Attachment 8.7

Gas Measurement Management Plan

2016/17 to 2020/21 Access Arrangement Information

Australian Gas Networks

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GAS MEASUREMENT MANAGEMENT PLAN

SOUTH AUSTRALIAN NATURAL GAS DISTRIBUTION NETWORK

AUGUST 2014

Prepared on behalf of Envestra Limited

by

APT O&M Services Pty Ltd

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1. INTRODUCTION

1.1 Company Relationships

Envestra Limited ("**Envestra**") is the holder of a Gas Distribution Licence for the South Australian natural gas distribution network. APT O&M Services Pty Ltd an entity of the APA Group ("**APA**"), has been contracted by Envestra to operate and manage these network assets.

This Gas Measurement Management Plan ("**Plan**") has been prepared by APA with respect to the distribution network in South Australia which APA operates and manages on behalf of Envestra.

1.2 Purpose of This Plan

The purpose of this Plan is to detail the procedures which are used to ensure that the measurement of natural gas meets the accuracy requirements of government regulations in an effective and efficient manner and provide a basis for continued improvement. The Plan has been prepared in accordance with clause 5 of the Essential Services Commission of South Australia's ("**ESCOSA**") Gas Metering Code (GMC/04 - February 2013) ("**Metering Code**").

1.3 Responsibility for Implementation

The South Australian Managers of System Operations and Planning and Engineering are responsible for implementing all aspects of the plan.

Appendix 1 shows the organisation chart for the metering and measurement activities described in this Plan.

1.4 Review of the Plan

This Plan will be reviewed annually and updated to reflect current practice, regulatory changes and technological advancements so as to enable continuous improvement of the accuracy and efficiency of gas measurement and billing.

2 METERING INSTALLATIONS

Envestra provides metering installations in accordance with section 2 of the Metering Code.

2.1 Ownership of Metering Installations

Envestra owns the assets (pipes, meters and ancillary equipment) associated with the natural gas distribution network in South Australia.

2.2 Provision of Metering Installation

Clause 2.4.2 of the Metering Code provides for the gas meter to be installed in a

"position which allows safe and unimpeded access to any person whose obligation it is to test, adjust, maintain, repair, or replace the metering installation, or collect metering data from the metering installation."

Accordingly:

- Metering installations are provided at an appropriate location;
- Metering installations contain an index register or some other means of accessing metering data that is acceptable to all persons entitled to access that metering data;
- Interval metering installations are provided where the annual gas consumption is expected to be greater than 10 TJ per annum; and
- Telemetry is installed at interval metered sites.

2.3 Metering Installation Registration Number

Each metering installation is issued a unique Metering Installation Registration Number (MIRN).

2.4 Installation Database

A database is maintained in respect to each metering installation recording (amongst other things):

- MIRN
- Location
- Equipment type (make, model, year)
- Customer address & install date
- Details of seals and labels
- Maintenance records
- Next scheduled date for testing
- Performance related data
- Calibration records
- Testing records

Information in the database is accessible for a minimum period of 16 months from the date of inclusion of the data and archived for a minimum period of seven years. In accordance with Clause 2.5.4 of the Metering Code, affected parties are provided, upon request in writing, access to information in the installation database relevant to that person within 2 business days where the information is held in the database or otherwise within 30 business days, from the date of receipt of the request.

2.5 Minimum Standards of Accuracy

The net volume of gas delivered to each delivery point is measured to an accuracy of plus or minus 2%.

Metering installations will not show systematic bias within the allowable margin of accuracy and will not be tampered with or calibrated with the intent of causing bias to the meter.

In addition, metering installations include pressure regulators where required to ensure flow and delivery pressure requirements are met. Pressure regulators for domestic customers shall have set delivery pressures of 1.4 kPa or 2.75 kPa.

2.6 Security

Seals are provided at a metering installation to enable detection of any attempted unauthorised interference.

Where a seal has been known to be broken, repairs are carried out promptly. Meter readers are instructed to report faulty or suspect installations for follow-up.

Costs for replacement of broken seals are generally borne by the distributor unless it is established that they have been broken by the customer.

Where a seal has been broken the meter is replaced. The installation is then acceptance tested to ensure that minimum standards of accuracy are maintained.

3 CLASSIFICATION OF METERS AND CONSUMERS

3.1 Domestic Meters

Domestic meters are considered by the distributor to be those meters with a badge capacity of 8.0 cubic metres per hour or less. This capacity of meter is generally sufficient for domestic gas usage.

3.2 Domestic Consumers

Domestic consumers are those consumers that are subject to a Domestic Haulage Service under Envestra's South Australian Access Arrangement. Domestic consumers account for approximately 20% of all natural gas delivered in the network. It should be noted that not all domestic consumers have domestic meters installed on their premises. There are a number that have industrial and commercial meters (i.e. meters with a capacity greater than 8.0 cubic metres per hour) installed.

3.3 Industrial and Commercial Meters

Industrial and Commercial (**I&C**) meters are generally classified as those meters with capacity of greater than 8 cubic metres per hour, and range from diaphragm meters which handle smaller capacities to rotary and turbine meters for larger installations.

3.4 Industrial and Commercial Consumers

Industrial and Commercial (**I&C**) consumers are those that receive either a Demand Haulage Service or Commercial Haulage Service under Envestra's South Australian Access Arrangement and account for approximately 80% of all natural gas delivered in the network. In some instances, due to low levels of consumption there are I&C consumers that have domestic meters (i.e. badge capacity less than or equal to 8.0 cubic metres per hour) installed on their premises.

3.5 Age Profile of Meters in SA

The Envestra network has 424,392 meter installations which are summarised in Table 1 according to age as at July 2014.

TABLE 1

Age	10 Year Life	15 Year Life	18 Year Life
0	7382	6663	7823
1	8571	11734	9624
2	13447	9091	9570
3	9846	10394	9693
4	15088	13409	11046
5	23343	9226	10471
6	24708	13027	13274
7	28447	8774	9803
8	17883	5210	9038
9	24158	5910	1576
10	11214	8288	1124
11	175	5336	0
12	109	13701	0
13	126	12080	0
14	93	10548	0
15	69	3041	0
16	18	81	0
17	17	41	0
18	27	5	0
19	27	12	0
20	2	10	0
22	2	3	0
23	2	3	0
24	1	2	0
26	0	1	0
27	0	2	0
28	0	2	0
30	0	1	0
Total	**184755**	**146595**	**93042**

For the “10 Year Life” meter, the age at 10 years means that the meter will turn 10 years of age during the 2014/2015 financial year. Similarly the “15 Year Life” meter, the age at 15 means that the meter will turn 15 years of age during the 2014/2015 financial year.

