MEASUREMENT MANUAL

QUEENSLAND PIPELINES GAS MEASUREMENT MANUAL

GAS-999-OM-GM-002

Revision Number: 3
Revision Date: 7/10/2025

AUTHORISATION

Reviewed by

Name	Job Title	Signature	Date
Fred Khalil	Metering Engineering Manager - Zinfra	fredkhalil	14/10/2025
Santhosh Ananthakrishnan	Engineering Integrity Manager – Gas Markets		14/10/2025

Approved by

Name	Job Title	Signature	Date
John van der Vyver	General Manager – Asset Management – Gas Markets (Acting)	JP	17/10/2025

PUBLIC

Jemena
bringing energy to life

DOCUMENT HISTORY

Revision	Date	Author	Description of Changes
A	23/11/2020	Santhosh Ananthakrishnan	Consolidation of ALP, DDP, NGP (Queensland Section), QGP, RNP Pipeline Measurement Manuals
0	1/12/2020	Santhosh Ananthakrishnan	Incorporated review comments
1	8/02/2021	Santhosh Ananthakrishnan	Incorporated comments from commercial team
2	24/07/2023	Ali Moradmand	Revision update Incorporated minor changes
3	07/10/2025	Ali Moradmand	Periodic revision update with new meter stations included.

REVIEW DETAILS

Review Period:	Review Date + 2 years
Next Review Due:	2027

TABLE OF CONTENTS

1 SCOPE AND GENERAL

1.1 SCOPE

The Queensland Petroleum and Gas (Production and Safety) Act 2004, hence forth referred to as the **P&G Act 2004**, has the below obligations to the controller of gas meters.

The controller of a meter must:

- Make a measurement scheme for the meter that complies with section 637 of the P&G Act 2004, and
- implement and maintain the scheme.

According to Section 637 of the P&G Act 2004 , a measurement scheme for a meter must contain the below:

a. Identifying each meter or meter family or type;
b. State the number of meters or meter family;
c. State the Australian standard or other standard to which each meter complies;
d. State a proposed time or interval for meter replacement or testing;
e. State tolerance for error for all meters or meter family;
f. Provide regular review of the scheme;
g. State key performance indicators to be used to monitor compliance with the scheme;
h. Specify competency requirements;
i. Comply with any relevant requirements of the National Measurement Act 1960;
j. State means of compliance with other relevant matters prescribed under a regulation, and
k. State other matters prescribed under a regulation.

The scheme must also address the following where relevant:

a. Installation and commissioning of meters;
b. Meter methods and frequency;
c. Maintenance processes;
d. Correction factor calculation;
e. Calibration and traceability of meter test equipment;
f. Meter security (incl protection during transportation, installation, Operation and unauthorised alteration of meter readings) ;
g. Process for estimated meter readings, reasons for estimation, and procedures for reconciling actual and estimated reading;
h. Procedures for meter failure, incorrect operation or meter bypass;
i. Levels of competency for persons working on the meters;
j. Training programs to maintain skill levels of person, and
k. Record keeping (Incl Records of anomalies, complaints and actions and minimum period of record keeping).

Jemena is the controller of the meters installed on all Jemena owned and operated Queensland assets. This manual is Jemena's Queensland Measurement Scheme as required by the P&G Act 2004. In addition, this manual also provides a technical reference for the operation and maintenance of the gas measurement and monitoring systems for all Queensland Gas Pipelines and processing facilities.

The list of Jemena's Queensland Gas Pipelines and associated processing facilities covered in this manual are as below:

- Atlas Lateral Pipeline (**ALP**)
- Darling Downs Gas Pipeline (**DDP**)
- Northern Gas Pipeline (**NGP** – Queensland Section)
- Queensland Gas Pipeline (**QGP**)
- Roma North Pipeline (**RNP**)

1.2 PIPELINE DESCRIPTION

1.2.1 ATLAS LATERAL PIPELINE (ALP)

The Atlas Lateral Pipeline consist of one section of pipeline:

- PPL2040 (Pipeline licence No. 2040): The pipeline connects Atlas Gas Processing Facility (**AGPF**) to PPL134 interconnect (single direction flow) on the Darling Downs Pipeline.

1.2.2 DARLING DOWNS PIPELINE (DDP)

The Darling Downs Pipeline consists of three sections of pipeline:

- PPL90 (Pipeline licence No. 90): Extending from the receipt/delivery Spring Gully manifold (Bi-directional) to the Darling Downs Power Station (**DDPS**) Interconnect (bi-directional), close to ML1A station at Wallumbilla, QLD.
- PPL134 (Pipeline licence No. 134): Extending from the DDPS interconnect to the PPL134 to PPL133 interconnect.
- PPL133 (Pipeline licence No. 133): From the PPL134 to PPL133 interconnect (single direction flow) to the delivery at DDPS.

