PLAN

METER REPLACEMENT PLAN

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INTERNAL

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1 INTRODUCTION

1.1 PURPOSE

The purpose of the document is to specify the background for the gas & hot water metering asset programs.

This plan serves as the foundation for the "Connection and Metering Forecasting Methodology", which forecasts volumes and, together with cost calculations, determines the capital and operating forecasts (and budgets) for the gas metering asset replacement programs.

This document forms part of the 'Plan' suite of documents under the Jemena Asset Management System and aligns to the requirements of the JGN Measurement Asset Class Strategy.

1.2 SCOPE

This document describes the plan and methodology to identify the number of meters required to be replaced for the various metering programs as listed below. The scheduling of meter replacements may be varied to manage deliverability risk, minimise the cost of the replacement and ensure compliance with regulatory obligations.

1. Planned replacement programs, including:
    a. End of Life Replacement of Residential Aged Gas Meters;
    b. End of Life Replacement of "Difficult to Access" Residential Gas Meters;
    c. Planned Statistical Sampling of Residential Aged Gas Meters In-service Life Extension;
    d. End of Life Replacement of I&C Aged Diaphragm Meters;
    e. Planned Statistical Sampling of I&C Diaphragm Meters In-service Life Extension;
    f. End of Life Replacement of I&C Aged Rotary Meters;
    g. End of Life Replacement of I&C Aged Turbine Meters;
    h. Upgrade/downgrade of I&C Meter Sets;
    i. End of Life Replacement of Hot Water Meters;
    j. End of Life Replacement of "Difficult to Access" Hot Water Meters.
2. Defective replacement programs, including:
    a. Replacement of Defective Residential Gas Meters;
    b. Replacement of Defective Residential Regulators;
    c. Replacement of Defective I&C Diaphragm Meters;
    d. Replacement of Defective I&C Rotary Meters;
    e. Replacement of Defective I&C Turbine Meters;
    f. Replacement of Defective I&C Regulators;
    g. Replacement of Defective Hot Water Meters.

2 BACKGROUND

2.1 OBJECTIVE

The Jemena Gas Networks (JGN) metering program delivers and maintains metrological performance of gas and hot water meters to ensure:

1. Compliance – Regulatory requirements require accurate and appropriate metering.
2. Customer Satisfaction - Replacing meters prior to failure leads to a reduction in estimated billing, including meeting the AEMO requirement of no more than two estimated reads in one year.
3. UAG Minimisation - The metering accuracy 'contribution' to unaccounted-for-gas is minimised.

2.2 REGULATIONS AND STANDARDS

JGN undertakes meter replacement based upon the following regulation and standards:

- National Measurement Act 1960 (sections 18GD and 18GE)
- NSW Gas Supply (Consumer Safety) Regulation 2012
- NSW Department of Fair Trading Guidelines
- AS/NZS 4944:2006 Gas meters – In-service compliance testing
- AS 1199:2003 Sampling procedures for inspection by attributes
- AS 3565.4:2007 Meters for cold and heated drinking water and non-drinking water supplies Part 4: In-service compliance testing

3 RESIDENTIAL GAS METERS AND REGULATORS

There are five meter replacement programs related to the residential (≤8m^3/hr) gas meters and regulators:

- End of Life Replacement of Residential Aged Gas Meters
- End of Life Replacement of Difficult to Access Residential Gas Meters
- Planned statistical sampling of Residential gas meters in-service life extension
- Replacement of Defective Residential Gas Meters
- Replacement of Defective Regulators

3.1 END OF LIFE REPLACEMENT OF RESIDENTIAL AGED GAS METERS

Residential diaphragm gas meter kits provide filtration, pressure regulation and metering to small end-point users connected to the network. There are over 1.4 million residential diaphragm gas meters installed in the network to provide gas supply to our customers. This program is consistent with the asset class strategy to ensure the reliability of JGN's gas meter families for accurate billing of residential customers and to reduce estimated meter readings.

JGN has three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Meters are only replaced on failure.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**Replace all meters at 15 years of age.** Although compliance with Regulatory requirements, this option is not in the best interests of customers.	**High** Would require all meters to be replaced that are currently >15 years old	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	JGN has proven that meters lives can be extended, thus reducing the level of expenditure and thus this option is not in the interest of customers.
3	**Replacement based upon statistical testing.** In this option residential gas meters, are statistically sampled in accordance with the requirements of AS/NZS4944:2006.	**Moderate** See parameters below	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	This is the **RECOMMENDED** option adopted by JGN. Residential meters are only replaced once they have failed statistical sampling or have reached 35 years of age.

The End of Life Replacement of Residential Aged Gas Meters program is based upon the following features:

1. Meters are replaced upon reaching 35 years of age; unless

2. Based upon testing, a family, class or lot of meters has through in-service life extension testing been shown to be at end of accurate life; or
3. Replaced as part the statistical sample used to perform the testing; or
4. If the family or lot of meters is less than 400; or
5. If analysis of defective meters indicates a family, class or lot of meters has through field failure testing been shown to be at end of serviceable life.