APA continues to prioritise changeovers of overdue gas meters. Despite continued attempts, including multiple site visits and written correspondence to property owners, there are a number of property owners that do not provide access to meters. In 2009 a new approach was initiated in relation to these sites by issuing letters requesting access to properties. Dedicated resources were assigned to regularly monitor and revisit these properties to gain access and complete the meter change. This initiative has steadily reduced the number of outstanding overdue meters.

Further changes to the changeover process commenced in 2011, with contractors instructed to send pre-notification letters to each domestic property owner. The letter explained the work to be performed, the reason this work was required to be done and provided a contact phone number for the property owner to arrange an appointment for gas meters with restricted or no access.

This process has reduced the number of "no access meters" and has contributed to the downward annual trend of overdue meters

Tables 2 and 3 summarise the progress of overdue meter changes since year 2011, showing a reduction of 89% and 88% in 10-year and 15-year life meters respectively over the last 3 years.

TABLE 2

10 year life			
Overdue as at July 2011	**Overdue as at July 2012**	**Overdue as at July 2013**	**Overdue as at July 2014**
5862	3696	1594	668

TABLE 3

15 year life			
Overdue as at July 2011	**Overdue as at July 2012**	**Overdue as at July 2013**	**Overdue as at July 2014**
1339	802	233	163

4 DOMESTIC METER PROCEDURES

4.1 Purchase and Acceptance of New Meters

Envestra utilises the services of APA's Procurement Group for the purchase of new domestic meters. Detailed requirement specifications are provided by APA's operational groups to ensure that meters purchased are suitable for their intended use.

4.2 Meter Tender Process

All domestic meters are purchased using a tender process. Tenderers are given a detailed specification with which they must demonstrate compliance for their tender to be considered. The specification incorporates the requirements of AS 4647-2011.

Tenderers are required to provide information on the following:

- Details of meter design
- Quality assurance program
- Manufacturer's meter test results
- Accelerated aging results
- Manuals and drawings
- Guarantee (a minimum 5 year warranty must be provided)

An APA committee representing South Australia, Victoria and Queensland personnel examines the tenders and the successful tenderer is awarded a supply contract.

During the course of the supply contract the supplier must notify APA at any time if the meter design has changed in any way and/or the materials of construction have changed. Manufacturers must also provide evidence and/or demonstrate that the change will have no detrimental effect on meter accuracy and/or life.

On rare occasions a meter type not previously purchased will be bought. Generally this is for evaluation reasons and in such a case the supplier must provide documentation demonstrating the meter's accuracy and reliability and contact details of other users of that meter type. Once purchased this meter will be closely monitored for accuracy and reliability before any further purchases are made.

4.3 Meter Ordering and Receipt

APA's Supervisor of Metering undertakes all meter ordering and receiving activities. On receipt of the meters the Supervisor checks:

- That the make and model number is correct;
- That the number of meters received is correct;
- For any visual signs of damage; and
- All paperwork has been received including a copy of the meter test results.

When the Supervisor is satisfied that everything is correct they acknowledge the receipt so that payment may be made. The meters are then entered into the installation database.

4.4 Meter Testing and Records

New domestic meters received are tested in accordance with section 4.9 of this Plan. Records are kept of all meter test results in accordance with the requirements of the Metering Code. Records of meters installed in the field are also kept, and includes the meter make, serial number and the date and place of installation.

4.5 Other

For meters produced in Melbourne (e.g. Landis & Gyr and EDMI meters) APA contracts an independent representative to carry out six-monthly audits of the supplier's manufacturing and testing processes.

Where there are any concerns about any aspects of a meter's construction or manufacturing process, the meter may be sent to an independent authority for testing.

4.6 Changeover Practice

The Office of the Technical Regulator ("**OTR**") stipulates a service life of all domestic meters of 10 years except where field life extension has been approved (see section 4.7 below).

4.7 Field Life Extension

As approved by the OTR "initial in service" compliance testing in accordance with AS/NZS 4944-2006 may be carried out on 3 to 5-year old meter families. Depending on the results of these tests, the life of the meters may be extended to 18 years.

The term "family" refers to the same type of meter manufactured in the same period (or batch) and installed during the same period i.e. financial year.

If there are no material changes to production between meter "families" (i.e. different years of installation), the OTR may grant a similar life extension for other meter families produced by that process subject to the above conditions being satisfied.

"Ongoing in service" testing as per AS/NZS 4944-2006 may also be carried out on meter families approaching their approved field life.

The number and types of meters eligible for life extension testing are identified from a report produced by the installation database known as the Meter Ageing Report. Once the meters in a family have been identified, information relating to a random sample of these meters is provided to the OTR for assessment. The information provided to the OTR includes meter serial numbers, test dates and location addresses to allow the random selection of a quantity of meters for field removal and testing. Generally, an additional quantity greater than the required sample size, is identified to allow for those sites where access cannot be obtained.

The meters are then carefully removed from the field taking due care to return the meters to APA's Meter Shop in the condition in which they were removed from site. Field life extension testing is conducted by a NATA certified testing laboratory. Prior to the meters being sent away for testing a sub-sample of meters (10%) are tested at APA Meter Shop at 100% and 20% flow rates with the results recorded. The entire sample is then carefully packaged and freighted to the NATA approved laboratory for testing.

To ensure there are no accuracy impacts during transport or from the test results obtained prior to shipping, the "sub-sample" of meters once returned to the meter shop shall be re-tested, and where required, this testing is witnessed by a representative from the OTR.

Envestra will, subject to test results, then seek formal OTR approval for field life extension. Currently meters with approved field life extension are:

Meter	Life Approved (years)
Email 602	15
Parkinson Cowan U6	15
Atlas U8	15
ABB DS5	15
Ampy 1010	18
Ampy 750	18

4.8 Acceptance Tests

Acceptance tests on meters are carried out:

- before a new meter is placed in service,
- before a used meter that has been removed from service is placed back in service, and
- after maintenance and/or recalibration performed on that meter have been completed.

4.9 Testing of New Meters

The testing process for new meters is as follows:

- New meters are tested by the manufacturer in accordance with AS 4647-2011 to an accuracy of at least ± 1.5% prior to delivery.
- Meters from manufacturers with accredited testing facilities, or whose testing equipment is checked for calibration and accuracy by a NATA accredited facility are sealed prior to delivery and accepted without further testing unless visual inspection indicates they may have been damaged in transit, in which case a sample will be tested. Meters from Landis & Gyr, Itron and EDMI are treated in this manner.
- All Meters received from other manufactures are sample tested on delivery.