1.2.3 NORTHERN GAS PIPELINE (NGP – QUEENSLAND SECTION)

The Northern Gas Pipeline (NGP) consists of two sections of pipeline:

- PPL 34 (Pipeline licence No. 34): License for the section of pipeline in Norther Territory (**NT**)
- PPL 2015 (Pipeline licence No. 2015): License for the section of pipeline in Queensland.

This manual only covers the metering equipment installed in the Queensland section of the NGP pipeline in Mt. Isa compressor station.

1.2.4 QUEENSLAND GAS PIPELINE (QGP)

The Queensland Gas Pipeline consist of one section of pipeline:

- PPL30 (Pipeline license No. 30): The pipeline connects the receipts/delivery facility at Wallumbilla to delivery facilities in Gladstone and Rockhampton.

1.2.5 ROMA NORTH PIPELINE (RNP)

The Roma North Pipeline consists of one section of pipeline:

- PPL2028 (Pipeline licence No. 2028): Gas from Senex gas fields are delivered to Roma North Gas Processing facility (**RNGPF**). The RNP connects RNGPF to Roma North Receiver

Station (single direction flow). The Roma North pipeline is then connected to the Comet Ridge Wallumbilla pipeline (PPL118) owned by GLNG.

2 METER SCHEME – SUBSECTION (1)

2.1 METER IDENTIFICATION

The below sections details the meters installed on each pipeline. The “Location” column provides the location of the meter in the associated station on the pipeline. The station can be a metering station, compressor station or a gas processing facility.

2.1.1 ATLAS GAS PROCESSING FACILITY

Table 1: AGPF Meters (Owned and Validated by Jemena)

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
Atlas Gas Processing Facility	Atlas Station Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
	Atlas Fuel Gas Meter	In use	Yes	Coriolis	Single	√	√	√	√	√	√
	Atlas Flare Gas Meter	In use	Yes	Ultrasonic	Single	√	√	√	√	√	√
	Atlas Flare Purge Gas Meter	In use	Yes	Rotameter	Single	X	X	X	√	X	X
	Atlas Produced Water Meter	In Use	No	Electromagnetic	Single	X	X	X	X	X	X

2.1.2 DARLING DOWNS PIPELINE (DDP)

Table 2: DDP Meters (Owned and Validated by Jemena)

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
ML1A	ML1A Station Run 6 Meter	In use	Yes	Ultrasonic	Single	√	√	√	√	√	√
	ML1A Station Run 7 Meter	In use	Yes	Coriolis	Single	√	√	√	√	√	
	ML1A Station Santos Meter	In use	Yes	Ultrasonic	Single	√	√	√	√	√	
SGW	SGW Station Run 9 Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
	SGW Station SGW Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	
Talinga	Talinga Station TMS1 Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
	Talinga Station TMS2 Meter	In use	No	Ultrasonic	Single	√	√	√	√	√	
Kenya	Kenya Station Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
Darling Downs Meter Station	DDPS Station Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
	DDPS Water Bath Heater1 Meter A	In use	Yes	Vortex	Single	X	X	√	√	√	
	DDPS Water Bath Heater1 Meter B	In use	Yes	Vortex	Single	X	X	√	√	√	

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
	DDPS Water Bath Heater2 Meter A	In use	Yes	Vortex	Single	X	X	√	√	√	
	DDPS Water Bath Heater2 Meter B	In use	Yes	Vortex	Single	X	X	√	√	√	

Table 3 contains metering facilities not owned and not validated by Jemena, but connected to the Darling Downs Pipeline (DDP).

Table 3 DDP Meters (Owned and Validated by 3rd Party)

Location	Status	Meter Assembly	Meter Runs
Spring Gully Manifold	In use	Ultrasonic	Dual
Taloona	In use	Ultrasonic	Single
Talinga Skid 4	In use	Ultrasonic	Dual
TPCF (Talinga Pipeline Compressor Facility)	In use	Ultrasonic	Dual
CTW (Condabri/Talinga/Wallumbilla)	In use	Ultrasonic	Single
Orana	In use	Ultrasonic	Dual
Ruby	In use	Ultrasonic	Single

2.1.3 NORTHERN GAS PIPELINE (NGP – QUEENSLAND SECTION)

Table 4: NGP Meters (Owned and Validated by Jemena)