Possibility of replacing more aged meters
We are currently optimistic about the forecast results from statistical sampling tests, and the projected replacement volumes based on these optimistic forecasts represent the minimum number we anticipate replacing over the next few years. However, should the actual results from these statistical tests indicate failures earlier than the expected 30 years, we will need to replace a greater number of meters than initially planned for in the Access Arrangement.

Maximum Life Extension
Based on the latest statistical testing, JGN has extended the maximum life for a residential meter by 10 years (two periods) to 35 years. The extension of any meter family will remain subject to the passing of life extension tests of that family. Based upon defective data, there is a marked increase in the level of meter failures in the field 'defective' meters post 32 years. As the 'safety' defects are generally time dependent, the risk level will increase as the meter ages and thus the extension to 35 years is the maximum that could be reasonably expected to maintain an acceptable level of risk.

3.2 END OF LIFE REPLACEMENT OF "DIFFICULT TO ACCESS" RESIDENTIAL GAS METERS

The End of Life Replacement of "Difficult to Access" Gas Meters program is an adjunct to the End of Life Residential Aged Gas Meters program ('Aged Meters). In undertaking the Aged Meters program, JGN has recognized that there are meters to be replaced but are unable to be accessed due to their physical location, e.g. located within a locked customer premise or where a meter has been installed in an inaccessible location.

Periodically, JGN initiates programs to target and replace 'difficult access' meters that have remained in the field beyond their in-service lifespan. In order to minimise the numbers of meters in this category, JGN's standard process is to attempt entry up to three times during the planned replacement program to ensure all efforts have been made to replace these meters.

JGN has identified three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Await the customer to request replacement.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.

2	**Include in Aged Meters Program.** Apply the Aged Meters processes.	**Low** Only minimal additional cost to the Aged Meters Program	**High** Meters would remain non-compliant and the backlog would increase	**High** Based upon customers with no measurement for period of time	This approach would result in a substantial backlog and presented issues that are difficult to access, necessitating a different approach from the standard aged meter replacement process.
3	**Separate 'Difficult Access' Program.** Apply specific processes to the management of meters that are identified as difficult to access.	**Moderate** Increase in additional resources and processing	**Moderate** Higher proportion of meters would be replaced prior to inaccuracy	**Low** Higher proportion of meters would be replaced prior to inaccuracy	This is the **RECOMMENDED** option adopted by JGN. This enables meters to be targeted and reduces the backlog and lower levels of customer service.

3.3 PLANNED STATISTICAL SAMPLING OF RESIDENTIAL AGED GAS METERS IN-SERVICE LIFE EXTENSION

The statistical sampling program is completed for residential diaphragm meters to meet the requirements of NSW Fair Trading that enables 'regulatory-life extension' past 15 years. The meters are statistically sampled and tested in accordance with *AS/NZS 4944:2006 Gas Meters – In-service compliance testing*; to determine the accuracy and leak tightness of meters.

This program is an enabler for the End of Life Replacement of Residential Aged Gas Meters.

Testing is undertaken in accordance to the following:

1. The test criteria is for 'inspection by variables'[1];
2. Sample sizes are set as per Table 1 in accordance with the requirements for inspection by variables. No testing or regulatory life extension are undertaken for families with less than 400 meters[2];
3. Samples of each meter population is removed from service two years prior to the initial 15 year life of the meter and again two years prior to any subsequent regulatory-life extensions;
4. If the meters pass[3] the statistical sampling test(s), and:
    a. fall into a band ±2% of accuracy of registration error of sample, then the diaphragm meters will be given a regulatory-life extension of five years; or
    b. fall into a band ±2.5% of accuracy of registration error of sample, then the diaphragm meters will be given a regulatory-life extension of three years. At the end of 3 years extension, this family will be replaced with no further statistical sampling test.
5. Although there is an option of a one year extension, this is not utilised due to the need to test meters two years prior to extension commencement.

[1] Refer to appendix for explanation of difference between methods of inspection by attributes versus variables for statistical sampling.

[2] Table 2 also shows that meters of population groups <400 are not statistically sampled as it is economically non-viable to remove samples from such small population groups from service. The cost for the planning and labour to remove, test and replace these meters would be greater than replacing the meter population.

[3] The life extension period is determined by the metrological performance and other performance characteristics of the meter as specified within AS/NZS 4944:2006 Table 5.

Table 1. Residential Meter Population Numbers which are Statistically Sampled

Population Group	Sample Size	Qty to Collect	Comment
0-400	Not Sampled		
401-500	25	35	Sampled
501-1200	35	45	Sampled
1201-3200	50	70	Sampled
3201-10000	75	95	Sampled
10001-35000	100	120	Sampled

The actual number of meters drawn from the in-service family "drawing number" is higher than the actual sample size required by AS/NZS 4944:2006 to allow for the additional meters if some meters are damaged in the process of collection and delivery to the testing establishment.