The sample test process is to test a random sample of 10% of the meters in the batch at both 20% and 100% flow rate. At least 80% of the sample tested must be accurate to ± 1.5%, all must be accurate to ± 2.0% and the sample must not show any systematic bias for the batch to be acceptable. If random sample tests are not acceptable the entire batch will be tested. If the batch of meters fails the sample test the batch is returned to the manufacturer. Where sample tests are acceptable the meters will be sealed ready for installation.

4.10 Refurbish and Testing of Used Meters

Used meters are those meters returned from the field usually as a result of periodic changeover. Occasionally however they may be returned for other reasons e.g. damaged index or termination of supply etc.

Depending on the meter type, used meters are either:

- condemned and scrapped;
- intested; or
- refurbished and tested.

4.11 Condemned Meters

Meters that cannot be intested or repaired or which are not cost effective to repair are condemned and scrapped.

The Parkinson Cowen U6 model meter will be condemned and scrapped upon arrival from the field. After a recent inspection of these meters upon arrival from the field, it was decided that the external condition of them required additional attention to refurbish to an acceptable level and therefore will be scrapped.

4.12 Intested Meters

Only the Email 602 model meter has prior approval to participate in the intesting program.

This means that these meters once removed from the field after their 15 years in service are eligible for intesting, and if this test is passed, they are to be reinstalled for another 10 years in service. Meters previously intested cannot be intested twice consecutively.

To improve the accuracy testing of domestic meters, an automated test bell has been purchased that tests meters at both 100% and 20% flow rates. It was suggested that APA endeavour to accuracy test all intested and refurbished meters at both 100% and 20% providing more accurate results in terms of a tighter band of percentage error.

The process is as follows:

- Testing the meter at 100% of badge capacity and if necessary adjusting to achieve an accuracy of ±1.5% at this flow
- Rewinding the index
- Pressure test
- Testing the meter at 20% of badge capacity and if necessary adjusting to achieve an accuracy of ±1.5% at this flow
- Painting (if required)
- Barcoding (if required)
- Sealing ready to be returned to the field

4.13 Refurbished Meters

Meters that have previously been intested (Email 602) or any other meter that has been removed from the field after they have reached their 10 years of service are refurbished. The refurbish process involves:

- Disassembling the meter
- Cleaning and replacing any worn or broken parts
- “Four point testing” to ensure that there are no internal leaks
- Rewinding the index
- Reassembly and pressure testing to ensure there are no casing leaks
- Testing at 100% of badge capacity to an accuracy of ± 1.5%
- Testing at 20% of badge capacity to an accuracy of ± 1.5%
- Painting (if required)
- Barcoding (if required)
- Sealing ready to be returned to the field

4.14 Installation

When a meter is installed in the field a record is kept showing the meter type, serial number and address of the premises and the date of installation. This facilitates the age of the meter to be tracked and ensures periodic change-over occurs as required.

4.15 Routine Maintenance of Domestic Meters

No regular maintenance is carried out on domestic meters unless a problem is identified or reported.

5 INDUSTRIAL AND COMMERCIAL METER PROCEDURES

5.1 Change-over and Replacement Practice

I&C meters are scheduled for replacement every 10 years or in the cases of field life extension, additional field life may be given as per section 4.7 of this Plan.

Where domestic meters are installed at I&C sites then the changeover practice is as per section 4.6 of this Plan.

5.2 Acceptance Tests

Acceptance tests on industrial and commercial meters used are carried out:

- before a new meter is placed in service;
- before a used meter that has been removed from service is placed back in service, and;
- after maintenance and/or recalibration performed on that meter has been completed.

All meters are required to achieve an accuracy of at least $\pm$ 1.5% during testing.

5.3 Purchase and Acceptance of New Meters

The process for purchasing and accepting new I&C meters is similar to that described in Section 4.2 above for the purchasing of domestic meters. The main difference is that because of the smaller numbers involved the tender process is not used. Generally the meters purchased are those that APA's Procurement Group has had previous experience with and have a proven record in the field (e.g. AL series meters, or Roots, Instromet and Elster meters if a rotary meter is required, or GT and Elster series if a turbine meter is required).

On rare occasions a meter type not previously purchased will be bought. Generally this is for evaluation reasons and in such a case the supplier must provide documentation demonstrating the meter's accuracy and reliability and contact details of other users of that meter type. Once purchased this meter will be closely monitored for accuracy and reliability before any further purchases are made.

All new I&C meters are accuracy tested on delivery in accordance with section 5.5 of this Plan.

I&C meters purchased from Landis & Gyr are pressure tested by Landis & Gyr prior to delivery. All other I&C meters are pressure tested by APA on delivery.

5.4 Meter Ordering and Receipt

As with domestic meters, I&C meters are ordered by APA's Supervisor of Metering. On receipt of the meters the Supervisor checks:

- The make and model number is correct;
- The number of meters received is correct;
- For any visual signs of damage; and
- All paperwork has been received including a copy of the meter test results.

When the Supervisor is satisfied that everything is correct he acknowledges the receipt so that payment may be made. The meter is then entered into the installation database.

5.5 Testing of New Meters

Meters from manufacturers with accredited testing facilities, or whose testing equipment is checked for calibration and accuracy by a NATA accredited facility are sealed prior to delivery and accepted without further testing unless visual inspection indicates they may have been damaged in transit, in which case a sample will be tested. Meters from Landis & Gyr, Itron and EDMI are treated in this manner.

All other meters are tested for accuracy and pressure on delivery.

5.6 Repair and Testing of Used Meters

Meters returned from the field are disassembled, overhauled, cleaned, repaired (if necessary), tested, pressure tested (if required), painted (if required) and then stored ready for re-installation.

Diaphragm meters are tested at 20% and 100% flow to an accuracy of $\pm$ 1.5%.

Other I&C meters (e.g. rotary and turbines) if repaired internally, are tested at three points (usually 10%, 50% and 100% capacity) on their flow curve to an accuracy $\pm$ 1.5%.

Other I&C meters (e.g. rotary and turbines), if repaired externally from manufacturers with accredited testing facilities or whose testing equipment is checked for calibration and accuracy by a NATA accredited facility, are sealed prior to delivery and accepted without further testing unless visual inspection indicates they may have been damaged in transit, in which case a sample will be tested. Meters from Landis & Gyr, Itron and EDMI are treated in this manner.