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
Mt.Isa Compressor Station	Mt.Isa Station Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√
	Mt.Isa Fuel Gas Meter	In use	Yes	Coriolis	Single	√	√	√	√	√	√

2.1.4 QUEENSLAND GAS PIPELINE (QGP)

Table 5 QGP Meters (Owned and Validated by Jemena)

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
Fairview	Fairview Station Meter	Not In use	Yes	Orifice	Single	√	√	√	√	√	√
Westgrove	Westgrove Station Meter	In use	Yes	Orifice	Single	√	√	√	√	√	√
Rolleston Compressor Station	Rolleston Compressor Station Meter	In Use (Note 1)	No	Ultrasonic	Single	√	√	√	√	X	X
	Fuel Gas to Compressors Meter	In Use (Note 1)	Yes	Coriolis	Single	√	√	√	√	X	
	Fuel Gas to GEA Meter	In Use (Note 1)	Yes	Coriolis	Single	√	√	√	√	X	
Rolleston Meter Station	Rolleston Meter Station Meters	In Use	Yes	Ultrasonic	Dual	√	√	√	√	√	X
Moura	Moura Station Meter	In Use	Yes	Coriolis	Single	√	√	√	√	√	√
Banana Compressor Station	Banana Compressor Station Meter	In Use (Note 1)	No	Ultrasonic	Single	√	√	√	√	X	X
	Fuel Gas to Compressors Meter	In Use (Note 1)	Yes	Coriolis	Single	√	√	√	√	X	
	Fuel Gas to GEA Meter	In Use (Note 1)	Yes	Coriolis	Single	√	√	√	√	X	
Larcom Creek	Larcom Creek Station Meter	In Use (Note 1)	No	Orifice	Single	√	√	√	√	X	X
Rockhampton City Gate	Rockhampton City Gate Station Meters	In Use (Note 1)	No	Orifice	Dual	√	√	√	√	X	X

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
QMAG	QMAG Station Meters	In Use (Note 1)	Yes	Turbine	Dual	√	√	√	√	X	X
Yarwun	Yarwun Station Meters	In Use	Yes	Ultrasonic	Dual	√	√	√	√	√	X
Gladstone City Gate	Gladstone City Gate Station Meters	In Use	No	Orifice	Dual	√	√	√	√	√	√
	Gladstone City Gate Heater 1 Meter	In Use	Yes	Diaphragm	Single	√	√	√	√	√	
	Gladstone City Gate Heater 2 Meter	In Use	Yes	Diaphragm	Single	√	√	√	√	√	
Orica	Orica Station Meters	In Use (Note 1)	Yes	Turbine	Dual	√	√	√	√	X	X
QAL	QAL Station Meter	In Use (Note 1)	Yes	Ultrasonic	Dual	√	√	√	√	X	X
Boyne Station Meter	Boyne Station Meter	In Use (Note 1)	Yes	Turbine	Single	√	√	√	√	X	X
Ticor Station Meter	Ticor Station Meter	In Use (Note 1)	Yes	Coriolis	Single	√	√	√	√	X	X
AMC	AMC Station Meter	Not in Use	No	Orifice	Single	X	X	X	X	X	X
QERL	QERL Station Meter	Not in Use	No	Orifice	Single	X	X	X	X	X	X

Note 1: These sites have live gas component downloaded to flow computers via SCADA

Table 6 contains metering facilities not owned and not validated by Jemena, but connected to the Queensland Gas Pipeline (QGP).

Table 6 QGP Meters (Owned and Validated by 3rd Party)

Location	Status	Meter Assembly	Meter Runs
Wallumbilla (Santos)	Not in use	Orifice	Single
Wallumbilla AGL (APA)	Not in use	Orifice	Single
Wallumbilla APA Run 3/4	In use	Ultrasonic	Single
Wallumbilla APA Run 10	In use	Ultrasonic	Single
Gooimbah	In Use	Ultrasonic	Dual
Rockhampton North	In Use	Turbine	Dual
Rockhampton South	In Use	Turbine	Single
Mimas Mooga QGP	In Use	Ultrasonic	Dual
Blain Drive Offtake	In Use	Coriolis	Single

2.1.5 ROMA NORTH PIPELINE (RNP)

Table 7: RNP Meters (Owned and Validated by Jemena)