3.4 REPLACEMENT OF DEFECTIVE RESIDENTIAL GAS METERS

Failure to replace a defective residential gas meter will result in a Regulatory non-compliance and has the potential to restrict customer supply. In addition, failure of the meter index system results in inaccurate or zero measurement impacting upon unaccounted for gas (UAG) leakage and providing customers with incorrect bills.

Defective meter replacement programs are forecasted based on a four year historical average spend, with an increase of one per cent (1%) for meters that have been in service for more than 30 years to recognize that the likelihood of failure increases with age. This has been validated through a review of a sample of meters greater than 30 years. This increase for meters of greater than 30 years is a conservative approach to the information in Appendix 1 indicating meters that have surpassed 33 years in service exhibit failure rates higher than 5%, and this rate escalates as meters age further. *Table 2* shows the defective rates for the past four years and illustrates how a 1% increase in meters older than 30 years contributes to the overall projected defect rate.

Table 2. Total Defective Rate of Residential Meters by Year and Projected Defective Rate

Asset		2020	2021	2022	2023	Average
Residential meters	Rate	0.36%	0.37%	0.40%	0.42%	0.39%
	Increase to account for meters older than 30 years					1%
	Overall percentage of meters older than 30 years					21%
	Total					0.6%

JGN has identified three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed meters until the Aged Program.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**Extreme** Based upon customers with no measurement for period of time	Rejected on the basis that does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**No allowance for meters older than 30 years** Apply the four year average.	**Low** Base case	**Moderate** Meters with defects may increase as budgetary restrictions are implemented.	**Low** Base case	Does not reflect defect data.
3	**Allowance for meters older than 30 years** Apply the four year average with % for meters older than 30 years.	**Moderate** Marginal increase in additional resources and processing	**Low** Focussed program	**Low** Same as base case	This is the **RECOMMENDED** option adopted by JGN. This reflects the data available.

3.5 REPLACEMENT OF DEFECTIVE RESIDENTIAL REGULATORS

The gas regulator has the purpose to supply filtered gas to customers at a designated pressure that is lower than the regulator inlet pressure (network pressure). It also controls gas pressure at a prescribed range to ensure safety of the downstream customer's residential installation and provides correct billing as customers' gas bills are based on a 'fixed factor billing' method that assumes certain values of pressure of gas delivered to the customer. Once a gas regulator has become defective then a customer will have reduced gas reliability and inaccurate billing.

JGN has identified three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed regulator until the Aged Program.	**N/A** Not-compliant	**High** Not replacing the defective regulators will result in regulatory breach.	**High** May cause gas leaks or loss of supply to customers.	Rejected on the basis that it does not meet the objectives, such that: • Result in regulatory breach. • May cause gas leaks or loss of supply affecting customers. • Produce inaccurate billing and increase in UAG which will consequently create loss of revenue to JGN.
2	**Replace the defective regulators with new regulators equipped with OPSO (Overpressure shut off)**	**Moderate** The regulator with OPSO is slightly more expensive than the low pressure residential regulator.	**Low** Focussed program	**Low** Base case	Rejected for the following reasons: • A process change is necessary to incorporate OPSO into domestic installation and services. • The product is not ready for rollout as it has not yet been tested and approved by our NATA-certified Meter Center.
3	**Replace the defective regulators like for like when found faulty.**	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN based on: • Replacement ensures JGN revenue. • Reduces risk of inaccurate billing. • Reduces risk of gas leaks and restricted gas supply issues. • Improve public perception.

The Replacement of Defective Residential Regulators is based on historical averages from the past four years data. Additionally, these defective regulators undergo field failure testing to identify the root cause of failures.

4 INDUSTRIAL & COMMERCIAL METERS

I&C gas meters are used in industrial & commercial and large residential sites. This category includes diaphragm meters with a badge capacity of greater than 8 m^3/hr, rotary meters and turbine meters.

There are nine meter replacement programs related to this category:

- End of Life Replacement of I&C Aged Diaphragm Meters
- Planned statistical sampling of I&C Diaphragm Meters in-service life extension
- End of Life Replacement of I&C Aged Rotary Meters
- End of Life Replacement of I&C Aged Turbine Meters
- Upgrade/downgrade of I&C Meter Sets
- Replacement of Defective I&C Diaphragm Meters
- Replacement of Defective I&C Rotary Meters
- Replacement of Defective I&C Turbine Meters
- Replacement of Defective I&C Regulators

4.1 END OF LIFE REPLACEMENT OF I&C AGED DIAPHRAGM METERS

I&C diaphragm gas meter sets provides filtration, pressure regulation, overpressure protection and metering to end-point I&C and large residential users connected to the network. There are about 61,000 I&C diaphragm gas meters installed in the network to provide gas supply to our customers. This program is consistent with the asset class strategy to ensure the reliability of JGN's gas meter families for accurate billing of I&C and large residential customers and to reduce estimated meter readings.