6 INDUSTRIAL AND COMMERCIAL SITES

6.1 Classification of Sites

Industrial and Commercial ("**I&C**") sites account for approximately 80% of the total annual gas distributed. I&C sites are generally classified as either low pressure sites (i.e. have a delivery pressure of less than 2.75 kPa) or elevated pressure sites (i.e. have a delivery pressure of 2.75 kPa or greater). The elevated pressure sites can be further broken down as follows:

- sites with remote telemetry and correcting instruments fitted to the meter (these sites – Tariff D Customers - account for approximately 67% of total annual gas distributed);
- sites with correcting instruments fitted to the meter but no remote telemetry (these sites account for approximately 3% of total annual gas distributed);
- sites with no correcting instruments or telemetry (these are known as fixed factor metering sites and along with the low pressure sites account for approximately 10% of total annual gas distributed).

Domestic installations account for the remaining 20% (approx.) of total annual gas distributed.

6.2 Accuracy Tolerances

The tolerances of the individual components (meters, correcting instruments, pressure and temperature transmitters) used to measure gas supplied to a consumer must be such that the gas measured is within a margin of accuracy of plus or minus 2% of the net volume of gas supplied.

Calorific value of the gas is nominally measured to an accuracy of plus or minus 1% (gas chromatographs at gate stations measuring heating value generally give an accuracy of better than plus or minus 0.3%).

6.3 I&C Metering Installation Records

Records for I&C metering installations are kept in accordance with section 2.5 of the Metering Code.

7 ROUTINE MAINTENANCE OF INDUSTRIAL AND COMMERCIAL METER INSTALLATIONS

7.1 Low Pressure Installations

These sites all have smaller diaphragm meters and no routine maintenance is carried out unless the consumer, retailer or APA field personnel report a problem.

7.2 Elevated Pressure Installations with Remote Telemetry and Correcting Instruments

Remote installations, communicating via various methods, provide corrected (or un-corrected) metering data on a regular basis to a data storage and processing system. Data retrieved from remote sites is validated in accordance with the requirements of the Metering Code. Data that fails validation is estimated or substituted (in accordance with the requirements of the Metering Code. Data that passes validation is provided to market participants in accordance with the requirements of the Retail Market Rules ("**RMR**"). Where adjustments are made to previously supplied data, this data is provided to market participants in a similar manner.

The sites are also visited on a 6-monthly basis to:

- check the pressure and temperature transducers for accuracy;
- compare the uncorrected flow on the meter index with the uncorrected flow from the correcting instrument; &
- check the isolation valve, check meter site for leaks and ensure that all signage is appropriate.

Sites are visited every three months where the meter requires oil top up or where a mechanical drive arm exists.

7.3 Elevated Pressure Installations with Correcting Instruments and No Remote Telemetry

These installations are visited on a 6-monthly basis to:

- check the pressure and temperature transducers for accuracy;
- compare uncorrected flow on the meter index with uncorrected flow from instrument;
- manually check correction factor calculation; &
- check the isolation valve, check meter set for leaks and ensure that all signage is appropriate.

Sites are visited every three months where the meter requires oil top up or where a mechanical drive arm exists.

7.4 Elevated Pressure Installations with No Correcting Instruments and No Remote Telemetry

These installations are visited either annually if they have a pressure relief valve or 3-yearly if they do not. The 3-yearly visit consists of checking the site and meter integrity, checking the set pressure on the regulator, checking the isolation valve, checking meter site for leaks and ensuring that all signage is appropriate. The meter set is also painted if required.

8 CORRECTION FOR PRESSURE, TEMPERATURE AND SUPER COMPRESSIBILITY

8.1 Installations without Correcting Instruments

Where sites have no correcting instruments the appropriate pressure correction factor is applied. Where a regulator is installed the pressure correction is based on the regulator set pressure. In low pressure networks where no regulator is installed it is assumed that the metering pressure is 1kPa and the appropriate pressure correction is automatically applied.

From February 2005 an additional metering pressure of 1.4kPa for customers connected to medium and high pressure was introduced.

In accordance with the Retail Market Procedures, Envestra advises affected parties (i.e. gas retailers) via the AEMO industry hub of the method employed for adjusting the meter reading.

8.2 Elevated Pressure Installations with Correcting Instruments and Telemetry

At these sites the correcting instrument automatically corrects for pressure and temperature variations on a continuous basis. The correcting instrument receives the uncorrected flow from the meter together with pressure and temperature signals from the respective transducers and calculates a corrected flow. The data is transmitted to the data storage and processing system for validation (in accordance with the requirements of the Metering Code) and then reported to the market in accordance with the requirements of the Retail Market Procedures.

8.3 Elevated Pressure Installations with Correcting Instruments but No Remote Telemetry

At these sites the correcting instrument applies pressure and temperature correction to the uncorrected flow from the meter on a continuous basis.

8.4 Elevated Pressure Sites with No Correcting Instruments and No Remote Telemetry

At these sites a fixed correction factor is automatically applied to the uncorrected flow. In most cases this fixed factor is based on the set pressure of the regulator and supercompressibility of the gas. However in some cases dependant on their location, altitude and temperature corrections are also applied to the flow calculation.

8.5 Calculation of Correction Factors

Correction factors are used to convert uncorrected volume flow to a corrected volume flow at standard pressure of 101.325 kPa and standard temperature of 15 degrees Celsius.

The correction calculations used are based on the Ideal Gas Law which is a combination of Boyle's and Charles' laws and as such, takes account of temperature and pressure.

8.6 Pressure Correction

In the case of regulated supply a pressure correction will be applied where the gas is delivered at a pressure of greater than or equal to 1.4 kPa.

The pressure correction factor = $(P+P_{at})\div 101.325$

P = the pressure of the gas at the measurement point measured in kPa and
P_{at} = atmospheric pressure
101.325 = base pressure

8.7 Temperature Correction

Temperature correction may be applied where the average temperature of the gas at the measurement point is less than 10 degrees or greater than 20 degrees.

The temperature correction factor = $288.15 \div (T+273.15)$

T is the average temperature of the gas at the measurement point measured in degrees Celsius and 288.15 is the standard Temperature in Kelvin.

In South Australia all sites with temperature correction have the temperature monitored continuously via a temperature transducer. Thus the temperature correction is calculated continuously during the flow period.

8.8 Correction for Supercompressibility of the Gas

Volume measurement will be corrected for supercompressibility when delivery pressures are 2.75kPa and above. The supercompressibility is calculated in accordance with the American Gas Association's Manual for the Determination of Supercompressibility of Natural Gas (commonly referred to as AGA8 or NX19 method).