Location	Meter Description	Status	Custody Transfer	Meter Assembly	Meter Runs	Temperature Measurement	Pressure Measurement	Flow Computer	SCADA	Gas Chromatograph	Moisture Analyser
Roma North Gas Processing Facility	RNGPF Station Meter	In use (Note 1)	No	Ultrasonic	Single	√	√	√	√	X	X
	RNGPF Flare Gas Meter	In use (Note 1)	Yes	Ultrasonic	Single	√	√	√	√	X	X
	RNGPF HP Fuel Gas Meter	In use (Note 1)	Yes	Orifice	Single	√	√	√	√	X	X
	RNGPF TEG Fuel Gas Meter	In use (Note 1)	Yes	Rotameter	Single	√	√	√	√	X	X
	RNGPF Flare Purge Gas Meter	In use (Note 1)	Yes	Rotameter	Single	√	√	√	√	X	X
	RNGPF Produced Water Meter	In use	No	Magnetic	Single	X	X	X	√	X	X
Roma North Receiver Station	RNRS Station Meters	In use	Yes	Ultrasonic	Dual	√	√	√	√	√	√

Note 1: These sites have live gas component downloaded to flow computers via SCADA

2.2 APPLICABLE STANDARDS

All meters shall be designed and installed in compliance with the appropriate meter standards mentioned in Table 8 Meter Standards.

Table 8 Meter Standards

Meter Type & Associated Equipment	Applicable Standard
Orifice Plate Meter	AGA-3
Turbine Meters	AGA-7
Ultrasonic Meters	AGA-9
Coriolis Meters	AGA-11
Diaphragm Meters	AS 4647
Compressibility Factor of Natural Gas and Related Hydrocarbon Gases	AGA-8
Gas Chromatograph	ISO 6976 - Natural Gas: Calculation of Calorific Values, Density, Relative Density and Wobbe index from composition.
Speed of Sound in Natural Gas	AGA-10

Additional standards that will be followed are noted in the Table 9 Additional Standards.

Table 9 Additional Standards

Standard Name	Standard Description
AS ISO 1000-1998	The International System of Units (SI) and Its Application
AS 1376 -1996	Australian Standard Conversion Factors
AS 4564 - 2020	Australian Standard Specification for general purpose natural gas
National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.36.	All installed flow computers for metering purposes shall be compliant with the accuracy requirements as mentioned in this document.

Standard Name	Standard Description
National Greenhouse and Energy Reporting (Measurement) Determination 2008,, refer Chapter 2, Part 2.3 Division 2.3.6 Section 2.31.	All installed pressure transmitters for metering purposes shall be compliant with the transmitter accuracy requirements as mentioned in this document.
National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.31.	All installed temperature transmitters for metering purposes shall be compliant with the transmitter accuracy requirements, as mentioned in this document.
National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.37.	All installed Gas Chromatograph shall be compliant with the accuracy requirements, as mentioned in this document.

2.3 METER TESTING AND REPLACEMENT PHILOSOPHY

Table 10 Testing and Replacement Philosophy contains the testing and replacement philosophy for each meter type. This philosophy is applicable only for the meters classified as “Custody Transfer” meters in the Section 2.1 Meter identification. A custody transfer meter is marked as “Yes” in the column “Custody Transfer” against the meter in the tables containing the meters for each pipeline.

Table 10 Testing and Replacement Philosophy

Meter Type	Testing or Replacement Philosophy
Ultrasonic Meters	Meter vendor will be engaged to perform performance checks and onsite validations at the end of each 10 year operating period and provide a consolidated meter health report. The vendor will identify key diagnostics parameters in their report, which will provide indication of the health and calibration drift of the meter. The values of these parameters will be benchmarked for each meter. Meter validations will be performed as per the specified validation intervals. During validations the meter diagnostics and the key parameters will be uploaded from the meter and compared against the benchmark values provided by the vendor. Any deviations outside the tolerance will be investigated and vendor will be engaged for rectification, if required. The below monitoring will be performed on a continuous basis and the results will feed into the 10 years Testing and Replacement Philosophy - For meters in Z configuration, deviation in flow between the meters in series operation will be detected during validation. The deviations beyond tolerance of 1.5% in Energy flow will be investigated. - Continuous Gas Unaccounted For (**GUF**) monitoring of the pipeline will be performed. GUF values beyond the acceptable tolerance will be investigated. This is expected to provide indications on meter deterioration.

Meter Type	Testing or Replacement Philosophy
Coriolis Meters	Re-calibrate every 10 years. The test medium will be water.
Turbine Meters	Replace meters every 10 years.
Orifice Plate Meters	Re-calibrate every 5 years. A lab re-calibrated orifice plate will be made available before removing the in-service orifice plate. The in-service orifice plate will be swapped with the new lab re-calibrated orifice plate and commissioned. The removed orifice plate will be sent to lab for re-calibration.
Diaphragm Meters	Re-calibrate every 5 years. The test medium will be Air.
Vortex Meters	Re-calibrate every 5 years. The test medium will be Water.
Rotameters	Re-calibrate every 10 years. These meters were only recently installed in Atlas and Roma North Compressor Station. This philosophy will be again reviewed at the end of 10 years of operating life.
Magnetic Meters	Run to Failure. These meters measure produced water flows.