JGN has three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Meters are only replaced on failure.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**Replace all meters at 15 years of age.** Although compliance with Regulatory requirements, this option is not in the best interests of customers.	**High** Would require all meters to changed that are currently >15 years old	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	JGN has proven that small I&C diaphragm meters(≤25m^3/h) lives can be extended, thus reducing the level of expenditure and thus this option is not in the interest of customers.
3	**Replacement based upon statistical testing.** In this option small I&C diaphragm meters(≤25m^3/h), are statistically sampled in accordance with the	**Moderate** See parameters below	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	This is the **RECOMMENDED** option adopted by JGN: Small I&C diaphragm meters are replaced only if they fail statistical sampling tests or reach 35 years for meters with capacities ≤10m^3/h, and 25 years for those >10m^3/h but ≤25m^3/h. Meanwhile, larger I&C diaphragm meters (>25m^3/h)

	requirements of AS/NZS4944:2016.				are replaced at 15 years of age.

The End of Life Replacement of I&C Aged Diaphragm Meters program is based upon the following features:

A) I&C Diaphragm meters ≤ 10m^3/hr
   1. Upon reaching 35 years of age; unless
   2. Testing has revealed that a specific family, class, or lot of meters, after undergoing in-service life extension testing through statistical sampling, has reached the end of its accurate service life; or
   3. Replaced as part the statistical sample used for life extension testing; or
   4. If the family or lot of meters is less than 16 in population; or
   5. If the examination of defective meters demonstrates that a particular family, class, or lot of meters has reached the end of its serviceable life, as evidenced by field failure testing.

B) 10m^3/hr < I&C diaphragm meters ≤ 25m^3/hr
   1. Upon reaching 25 years of age; unless
   2. Testing has revealed that a specific family, class, or lot of meters, after undergoing in-service life extension testing through statistical sampling, has reached the end of its accurate service life; or
   3. Replaced as part the statistical sample used for life extension testing; or
   4. If the family or lot of meters is less than 16 in population; or
   5. If the examination of defective meters demonstrates that a particular family, class, or lot of meters has reached end of its serviceable life, as evidenced by field failure testing.

C) Large I&C diaphragm meters > 25m^3/hr
   1. Upon reaching 15 years of age

Phase out of large I&C Diaphragm Meters

As part of our long-term infrastructure planning, the larger I&C diaphragm meters >25m^3/hr will be systematically phased out when they are reaching 15 years. The key driver for this program is to remove the risk of manual handling for employees and contractors. By introducing more ergonomically designed meters, there is no impact to data accuracy and reliability.

4.2 PLANNED STATISTICAL SAMPLING OF I&C DIAPHRAGM METERS IN-SERVICE LIFE EXTENSION

The statistical sampling program is completed for I&C diaphragm meters ≤25m^3/hr to meet the requirements of the Office of NSW Fair Trading that enables 'regulatory-life extension' past 15 years. The meters are statistically sampled and tested in accordance with *AS/NZS 4944:2006 Gas Meters – In-service compliance testing and AS1199:2003 Sampling procedures for inspection by attributes*; to identify the accuracy and leak tightness of meters installed in the network.

Testing is undertaken in accordance to the following:

1. The test criteria is for 'inspection by attributes'[4];

[4] Refer to appendix for explanation of difference between methods of inspection by attributes versus variables for statistical sampling.

2. Sample sizes are set as per Table 3 in accordance with the requirements for inspection by attributes. No testing or regulatory life extension are undertaken for families with less than 16 meters[5];
3. Samples of each meter population is removed from service two years prior to the initial 15 year life of the meter and again two years prior to any subsequent regulatory-life extensions;
4. If the meters pass[6] the statistical sampling test(s), and:
    a. fall into a band ±2% of accuracy of registration error of sample, then the diaphragm meters will be given a regulatory-life extension of five years; or
    b. fall into a band ±2.5% of accuracy of registration error of sample, then the diaphragm meters will be given a regulatory-life extension of three years. At the end of 3 years extension, this family will be replaced with no further statistical sampling test.
    c. although there is an option of a one year extension, this is not utilised due to the need to test meters two years prior to extension commencement[7].

Table 3. I&C Diaphragm Meter Population Numbers which are Statistically Sampled

Population Group	Sample Size	Qty to Collect	Comment
0-15	Not Sampled and replaced		
16-25	3	5	Sampled
26-50	13	16	Sampled
51-90	13	16	Sampled
91-150	20	25	Sampled
151-280	32	40	Sampled
281-500	50	60	Sampled
501-1200	80	90	Sampled
1201-3200	125	140	Sampled
3201-10000	200	230	Sampled

[5] Table 2 also shows that meters of population groups <400 are not statistically sampled as it is economically non-viable to remove samples from such small population groups from service. The cost for the planning and labour to remove, test and replace these meters would be greater than replacing the meter population.

[6] The life extension period is determined by the metrological performance and other performance characteristics of the meter as specified within AS/NZS 4944:2006 Table 5.

[7] The one year option to extend the life of a meter family has a significant impact on resourcing. This has a detrimental flow on effect to the subsequent planned residential gas meter replacement program the following year.

The actual number of meters drawn from the in-service family is higher than the actual sample size required by AS/NZS 4944:2006 to allow for the additional meters if some meters are damaged in the process of collection and delivery to the testing establishment.