9 CALORIMETERY

9.1 Overview of Capability

The heating values used for billing purposes are supplied by transmission pipeline operators. Envestra has however established calorimetry systems to ensure that the heating value of reticulated natural gas can be accurately verified. The heating value of the gas is checked using NATA accredited chromatographic test methods. This ensures repeatability and accuracy of analysis and therefore the heating value determination. In addition common samples are tested on several different instruments across the state and the results compared to ensure proficiency of the facilities and personnel involved.

9.2 Natural Gas from Moomba

Adelaide, Whyalla, Port Pirie, Peterborough, Burra, Angaston, Nuriootpa, Murray Bridge and Berri receive natural gas from Moomba.

The current practice is that the gross heating value of Moomba natural gas is determined daily using a Daniel Process Gas Chromatograph owned by Epic Energy (Pipeline Licensee of the Moomba to Adelaide Pipeline) ("**Epic**") and located at Gepps Cross. The gross heating value is calculated based on component analysis every six minutes. A daily mass weighted average is then determined by averaging all heating values from each analysis at the end of each hour. The gas chromatograph has an accuracy tolerance of $\pm$0.1% and is calibrated bi-monthly as part of the scheduled accuracy verification testing using a certified internationally traceable gas as a standard. The Epic daily heating value is provided, checked against APA's value and if accepted, it is entered into the billing system database. At any point in time the previous three months' figures may be retrieved from the billing system database.

9.3 Natural Gas from South East Australia

Since completion of the SEAGas pipeline in 2003 Adelaide has received natural gas from gas fields in South East Australia (SEA). This gas enters the distribution system just downstream of the Epic Gepps Cross gate station. The heating value of this gas is measured, as per Moomba gas, using a gas chromatograph located in the SEAGas gate station prior to entering the distribution system.

9.4 Heating Value for the Adelaide Distribution System

The layout of the Adelaide distribution system is such that the majority of consumers receive co-mingled gas (i.e. a mixture of Moomba gas and SEA gas) whilst the remainder receive only Moomba Gas. A network analysis of the system has been carried out to determine the suburbs in the Adelaide distribution system that fall into either category. A list of the suburbs receiving only Moomba gas is given in Appendix 3. All suburbs not listed in Appendix 3 receive co-mingled gas.

Daily flows and average daily heating values received from Epic (for Moomba gas) and SEAGas (for SEAGas) are used to calculate a volume weighted daily average heating value for the co-mingled gas. This average heating value is used to determine energy consumption (refer 12.8) for consumers receiving co-mingled gas.

9.5 Monitoring Heating Value

As outlined above, the majority of consumers in the Adelaide distribution system receive co-mingled gas. The procedure for calculating the average daily heating value of this co-mingled gas is outlined in 9.4. To verify the accuracy of the calculated value, the on-line gas chromatograph stationed at APA's operational depot at Kidman Park is used to monitor the heating value and compare it to the daily calculated value.

A database is kept with the comparison of the calculated and measured values. In addition monthly samples are taken from six points within the network, at least two of which are considered to be outside of the addresses receiving the co-mingled gas. The heating values derived from these samples are compared with each other and also those derived at Kidman Park.

A database is also kept of the Epic heating value and the Santos (Moomba) derived heating values, for comparison on a monthly basis.

In the case of the northern regional areas (Port Pirie and Whyalla) gas samples are collected quarterly and analysed using a gas chromatograph at Kidman Park. These compositional and heating value results are stored in a database and compared to the Moomba (daily/monthly) results and also to the monthly results provided by Santos.

On 3 July 2014, Valve 861 in the network, that provides some flow control between the northern and central part of the Adelaide distribution system, was opened. The effect of this change on gas flows within the network, and hence on heating value, is being monitored.

9.6 South East Natural Gas

The Mount Gambier township and surrounding sites receive natural gas via Epic's Southeast natural gas Pipeline System (SEPS). This gas comes from SEAGas via the South East South Australia (SESA) Pipeline.

SEAGas heating values are determined daily using a gas chromatograph. SEAGas provides the daily heating value information to Epic who then calculate the co-mingled heating value and provide it to APA for billing.

Records are kept by APA of the daily heating values used for billing purposes.

10 METER READING AND DATA

The following sections describe how Envestra's processes are in accordance with the Retail Market Rules in respect of meter reading and meter data collection.

10.1 Frequency of Meter Reading and Collection of Meter Reading Data

APA has contracted Service Stream (formerly known as "Automated Meter Reading Services" or "AMRS") to undertake meter readings for all customers.

Meters for all domestic consumers and most I&C consumers (basic metered sites) are read on a monthly or quarterly basis. For these sites the read date depends on the reading cycle. There are 4 x 58 read cycle days = 232 reading days in a calendar year. The annual reading schedule is sent to each retailer at least three months prior to the end of each calendar year.

The larger I&C consumer's meters (interval metered sites) are read by telemetry hourly. Monthly meter reads of these Demand customers (conducted by manually reading the meter or correcting instrument on the last working day of each month) may be used as means of reconciling the telemetered metering data.

10.2 Process for Estimating Reads (Basic metered sites)

If a meter reading is not obtained, APA's system will use two estimation-type methodologies depending on the historical data held. If there is over 12 months of historical data available the system will use "same time last year" estimation. If no historical data is available the system will use trend data to estimate consumption.

10.3 Process for Estimating Reads (Interval metered sites)

The process for estimating (or substituting) interval metering data is undertaken in accordance with Schedule 1 "Validation, Substitution and Estimation – Interval Metering Installation" of the Metering Code which sets out the various methods which may be used.

10.4 Actual Meter Reads

At the end of each calendar year meter read requests are sent to Service Stream to obtain a meter read for sites that have not been read over a 12-month period. Arrangements have been made for Service Stream to call outside normal hours if required to obtain these reads.

10.5 Management and Exchange of Basic Meter Reading Data with Retailers

Five days prior to the scheduled read the file is sent to Service Stream via electronic file transfer. The meter is read on the scheduled read date and at the end of the day the meter reads are returned to APA via electronic file transfer. These readings are then validated and billed and then sent to the retailer. From time to time a 'Special Read' may be requested by the retailer.

10.6 Basic Meter Data Adjustments

When the data required for billing is unknown or uncertain, a reasonable estimation will be made of the gas supplied to the consumer in accordance with the RMR. Factors that may be considered in the estimation process are:

- Methods of estimation set out in the contract with the consumer
- Previous usage history for same period in previous years
- Number and type of appliances connected
- Current usage
- Customer information concerning gas usage

10.7 Provision of Interval Meter Reading Data to AEMO and Retailers

Within 3.5 hours of the end of the gas day, the meter reading data for interval metered sites is sent to AEMO and retailers (via secure File Transfer Process or FTP). Corrections or revisions to metering data may be provided to the Market at any time, within 425 days of the GD value if "better quality" data is obtained, however if known erroneous data has been provided, APA must obtain amended interval metering data and provide the amended interval metering data to AEMO within 51.5 hours of the start of the affected gas day.