Notes:

1. In the event of an unrecoverable fault on any of the meters, the meter will be replaced with a new meter with similar technology.
2. Where there are single meters, re-calibration will be performed during a shutdown to minimize the impact due to unavailability of flow measurement.
3. If meters are redundant, one meter will be re-calibrated first and installed, before the second meter is sent for re-calibration.
4. The above philosophy may be adopted for the non-custody transfer meters, but will depend on other factors like age, health status, cost etc. of the installed meter. The decision will be at the discretion of Asset Management.

2.4 TOLERANCE FOR ERRORS

2.4.1 OVERALL TOLERANCE FOR METERING

The overall acceptable tolerance of error for custody transfer meters (excluding flare gas meters and produced water meters) is detailed in Table 11: Acceptable Tolerance of Error for Custody Transfer Meters. The validation checks shall ensure the meters operate within these tolerances.

Table 11: Acceptable Tolerance of Error for Custody Transfer Meters

Flow Range	Acceptable Error %
Flow < 25 m3/Hr	$\pm$ 1.5%

Flow: 100 TJ/year to 1 PT/year	± 1.0%
Flow: > 1 PT / year	± 1.0%

The overall acceptable tolerance of error for flare gas meters is detailed in the Table 12: Acceptable Tolerance of Error for Flare Gas Meters.

Table 12: Acceptable Tolerance of Error for Flare Gas Meters

Flow Range	Acceptable Error %
Zero percent of capacity to Q_{min} to Q_t	± 10.0%
Q_t to Q_{max}	± 5.0%

The overall acceptable tolerance of error for produced water meters is detailed in Table 13: Acceptable Tolerance of Error for Produced Water Meters.

Table 13: Acceptable Tolerance of Error for Produced Water Meters

Flow Range	Acceptable Error %
All Flow Ranges	± 5.0%

2.4.2 TOLERANCE FOR TRANSMITTERS

The overall acceptable tolerance of error for transmitters is detailed in Table 14: Acceptable Tolerance of Error for Transmitters.

Table 14: Acceptable Tolerance of Error for Transmitters

Equipment	Acceptable Error %
Pressure Transmitter	± 0.1%
Differential Pressure Transmitter	± 0.1%
Temperature Transmitter	± 0.2%

2.5 REVIEW OF MEASUREMENT MANUAL

This measurement manual shall be revised if any of the below scenarios occur:

- If a new meter is installed, or proposed to be installed, which is not mentioned in this measurement manual;
- If there is an amendment of the American standard, or other applicable standard(s) referred to in this measurement manual;
- If an event (such as a significant development in the technical knowledge) relevant to the measurement manual becomes known; and
- If the operator of the Metering System becomes aware of a significant anomaly or likelihood of inaccurate measurement as mentioned in this measurement manual.

If none of the above scenarios occur, then this measurement manual will be reviewed in a 2-year period to ensure changes in regulation, technological advancement and operating procedures are captured.

2.6 KEY PERFORMANCE INDICATORS

The key performance indicators are outlined below

- Continuous GUF monitoring will be performed for all pipelines. The acceptable tolerance for 30 days rolling GUF% will be +/-1%.
- Individual total meter accuracy for custody transfer meters, from the validation report, shall fall within tolerance specified in section 2.4 Tolerance for errors.
- Perform validations within the defined periods as stated in this manual in section 3.2.3 Frequency of Validations.

2.7 NATIONAL MEASUREMENT SCHEME

Section 637(i) of the QLD P&G Act 2004 requires the installed meters to comply with any relevant requirements under the National Measurement Act 1960. The meters installed on Jemena's facilities are classified as utility meters, hence this requirement is not applicable for meters mentioned in this measurement manual.

2.8 COMPLIANCE WITH RELEVANT MATTERS PRESCRIBED UNDER A REGULATION

The details of compliance with other relevant matters prescribed under the Queensland Petroleum and Gas regulation 2017 (S59 & S60)[1], henceforth referred to as the **QLD P&G regulation 2017**, can be found in the following sections in this manual

- Section 2.4 Tolerance for errors,
- Section 3.2.3 Frequency of Validations,
- Section 3.4 Correction factor calculation and
- Section 5.1 Reference Conditions.