Extension of I&C meters
U10, Email 1010, 400A, AL425, 1000A and AL1000 meters may also be statistically sampled prior to the 25 year mark to validate and record the accuracy, performance and integrity of the meter. This can enable a life-extension beyond the standard 15 years Unless we have direct evidence to the contrary, we assume that meters would successfully pass two life extension tests but fail in the third. These I&C meters thus will have a maximum of 25 years in service.

4.3 END OF LIFE REPLACEMENT OF I&C AGED ROTARY METERS

Rotary meter sets deliver the measurement and regulation of high pressure gas to I&C customers using a significant amount of natural gas. There are about 2,700 I&C rotary meters installed in the network to provide gas supply to our customers. This program is consistent with the asset class strategy to ensure the reliability of JGN's gas meter families for accurate billing of I&C customers and to reduce estimate meter readings.

JGN has three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Meters are only replaced on failure.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers
2	**Replace all meters at 10 years of age.** Although compliance with Regulatory requirements, this option is not in the best interests of customers.	**High** Would require all meters to changed that are currently >15 years old.	**Low** Meters would be replaced prior to inaccuracy.	**Low** Meters would be replaced prior to inaccuracy.	JGN has proven that some I&C rotary meters lives can be extended to 15 years by a throughput analysis, thus reducing the level of expenditure and thus this option is not in the interest of customers
3	**Replacement based upon throughput analysis outcome.** Under this option, some I&C rotary meters may remain in service for up to 15 years, following a throughput analysis.	**Moderate** See parameters below	**Low** Meters would be replaced prior to inaccuracy.	**Low** Meters would be replaced prior to inaccuracy.	This is the **RECOMMENDED** option adopted by JGN: through lab-proofing throughput analysis, the in-service life of some I&C rotary meters can be extended from 10 years to 15 years, while still maintaining their accuracy and performance integrity.

The I&C rotary meters do not undergo statistical sampling and are replaced at a set age of 10 years or 15 years of in-service life. A throughput analysis is conducted on the I&C rotary meters based on the last 5 years actual flow history and compared with the manufacturer's specified capacity.

If the usage of the rotary meter fall significantly below the manufacturer's specified capacity, the rotary meter's in service lifespan can be extended from 10 years to 15 years.

Once removed from service, meters are tested for 'as found performance' to monitor their accuracy. These rotary meters are subsequently send to a certified repair facility for refurbishment and re-calibration, aiming to restore their accuracy levels before being installed for a different customer.

4.4 END OF LIFE REPLACEMENT OF I&C AGED TURBINE METERS

Turbine meters are typically used for large users such as demand market contract customers. They are also used at custody transfer points to measure for billing purposes. There are 82 I&C turbine meters installed in the network to provide gas supply to our customers. This program is consistent with the asset class strategy to ensure the reliability of JGN's gas meter families for accurate billing of I&C customers and to reduce estimate meter readings.

JGN has three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Meters are only replaced on failure.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**Replace all meters at 5 years of age.** Although compliance with Regulatory requirements, this option is not in the best interests of customers.	**High** Would require all meters to changed that are currently >15 years old	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	JGN has proven that some I&C turbine meters lives can be extended to 7 years by a throughput analysis, thus reducing the level of expenditure and thus this option is not in the interest of customers
3	**Replacement based upon throughput analysis outcome.** Under this option, some I&C turbine meters may remain in service for up to 7 years, following a throughput analysis.	**Moderate** See parameters below	**Low** Meters would be replaced prior to inaccuracy	**Low** Meters would be replaced prior to inaccuracy	This is the **RECOMMENDED** option adopted by JGN: through lab-proofing throughput analysis, the in-service life of some I&C turbine meters can be extended from 5 years to 7 years, while still maintaining their accuracy and performance integrity.

The I&C turbine meters do not undergo statistical sampling and are replaced with either a refurbished or new meter at a set age of 5 years or 7 years in-service life. A throughput analysis is conducted on the I&C turbine meters based on the last 4 years actual flow history and compared with the manufacturer's specified capacity.

If the usage of the turbine meter fall significantly below the manufacturer's specified capacity, the turbine meter's in service lifespan can be extended from 5 years to 7 years.

Once removed from service, meters are tested for 'as found performance' to monitor their accuracy. These turbine meters are subsequently send to a certified repair facility for refurbishment and re-calibration, aiming to restore their accuracy levels before being installed for a different customer.

4.5 UPGRADE/DOWNGRADE OF I&C METER SETS

The upgrade/downgrade of I&C Meter sets program is to align meter sizing with the current and anticipated energy consumption patterns of I&C customers. This ensures that meter set efficiently meets the demands of changing consumption levels, thereby optimizing operational efficiency and accuracy in billing.

