

7.9.1. Systems and Dataflow audit

The audit to date has identified the following issues.

- Missing or partially loaded invoices impacting on basic metered Class B UAFG calculations.
- Missing settlement data that was issued by AEMO
- Duplicate settlement data
- Incorrect classification of settlement data quality

The following causes and risks were identified.

- Insufficient or non-existent error handling and alerting when loading both SAP billing data and AEMO MIBB files.
- Incorrect program logic used for loading and classifying settlement files.
- Lack of formal reconciliation to ensure data feeding the UAFG calculation model is complete.
- Outdated systems (out of vendor support) and customisations with limited documentation.
- Insufficient retention of source data from AEMO and from SAP.

7.9.2. Reconciliation Model audit

The calculation model appears to be correctly calculating Injected energy and interval metered withdrawals. The audit to date has identified the following risks and issues.

- Incorrect exclusion of some billed volumes due to perceived duplication
- Allocation of UAFG to a specific retailer can be incorrect under certain conditions
- Web interface for executing jobs is restrictive.
- A lot of data is copied and produced when not required resulting in performance issues.
- Insufficient documentation on calculation model and associated reports

7.10. Estimated read reasons

Table 7-10 Estimated read reasons

Read code	Short Description
0	Other
1	Meter Removed
2	Meter Obstructed
3	Dirty Dial
4	Can't Locate Meter
5	Gate Locked
6	Savage DOG
7	Meter Changed
8	Refused Access
9	Locked & No Answer
10	Delayed Read
11	Adjustment Read
12	Damaged Meter
13	Dial Out of Alignment
14	Key Required
15	Access Overgrown
16	Hi/Low Failure
17	Meter Capacity Failure

7.11. List of Figures

7.12. List of Tables

UAFG data required by the Essential Services Commission

Multinet - DTS network

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
CTM injections (GJ)	62,016,000	62,109,000	57,170,000	63,060,000	56,967,792	60,764,227	58,433,551	60,895,871	58,304,035	59,976,345	57,441,524	54,884,218	59,960,143		
Total withdrawals (GJ)	60,317,000	60,401,000	55,301,000	60,886,000	54,780,490	58,540,409	56,246,920	58,439,287	56,212,000	57,403,000	54,730,075	52,348,307	56,576,732		
Class A withdrawals (GJ)	5,830,000	6,016,000	5,734,000	5,807,000	5,257,238	4,343,787	4,646,787	4,411,062	3,916,157	3,747,998	3,948,956	3,874,940	3,667,846		
Class B withdrawals (GJ)	54,487,000	54,385,000	49,567,000	55,079,000	49,523,252	54,196,622	51,600,132	54,028,226	52,295,843	53,659,719	50,781,119	48,473,367	52,908,886		Added this line for total Class B withdrawals as energy not split by tariff.
Class B withdrawals - D customers (GJ)															
Class B withdrawals - V customers (GJ)															
Actual UAFG (GJ)	1,699,000	1,708,000	1,869,000	2,174,000	2,187,302	2,223,818	2,186,631	2,456,583	2,127,623	2,568,629	2,711,449	2,535,911	3,383,410		
Class A UAFG (GJ)	17,543	18,102	17,254	17,473	15,819	13,071	13,982	13,273	11,748	11,244	11,847	11,625	11,037		
Class B UAFG (GJ)	1,681,457	1,689,898	1,851,746	2,156,527	2,171,483	2,210,747	2,172,648	2,443,310	2,115,875	2,557,385	2,699,602	2,524,286	3,372,374		
% UAFG	2.74%	2.75%	3.27%	3.45%	3.84%	3.66%	3.74%	4.03%	3.65%	4.28%	4.72%	4.62%	5.64%		
% Class A UAFG	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%	0.30%		
% Class B UAFG	2.99%	3.01%	3.60%	3.77%	4.20%	3.92%	4.04%	4.33%	3.89%	4.55%	5.05%	4.95%	5.99%		

Reconciliation amounts received/(paid) $000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]	
Total				($320,071.73)	($1,060,889.15)	($662,007.16)	($1,667,993.72)	($2,424,789.12)	($1,702,939.59)	($3,330,668.25)	($3,213,460.02)	($1,805,201.39)	($5,148,199.80)	
Note:	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	Settled	

If any unsettled data is provided, please indicate.