10.8 Calculation of Volume to Energy

Energy (MJ) = corrected flow (m^3) x average calorific value (MJ/m^3).

The average calorific value is the weighted average value over the billing period for e.g. for natural gas supplied from Moomba the average calorific value is the average of the weighted average daily values over the billing period.

For domestic consumers the relevant pressure (in kPa) is multiplied by the uncorrected flow (m^3) for each site as part of the energy calculation. Domestic customers are supplied at a pressure of 1kPa, 1.4kPa or 2.75kPa depending on a variety of factors including the pressure of the main supplying the meter.

Amount ($) = Energy (MJ) x Tariff ($/MJ)

10.9 Requests for Meter Tests

In accordance with Section 3.3.1 of the Metering Code a retailer may at any time request a test of a metering installation to ascertain whether or not that metering installation is defective.

The test will be conducted within 15 business days (or some other mutually agreed date) from the date of request by the retailer. The retailer will be provided with results of the test within 5 business days of the test being conducted.

If as a result of the test the meter results are found to be outside the allowable margins for accuracy, Envestra will bear the costs of the test. Furthermore to ensure adjustment of the relevant gas account, the retailer sends the results of the tests to APA's Metering and Site Billing division who will make the adjustment to reflect either the actual gas supplied or a reasonable estimation of the gas supplied.

If the metering installation is found to be within the allowable margins for accuracy then Envestra may seek to recover from the retailer the costs incurred in conducting the tests.

If the retailer disputes the results or test methods the meter will be sent to an independent NATA certified test facility for testing.

11 UNACCOUNTED FOR GAS (UAFG)

11.1 Definition of UAFG

The difference between the quantity of gas entering and departing from a distribution network is difficult to measure accurately.

The definition of UAFG is as follows:

- $Gas_{injected}$ - $Gas_{delivered}$ = Unaccounted for gas (UAFG)

Using terminology consistent with Rule 230 of the RMR, UAFG is defined as:

$$UAFG = \sum PI - \sum UIW - \sum UBW$$

where PI represents gas injections and UIW and UBW represents gas delivered to interval-metered withdrawal points and basic-metered withdrawal points respectively (and together 'gas delivered').

11.2 Determination of UAFG

AEMO calculates UAFG (or 'Actual UAFG') in accordance with Rule 230 of the RMR each day.

In doing so AEMO, pursuant to the RMR, utilises a Net System Load profiling approach to apportion basic-meter reads (which generally have a span of approximately 90 days or 3 months) between gas days. The AEMO calculation also incorporates estimates for the amount of Unbilled Gas (or estimated basic withdrawals) in its determination of UBW. As actual basic meter reads are undertaken estimates are replaced with actual figures so that after approximately 90 days the UAFG calculation for a specific gas day comprises entirely (or almost entirely) of actual data points.

Nevertheless, all data sources whether gas injections, interval-metered consumption for large consumers or basic-metered consumption for small consumers, are subject to revision where errors are detected at some point after their initial determination. To this end AEMO revises its calculation of UAFG for a specific gas day for the subsequent 425 days to ensure that the most recently available data is utilised to yield the most accurate result. AEMO publishes the UAFG results as updated for the preceding 425 days making them available to Envestra as network operator and to Envestra's nominated UAFG providers at the end of each calendar month. These results are utilised within the wholesale market settlement process and under Envestra's contractual arrangements for the purchase of UAFG.

In publishing UAFG statistics, Envestra utilises the most recently available AEMO calculation for the relevant period.

11.3 Breakdown of UAFG Sources

Exercises have been conducted (locally, interstate and overseas) in the past with varying degrees of success to identify the contribution to the total UAFG figure by leakage, theft, and metering errors.

Given the importance of UAFG, Envestra regularly undertakes a range of analyses to ensure it appropriately understands its drivers and takes corrective action where this is deemed appropriate. This includes amongst others, monitoring the AEMO UAFG calculations and cross-checking using a number of alternative basic-meter profiling methodologies. The level of UAFG is regularly monitored and reported through to the highest level of Envestra management.

12 TRAINING

All personnel carrying out work processes described in this Plan are required to have undertaken appropriate training and to have demonstrated competency in those activities.

12.1 General Training

All employees are required to attend formal training sessions which generally affect everyone in APA. Examples of these are

- Workplace Inductions;
- Workplace Safety;
- Risk Identification and Assessment; and
- Manual Handling.

12.2 Specific Training

This is training in specific activities that the employee is required to perform in their current position. In particular, employees carrying out any of the activities listed in the Gas Measurement Management Plan 'Relevant Procedures' must have been trained in those procedures and have demonstrated competence in performing them. A list of relevant procedures for work associated with this Plan is shown in Appendix 4.

This training process has several stages:

1. Written procedures are prepared for each of the activities to be performed. It is the responsibility of the Supervisor/Manager of the Department to ensure the procedures are up to date.
2. The Supervisor/Manager (in consultation with the employee) then assesses the training requirements of each employee and a formal training needs analysis is prepared.
3. Formal training sessions are conducted for all of the procedures. Records of these training sessions are maintained.
4. Employees are audited against the procedures to ensure they are competent in the task
5. Refresher training sessions are carried out as required and training packages each include a review date (e.g. if there is a change to the procedure or audits show that a refresher training session is required).

12.3 Training Records

Training records are maintained by APA's National Training Group.

13 INTERNAL AUDITING

13.1 Field and Workshop Audits

Field and workshop audits are carried out to ensure that personnel are familiar with the procedures and are competent in performing them.

Formal audit systems are in place in the Maintenance, New Work, Engineering Services and Electronics and Instrumentation, Network Maintenance and Metering divisions. The audit scope is derived from relevant work instructions and procedures specific to each functional area and as such examines key relevant requirements related to each area.

13.2 Administrative Audits

Auditing of other activities described in the Gas Measurement Management Plan is carried out as part of APA's administrative and reporting processes usually on a monthly basis.

13.3 Meter Repair Process

All meter test results are now entered onto a database and are checked by the Supervisor of Metering prior to entering them into the database.

The number of meters repaired/intested is checked daily and monthly as part of APA's monthly reporting system.

The stocks (including number and make) of meters are compared monthly against computer records.

13.4 Meter Change-over Process

The number of meters changed is monitored on a monthly basis as part of the monthly reporting system. These figures are compared with the number change dockets received, the number of meters issued and with records in the work management system (Maximo).