JGN has two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Remain the meter set as it is.**	**N/A** Customer complaints, damage the company reputation	**High** Using an incorrectly sized meter poses a risk of measurement inaccuracies, especially when recording gas flow at low rates. This can lead to unaccounted-for gas (UAG) and result in revenue loss	**High** Customers with higher gas capacity needs may encounter low pressure issues during periods of increased usage	Rejected on the basis that it fails to meet objectives, leading to increased unaccounted for gas (UAG), revenue losses, customer complaints, and potential harm to the company's reputation.
2	**Upgrade/downgrade the I&C meter set according to the customer's required load.**	**Moderate** See parameters below	**Low** Meter set would be upgraded/downgraded according to the new customer required load	**Low** Customer will get the gas supply according to the new requirement	This is the **RECOMMENDED** option adopted by JGN: meet the customer's requirement, minimise the impact to the UAG and maintain the company's reputation.

The forecast for the upgrade/downgrade I&C Meter sets program is dependent on the past four years actual of this program.

4.6 REPLACEMENT OF DEFECTIVE I&C DIAPHRAGM METERS

Defective I&C diaphragm meters are replaced mainly due to faults in registering, leakage and damage to the casing. Failure to replace a defective meter will result in a Regulatory non-compliance and has the potential to restrict customer supply. In addition, failure of the meter index system results in inaccurate or zero measurement impacting upon unaccounted for gas (UAG) leakage and providing customers with incorrect bills.

JGN has identified two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed meters until the Aged Program.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**Extreme** Based upon customers with no measurement for period of time	Rejected on the basis that does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**Replace the defective meters**.	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN to fulfill regulatory obligations and ensure the provision of a safe and reliable service that meets customer expectations.

Defective meter replacement programs are forecasted based on a four year historical average spend on replacement of defective I&C diaphragm meters. Additionally, these defective I&C diaphragm meters undergo field failure testing to identify the root cause of failures.

4.7 REPLACEMENT OF DEFECTIVE ROTARY METERS

Defective I&C rotary meters are replaced mainly due to faults in registering, leakage and damage to the casing. Failure to replace a defective meter will result in a Regulatory non-compliance and has the potential to restrict customer supply. In addition, failure of the meter index system results in inaccurate or zero measurement impacting upon unaccounted for gas (UAG) leakage and providing customers with incorrect bills.

JGN has identified two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed meters until the Aged Program.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**Extreme** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers. Potentially also impact the UAG.
2	**Replace the defective meters**.	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN to fulfill regulatory obligations and ensure the provision of a safe and reliable service that meets customer expectations.

Defective meter replacement programs are forecasted based on a four year historical average spend on replacement of defective I&C rotary meters. Defective meters are replaced with new/refurbished meters and undergo field failure testing to identify the root cause of failures.

4.8 REPLACEMENT OF DEFECTIVE TURBINE METERS

Defective I&C turbine meters are replaced mainly due to faults in registering, leakage and damage to the casing. Failure to replace a defective meter will result in a Regulatory non-compliance and has the potential to restrict customer supply. In addition, failure of the meter index system results in inaccurate or zero measurement impacting upon unaccounted for gas (UAG) leakage and providing customers with incorrect bills.

These defective turbine meters are replaced based upon the following:

1. Failed meters are replaced on a “like for like” basis in order to ensure quick restoration of metering and billing;
2. Damaged indices may be replaced and re-sealed on site.

JGN has identified two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed meters until the Aged Program.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**Extreme** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers. Potentially the failed turbine meter will impact the UAG as well.
2	**Replace the defective meters**.	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN to fulfill regulatory obligations and ensure the provision of a safe and reliable service that meets customer expectations.

Defective meter replacement programs are forecasted based on a four year historical average spend on replacement of defective I&C turbine meters. Defective meters are replaced with new/refurbished meters and undergo field failure testing to identify the root cause of failures.

4.9 REPLACEMENT OF DEFECTIVE I&C REGULATORS

The I&C gas regulator has the purpose to supply filtered gas to customers at a designated pressure that is lower than the regulator inlet pressure (network pressure). It also provides over-pressure protection at a prescribed range to ensure safety of the downstream customer's installation and provides correct billing for customers' gas bills on a 'fixed factor billing' setup that assumes certain values of pressure of gas delivered to the customer. Once a gas regulator has become defective then a customer will have reduced gas reliability, inaccurate billing, as well as encounter a safety risk.

JGN has identified two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed regulator until the Aged Program.	**N/A** Not-compliant	**Extreme** Not replacing the defective regulators will result in regulatory breach	**Extreme** May cause gas leaks or loss of supply to customers.	Rejected on the basis that it does not meet the objectives, such that: • Result in regulatory breach. • Risk of over-pressurising the downstream equipment and causing damage to customers. • May cause gas leaks or loss of supply affecting customers. • Produce inaccurate billing and increase in UAG which will consequently create loss of revenue to JGN.
2	**Replace the defective regulators when found faulty.**	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN based on: • Compliance to Jemena policies regarding regulator maintenance. • Replacement ensures JGN revenue. • Reduces risk of over-pressurisation and safety of customer's appliances. • Reduces risk severity of inaccurate billing. • Reduces risk of gas leaks and restricted gas supply issues. • Improve public perception.

The Replacement of Defective Regulators is based on historical averages from the past four years data. Additionally, these defective regulators undergo field failure testing to identify the root cause of failures.