2.9 STATE OTHER MATTERS PRESCRIBED UNDER A REGULATION

The below relevant matters (S62 & S63)[2] prescribed under the QLD P&G regulation 2017 is not applicable for transmission pipeline facilities. Hence not applicable for the scope of this manual.

[1] S59 Other requirements for accuracy of meter – 100 TJ to 1 PJ

1) This section applies in relation to a meter that measures 100TJ or more, but not more than 1PJ, a year.
2) The controller of the meter must ensure the meter is installed with a device to correct the meter's readings to standard temperature and pressure.
3) The overall tolerance for error for the meter, including the correcting device, is plus or minus 1%.
4) The accuracy of the meter must be checked at least once in each 6-month period.
5) In this section - standard temperature and pressure see the 2004 Act, section 11(3).

S60 Other requirements for accuracy of meter – Over 1 PJ

1) This section applies in relation to a meter that measures more than 1PJ a year.
2) The controller of the meter must ensure the meter is installed with a flow computer to calculate the energy of the petroleum or fuel gas flowing through the meter.
3) The overall tolerance for error for the meter, including the flow computer, is plus or minus 1%.
4) The accuracy of the meter must be checked at least once in every 3-month period.

[2] S62 Requirement for gas pressure regulator

The controller of a meter must ensure the addition of a gas pressure regulator to the meter does not disadvantage a consumer.

Example of how a gas pressure regulator could disadvantage a consumer - Excessive regulator droop that could result in incorrect billing

S63 Metering factors

If there is a correction factor for calculating the price of gas flowing through a meter, the controller of the meter must ensure the pressure at which the meter must be operated is clearly marked on, or in the immediate vicinity of, the meter.

3 METER SCHEME – SUBSECTION (2)

3.1 INSTALLATION AND COMMISSIONING OF METERS

All meters shall be designed and installed in compliance with the associated AGA standards for the meter and details mentioned in this document. Industry and manufacturers best practices shall be taken into consideration for design and installation. Any deviation to the standard or this document for meter installation will require approval from the Principle E&I engineer.

The custody transfer flow meters shall be factory calibrated and certified prior to installation and commissioning. A Factory Acceptance Testing (**FAT**) shall be undertaken to verify the system is functioning as per design prior to transporting to site for installation. Site Acceptance Testing (**SAT**) shall be undertaken before the meter is placed into operation.

3.2 METER TESTING METHODS AND FREQUENCY

3.2.1 VALIDATION OVERVIEW

Validation is the process of ensuring the conditions of measurement equipment is in order, for it to function within agreed tolerances.

3.2.2 VALIDATION (TESTING) METHODS

A validation excel spreadsheet is used for the validation process. Jemena uses Kelton FloCal, a proprietary software to perform meter validations. This software is "called" from the validation spreadsheet to calculate gas flow data in accordance with the AGA standards. The validation spreadsheets performs a comparison of the Kelton FloCal calculated flows Vs the flow computer calculated flows and provides any discrepancies between the two readings. If the discrepancies are outside the acceptable tolerances for the meter, then appropriate action is taken to rectify the discrepancy.

Following is a typical list of relevant validation forms within the validation spreadsheet that is used to validate the meter installation:

- Test Equipment form
- Pressure Transmitter form
- Temperature Transmitter form
- Gas Chromatograph Tolerance Check Form
- Moisture Analyser Tolerance Check form
- Series Meter Comparison Form
- Ultrasonic Diagnostic Check form
- Ultrasonic Meter FC V’s Kelton FloCal form
- Oxygen Analyser Tolerance Check form
- Data transfer to compare Instrument, Flow Computer and SCADA values

The details of the appropriate validation forms for each facility can be found under each facilities validation procedures.

3.2.3 FREQUENCY OF VALIDATIONS

The frequency of periodic validations is shown in Table 15 Frequency of Meter Periodic Validations for all facilities. These periods may be shortened due to gas quality or when Energy Accounting equipment are found to be outside of tolerances. They shall never be extended beyond the times noted in Table 15, these frequencies are in accordance with the QLD P&G regulation 2017.

Table 15 Frequency of Meter Periodic Validations

	Flow less than 25 m3/Hr	Flow Greater than 25 m3/Hr + Accumulation < 100 TJ	Flow Greater than 25 m3/Hr + Accumulation = 100 TJ to 1 PT	Flow Greater than 25 m3/Hr + Accumulation > 1 PT
Frequency of Validations	None	None	6 Months	3 Months

3.3 METER MAINTENANCE

Maintenance procedures as defined by the meter manufacturer should be carried out during the scheduled validation process if any of the validation or diagnostics checks result in out of tolerance. Due to the wide range of meters installed on various pipelines, the maintenance procedures are site specific and are based on manufactures guidance and history of the equipment.