The number of used meters returned from the field is checked monthly against the number of new/repaired meters issued.

All I&C meter changes are checked and recorded in the Metering division as well as being entered into Maximo.

13.5 Field Maintenance

All routine field maintenance at meter sites is recorded and checked against monthly targets and objectives.

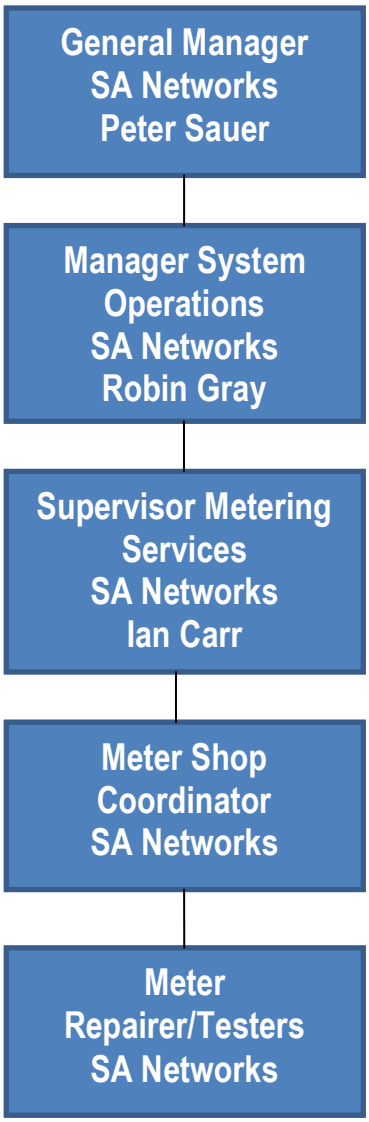
14 ANNUAL OPERATIONAL INFORMATION

The Annual Operational Information, submitted to ESCOSA in accordance with Gas Industry Guideline No. 1 contains the following information:

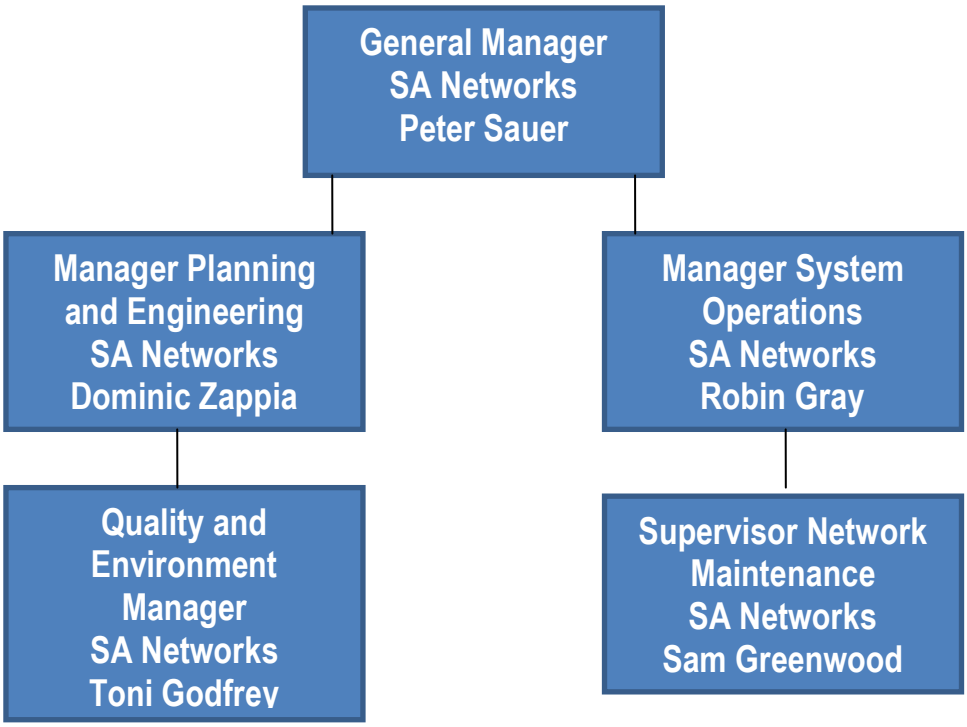
- The number and type of meters changed over during the year;
- The mean error of meters acceptance tested (prior to installation);
- The number of meters tested (on return from the field) that are outside specification;
- Number of requests for meter tests during the year and the number of tests outside specification; and
- Average monthly heating values;
- Results of witness tests on the Gas Chromatograph;
- Data on response time to consumer request for meter tests.

APPENDIX 1: Organisation Charts

SA Networks Metering Division Organisational Chart



SA Networks Measurement Division Organisational Chart



APPENDIX 2: All Consumers by Meter Type and Age

Delivery points with 10 year meters

10 Year																									
Model	Under 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	24	Grand Total
E602 INTEST		239	313	464	3951	7802	15479	13832	4784	13178	6061	36	14	16	28	12	3						2	1	66215
G2000	1180	1421	1670	3148	6736	3832	2246	6185	6062	3684	2057	31	1	13	22	10	2	2	2	10	1	1			38315
E610	907	2055	6028	2414	2153	8470	4734	5475	3607	13	64	26	42	59	3	8	3	6	13	9					35989
ATLAS U6	2289	1744	3027	851	812	980	468	206	656	3096	1089	23	15	5	1										15262
PC U6 INTEST				1	637	1120	798	1701	2234	2998	1063	15	13	14	17	17	8	7	6	2		1			10652
ATLAS U8	1905	990	594	1004																					4493
ATLAS U10	450	1036	606	1050	49	104	28	84	12	444	339	6	3		1										4212
AL425	192	356	379	298	254	275	259	277	198	231	157	8	2	2	6	3		2	2						2901
PC U16	180	268	388	251	116	257	293	314	228	180	209	14	12	14	13	16			3	2	1				2759
AL1000	76	63	135	111	100	133	111	104	103	111	58	8	4	1		1									1119
AC-630	75	116	55	128	146	110	96	78	13	84	26														927
OTHER I&C	75	173	152	67	61	106	57	19	19	20	22	3	1	1						1					777
ROOTS	13	33	38	24	35	45	42	32	16	32	24	1			1	1				2					339
MR9	10	15	20		2	41	61	52	12	25	15														253
AL2300	12	10	19	13	17	31	14	25	24	22	4	3	1	1											196
AL1400	4	19	14	13	12	18	14	24	11	14	6														149
AL5000	9	10	5	7	2	16	5	11	4	21	2				1										93
OTHER DOMESTIC		14						23		1	2					1	1		1	1					44
SINGER	5	5	2		3		2	4		3	12	1													37
AL800		4	2	2	3	3	1	1					1												17
AERZENER										1	4														5
E600																	1								1
Grand Total	7382	8571	13447	9846	15088	23343	24708	28447	17883	24158	11214	175	109	126	93	69	18	17	27	27	2	2	2	1	184755