5 HOT WATER METERS

There are three hot water meter replacement programs related to this category of meters:

- End of Life Replacement of Aged Hot Water Meters
- End of Life Replacement of Difficult to Access Hot Water Meters
- Replacement of Defective Hot Water Meters

5.1 END OF LIFE REPLACEMENT OF AGED HOT WATER METERS

Within JGN, hot water meters are installed across the medium-density high-rise market, with approximately 250,000 units in the network. The goal of the planned replacement program for hot water meters is to replace them before they fail to register usage. Once these meters stop registering, estimated readings are needed to bill customers. This proactive replacement strategy minimizes the disruption caused by a large number of meters failing simultaneously, which would otherwise necessitate ad-hoc replacements and potentially delay the replacement of non-registering meters.

JGN has two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Meters are only replaced on failure.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers
2	**Replace all hot water meters at the manufacturer specified lifespan.**	**Moderate** Would require all meters to replace at the manufacturer specified lifespan	**Low** Meters would be replaced prior to stop registering	**Low** Meters would be replaced prior to stop registering	This is the **RECOMMENDED** option adopted by JGN to fulfill regulatory obligations and ensure a reliable service that meets customer expectations.

No life extension of water meters is proposed. Water meters are not regulated and thus the in-service period is based upon field information and initial purchase specifications, including OEM recommendations. The forecast is to be based upon the following:

1. Mechanical hot water meters are replaced at 20 years. This reflects the historical field failure data.
2. Hot water meters with a Cyble head battery are replaced at 10 years. This reflects the battery life of 10 years, as indicated by the OEM.
3. Ultrasonic hot water meters are replaced at 15 years. This reflects the battery life of 15 years, as indicated by the OEM.

5.2 END OF LIFE REPLACEMENT OF “DIFFICULT TO ACCESS” HOT WATER METERS

The End of Life Replacement of “Difficult Access” Hot Water Meters program is an adjunct to the End of Life Replacement of Aged Hot Water Meters program (‘Aged Meters’). In undertaking the Aged

Meters program, JGN has recognized that there are meters to be replaced but are unable to be accessed due to their physical location e.g. located within a locked customer premise or where a meter has been installed in an inaccessible location.

Periodically, JGN initiates programs to target and replace 'difficult access' meters that have remained in the field beyond their in-service lifespan. In order to minimise the numbers of meters in this category, JGN's standard process is to attempt entry up to three times during the planned replacement program to ensure all efforts have been made to replace these meters.

JGN has identified three potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Operate to failure.** Await the customer to request replacement.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**High** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.
2	**Include in Aged Meters Program.** Apply the Aged Meters processes.	**Low** Only minimal additional cost to the Aged Meters Program	**High** Meters would remain non-compliant and the backlog would increase	**High** Based upon customers with no measurement for period of time	This approach would result in a substantial backlog and presented issues that are difficult to access, necessitating a different approach from the standard aged meter replacement process.
3	**Separate 'Difficult Access' Program.** Apply specific processes to the management of meters that are identified as difficult to access.	**Moderate** Increase in additional resources and processing	**Moderate** Higher proportion of meters would be replaced prior to inaccuracy	**Low** Higher proportion of meters would be replaced prior to inaccuracy	This is the **RECOMMENDED** option adopted by JGN. This enables meters to be targeted and reduces the backlog and lower levels of customer service.

5.3 REPLACEMENT OF DEFECTIVE HOT WATER METERS

Failure to replace a defective hot water meter will result in a Regulatory non-compliance and has the potential to restrict customer supply. In addition, failure of the meter registering results in inaccurate or zero measurement impacting upon unaccounted for gas (UAG) and providing customers with incorrect bills.

JGN has identified two potential options with respect to this program:

Option	Description	Cost	Risk	Level of Service Impact	
1	**Do nothing.** Leave failed meters until the Aged Program.	**N/A** Not-compliant	**Extreme** Based upon non-compliance	**Extreme** Based upon customers with no measurement for period of time	Rejected on the basis that it does not meet the objectives, such that it is not compliant with Regulatory requirements nor in the interests of customers.

2	**Replace the defective hot water meters when found faulty.**	**Low** Base case	**Low** Focussed program	**Low** Base case	This is the **RECOMMENDED** option adopted by JGN based on: • Replacement ensures JGN revenue. • Reduces risk of inaccurate billing and potential impact to UAG. • Improve public perception.

The Replacement of Defective Hot Water Meters is based on historical averages from the past four years data. Additionally, these defective hot water meters undergo field failure testing to identify the root cause of failures.