3.4 CORRECTION FACTOR CALCULATION

The meter assembly measures actual flow. The Pressure and Temperature Transmitters and Resistance Temperature Detectors (**RTD**) are mounted with each meter assembly.

Each meter is connected to a local flow computer (**FC**), which receives and records the instantaneous values for all primary measurement inputs, i.e. volume flow signals from the meter, pressure, temperature and Gas Chromatograph data.

The correction factor calculation is implemented in the flow computer. The flow computer performs temperature and pressure compensation of the measured flow (Actual) to produce instantaneous volumetric and energy based flow rates at standard conditions using the gas composition data from gas chromatographs. AGA calculation standards relevant to the type of meter are implemented in the flow computer to perform these calculation for e.g. AGA9 for USM. All flow computers accumulate volume and energy totals.

The below typical data are transferred to SCADA from the flow computer:

- Pressure
- Temperature
- Flow Rate
- Energy Rate
- Accumulated Flow
- Accumulated Energy

- Specific Gravity
- Heating Value
- Gas component data
- Yesterday's energy
- Yesterday's volume
- Contract energy accumulator
- Contract volume accumulator

The equipment specification varies between various facilities, however the schematic shown in Figure 1 identifies and links the key repeated components.

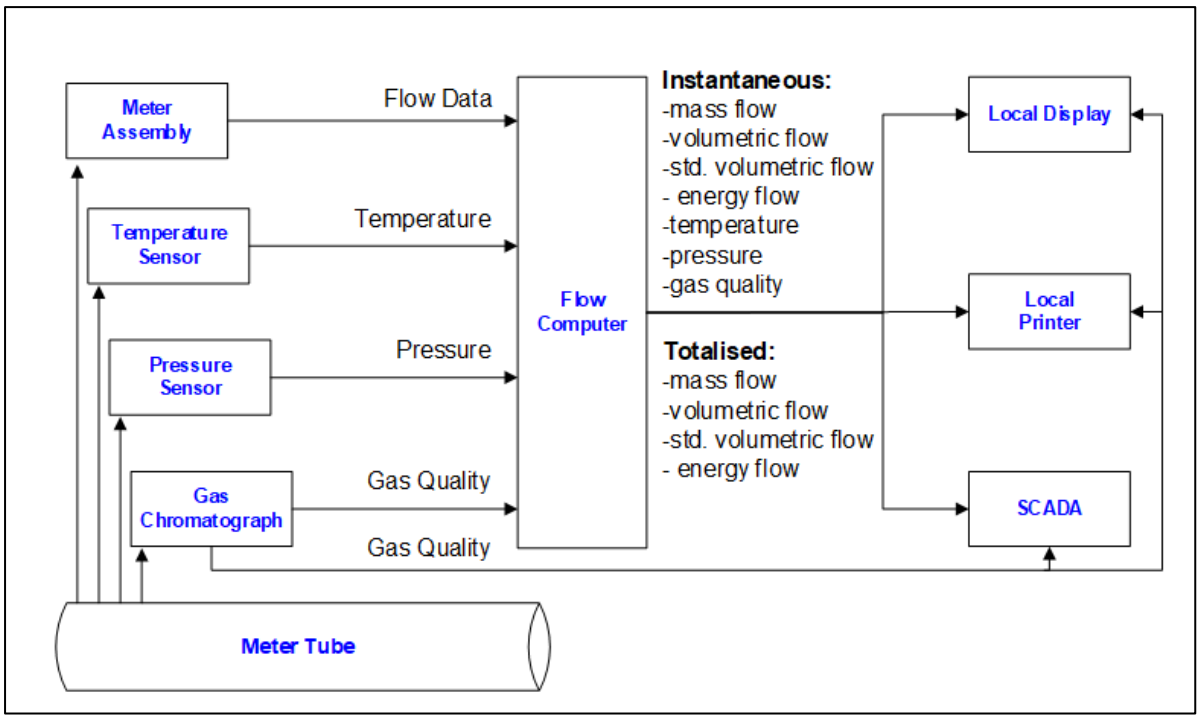

Figure 1: Measurement Facility Schematic

3.5 3RD PARTY DATA TRANSFER REQUIREMENTS

Jemena shall require at a minimum the below data to be transferred from 3rd party owned and operated meter installations to Jemena's SCADA.