Delivery points with 15 year meters

15 Year																												
Model	Under 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	28	30	Grand Total
E602	6655	10605	5230	6478	6051	4265	3601	3993	1774	3286	7056	4366	9579	4473	3605	1575	18	40	3	7	10	3	2	1	1	2	2	1	82582
PC U6		869	3705	3787	5231	4073	7317	3044	3344	2623	1224	1070	4122	5112	2650	1466	63	1	2	5			1	1					49710
ABB DS5	4	240	155	17	964	80		44	92	1	8			2495	4293														8393
ATLAS U8	4	20	1	112	1163	808	2109	1683																					5810
Grand Total	6663	11734	9091	10394	13409	9226	13027	8774	5210	5910	8288	5336	13701	12080	10548	3041	81	41	5	12	10	3	3	2	1	2	2	1	146595

Delivery points with 18 year meters

18 Year												
Model	Under 1	1	2	3	4	5	6	7	8	9	10	Grand Total
AMPY 750	7596	9203	9131	9370	10195	9616	12360	8899	8463	1301	1124	87258
AMPY 1010	227	421	439	323	851	855	914	904	575	275		5784
Grand Total	7823	9624	9570	9693	11046	10471	13274	9803	9038	1576	1124	93042

APPENDIX 3: Suburbs Receiving Moomba Gas

All suburbs in the Adelaide Distribution System receive co-mingled gas except for the following, which receive Moomba gas.

Postcode	Suburb	Postcode	Suburb	Postcode	Suburb	Postcode	Suburb	Postcode	Suburb
5016	Largs Bay	5097	Ridgehaven	5110	Direk	5114	Craigmore	5118	Gawler South
5016	Largs North	5097	St Agnes	5110	Waterloo Corner	5114	Gould Creek	5118	Gawler West
5016	Peterhead	5106	Parafield	5111	Edinburgh	5114	Smithfield	5118	Hewett
5017	Osborne	5106	Salisbury South	5112	Elizabeth	5114	Smithfield Plains	5118	Kalbeeba
5017	Taperoo	5107	Green Fields	5112	Elizabeth East	5115	Kudla	5118	Willaston
5018	North Haven	5107	Parafield Gardens	5112	Elizabeth Grove	5115	Munno Para	5120	Virginia
5018	Outer Harbor	5108	Paralowie	5112	Elizabeth South	5115	Munno Para West	5121	Macdonald Park
5091	Banksia Park	5108	Salisbury	5112	Elizabeth Vale	5116	Evanston	5125	Golden Grove
5091	Tea Tree Gully	5108	Salisbury Downs	5112	Hillbank	5116	Evanston Gardens	5125	Greenwith
5091	Vista	5108	Salisbury North	5113	Davoren Park	5116	Evanston Park	5126	Fairview Park
5092	Modbury	5109	Brahma Lodge	5113	Elizabeth Downs	5116	Evanston South	5126	Surrey Downs
5092	Modbury Heights	5109	Salisbury East	5113	Elizabeth North	5117	Angle Vale	5126	Yatala Vale
5092	Modbury North	5109	Salisbury Heights	5113	Elizabeth West	5118	Concordia	5127	Wynn Vale
5096	Gulf View Heights	5109	Salisbury Park	5113	Elizabeth Park	5118	Gawler		
5096	Para Hills West	5109	Salisbury Plain	5114	Andrews Farm	5118	Gawler Belt		
5097	Redwood Park	5110	Burton	5114	Blakeview	5118	Gawler East		

APPENDIX 4: Relevant Procedures

As different functions relating to this Plan are carried out by different departments, the procedures below are contained in a range of operational manuals and field books which are held by those departments carrying out the respective activities.

Meter Repair and Testing Procedures

The following procedures are in the Metering division Workshop Procedures Manual located in the Meter Shop at Kidman Park:

- Domestic Diaphragm Meter Repair
- Email 602 Index Rewind
- Pressurizing of Domestic Gas Meters
- Sealing of Domestic Gas Meters
- Diaphragm Meter Testing Using Manual Bells
- Calculation of Percentage Error
- Adjustment of Diaphragm Meters
- Pressure Testing of Industrial Gas Meters Using Mechanical Pressure Device
- Pressure Testing of Industrial Gas Meters Using Compressed Air
- Pressure Testing of Industrial Gas Meters Using Multiple Series Pressure Bench
- Sealing Industrial Gas Meters
- Repairing Turbine Industrial Gas Meters
- Repairing Rotary Industrial Gas Meters
- Setting Up Industrial Meters On The Roots Prover
- Computer Testing Procedure Using Roots Prover
- Meter Shop Spray Painting Procedure
- Calibration of Test Bells

Correcting Instrument Calibration Procedures

These procedures are in the Pressure Control and Metering Manual (various locations).

- Calibration Of Flo-cal Correcting Instrument
- Inline Correcting Instrument Calibration and Test

New Meter Installation and Change-over Procedures

These procedures are in the Gas Fitting and First Response Manual (various locations)

- Work Instruction 3102 New Meter Installation
- Work Instruction 3109 Setting Regulator Pressures
- Work Instruction 3115 Changing Service Regulators
- Work Instruction 3103 Meter Change
- Work Instruction 7810 Industrial and Commercial Meter Change Using Bypass to Maintain Supply
- Work Instruction 7811 Industrial and Commercial Meter Change With No Bypass
- Work Instruction 7812 Industrial and Commercial Meter Change With 1 Bypass or an Isolation Valve
- Work Instruction 3108 Purging Domestic Gas Meters
- Work Instruction 3110 Purging Consumer Piping
- Work Instruction 3111 Pressure Testing Consumer Piping

- Work Instruction 3112 Relighting Appliances
- Work Instruction 3114 Electrical Safety for Meter Work
- Work Instruction 3116 Pressure Testing Industrial and Commercial Consumer Piping

Monitoring and Maintenance Procedures

These procedures are in the Network Maintenance Procedures Manual located in the Network Maintenance division:

- Entering Daily Heating Values into database
- Flow percentage error checks at telemetered sites
- Odorising procedure 9/2002 System Monitoring
- Routine Monthly checks
- Routine 2 monthly checks
- Routine 3 Monthly checks
- Routine 3 yearly checks