6 REFERENCES

Document Number	Document name
AS/NZS 4944:2006	Gas Meters In-Service Compliance Testing
AS 1199:2003	Sampling procedures for inspection by attributes
AS 3565.4:2007	Meters for cold and heated drinking water and non-drinking water supplies Part 4: In-service compliance testing
GAS-1799-SP-GM-007	Jemena Policy on Field Failure Measurement and Reporting of Metering Assets JGN
GAS-1799-SP-GM-008	Metering Equipment Maintenance and Service Life
GAS-1799-PA-GM-001	JGN Measurement Asset Class Strategy 2023
	National Measurement Act 1960 (sections 18GD and 18GE)
	NSW Gas Supply (Consumer Safety) Regulation 2012
	NSW Department of Fair Trading Guidelines

7 TERMS AND DEFINITIONS

Term	Definition
Inspection by attributes	Inspection wherein the meter is classified simply either as conforming or non-conforming, or the number of non-conformities in the meter is counted with respect to given requirements.
Inspection by variables	A method that consists of measuring a quantitative characteristic for each item of a population or a sample taken from this population. The quantitative characteristic is used to establish statistically the acceptability of the population from the result obtained from the items in a sample.
Population	A quantity of meters that is considered uniform.
Sample	One or more meters taken from a population intended to provide information about the population.
Lot	Each group of items is called a lot. Each lot should consist of items manufactured under essentially the same conditions during one time period.

	This is important if the acceptable quality level concept is adopted and there are a series of lots to be delivered. From each lot a sample is drawn and inspected. Under attributes inspection, each lot is classified as acceptable or unacceptable on the basis of the number of nonconforming items or nonconformities found in each sample. Each successive lot is therefore dealt with as more or less independent unit.

8 APPENDICES:

8.1 APPENDIX 1: PERFORMANCE REVIEW OF DEFECTIVE RESIDENTIAL METERS

An analysis of residential gas meters has revealed a concerning trend: meters aged 33 years and older exhibit a defect rate exceeding 5%, with the rate increasing for meters beyond this age (refer to *Figure 1*).

The primary failure modes identified include physical damage/corroded body, moisture in the meter index, and meter leaking. According to data presented in *Table 4*, approximately half of these failures result from physical damage/corroded body or leaks, raising significant safety concerns for consumers.

This evidence supports our strategy to extend meter lifespans only until their performance degrades to an unsatisfactory level, assuming such extensions are justifiable. Graphical data demonstrating the overall defect rate by meter age validates our policy to replace all residential meters at the 35-year mark, foregoing additional life extension tests.

With meters passing accuracy tests expected to reach 25 to 35 years of age between 2025 and 2030, there is an anticipation of unreliability in gas usage measurement among these meters. Our current data on meters within this age range is sparse, marking our initial encounter with meters of such age. Despite potential accurate performance while in service, the high likelihood of failure within this age group necessitates their replacement.

Table 4. Failure modes percentage to the total failures(data the period July 22 - Jun 23)

Failure modes	Percentage
Physical damage/corroded body	40%
Water damage	1%
Ants nest	3%
Condensation in index	36%
Meter leaking	4%
Pulsing issue	2%
No fault found	14%
Quality issue	0%
Total	100%

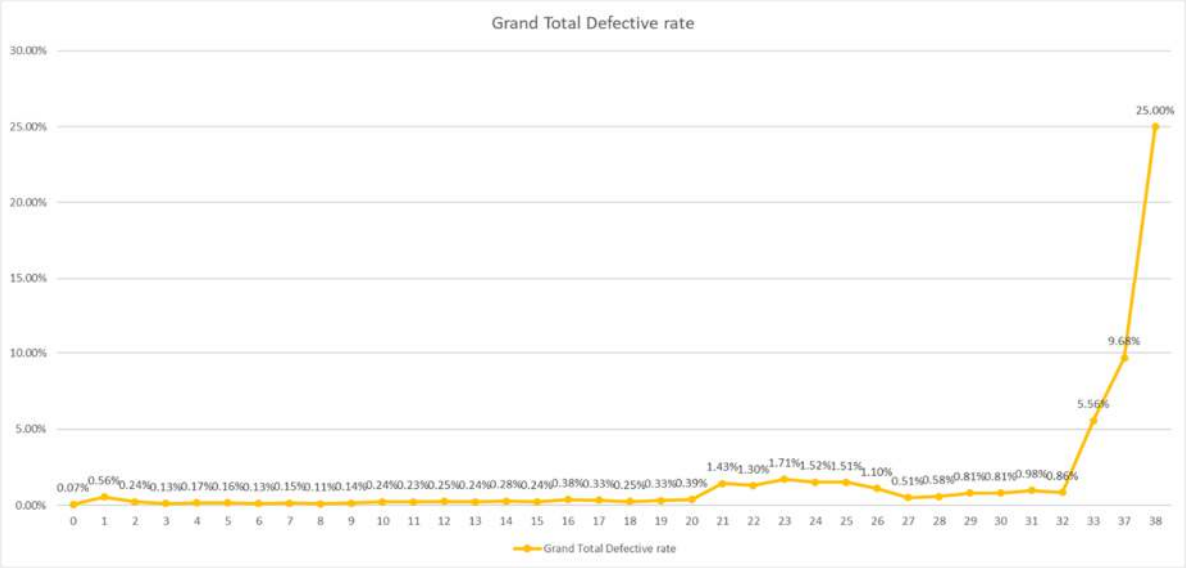

Figure 1: Total defective rate of residential meters by meter age(data as of Jun 2023)