- Metering Pressure
- Metering Temperature
- Meter Frequency
- Actual, Standard and Energy Flow Rates
- Today's Actual, Standard and Energy accumulation
- Yesterday's Actual, Standard and Energy accumulation
- Contract Actual, Standard and Energy accumulation
- Non-resetting Actual, Standard and Energy accumulation
- Gas Chromatograph data, If installed
- Sulphur Analyser data, If installed
- Moisture Analyser data, if installed

- Meter Configuration (Single, Series, Parallel)
- Selected Duty Meter, if redundant meters are installed
- Validation status of installed meters
- Selected Duty GC, if multiple GCs are installed or manual values can be entered.
- GC calibration mode, communications failure, out-of-range and Malfunction alarms.
- Selected Duty regulator, if multiple regulators are installed
- Master & Slave Clock register for communications watchdog purposes
- Isolation valve status
- Jemena flow permissive command

Notes:

1. The flow information is required for individual meter runs and for the overall station in both forward and reverse direction, if configured in the 3rd party control systems.
2. Jemena's permissive command shall be configured in the 3rd party control systems to open/close the flow isolation valve in the event of off-spec gas or in an emergency to stop flow. The Jemena flow permissive signal will have the below two states
    - State 0 = NO FLOW
    - State 1 = FLOW

    When the permissive is set to "NO FLOW", the isolation valve will close and will remain closed until the permissive is set to "FLOW" by Jemena. It is then, the responsibility of the 3rd party to initiate an open command, upon restoration of the Jemena flow permissive. Jemena will not have the ability to open the isolation valve.

    If a communications link failure occurs the Jemena flow permissive will remain in the last state. If isolation is required Jemena control room will contact 3rd party control room to perform isolations following an agreed process.

    Jemena SCADA will transport clock value in the Slave clock register to Master clock register at a set time (e.g. every 5 Sec). On communications failure, this value in the Slave Clock register will remain unchanged and a communications failure alarm can be configured in the 3rd party control systems and can be used to mask the Jemena flow permissive signal to shut down the isolation valve.

The hardware requirements and the communications architecture to implement this data transfer shall be discussed with Jemena team. A communications interface specification shall be developed that will contain the requirements of hardware, power, installation, communication redundancy, communication protocols, communication address. data set and acceptance testing for the interface. This document will be accepted by both parties before implementation.

3.6 CALIBRATION AND TRACEABILITY OF METER TEST EQUIPMENT

A standard set of equipment for the meter validations comprises the following items:

1) Multifunction Calibrator
2) Hydraulic Dead Weight Tester (**DWT**)
3) Mercury In Glass Thermometer
4) Resistance Decade Box
5) Certified RTD

Some other equipment may also be used.

The equipment is periodically checked and its accuracy verified by NATA accredited laboratories. Appropriate calibration certificates will be obtained and stored in ECMS after the verification process.

The frequency of re-calibration shall be as detailed in Table 16 Calibration Period of Validation Instruments.

Table 16 Calibration Period of Validation Instruments

Validation Instrument	Examples of Instruments Used		Re-Calibration Period Required
	Brand Name	Catalogue No	
Multifunction Calibrator	Beamex Advanced Calibrator	MC6	Every 12 months
	Druck Unimat Calibrator	TRX II	
	Druck Modular Calibrator	DPI610 IS	
	Druck Advanced Modular Calibrator	DPI620	
Hydraulic Dead Weight Tester	Ametek	PK II	Every 36 months
Function Generator		TG550	Every 12 months
Crystal Digital Test Gauge		3KPSIXP2	Every 12 months
Mercury in Glass Thermometer	AMA		Every 5 years
Delta Ohm Digital Thermometer		HD9215	Every 12 months
Time Electronic Decade Box			Every 12 months
Digital Multimeter	Fluke	45	Every 12 months
Certified RTD			Every 12 months

3.7 METER SECURITY

3.7.1 PHYSICAL SECURITY

All Jemena's remote and un-manned facilities are fenced and under regular remote surveillance by Jemena personnel or external security company. Site security system alarms are configured in the SCADA system. This ensures that any unauthorised access to site is immediately alarmed in the Melbourne Control Centre.

External contractor access to these facilities are controlled by induction processes and permit to work system.

3.7.2 SOFTWARE SECURITY

Flow meters used for custody transfer application(s) are protected by a password and only accessible through special software. Additionally, a parameter write lock in the Signal Processing Unit (**SPU**) of the meter prevents unauthorised changes to the meter configuration.

Temperature and pressure transmitters are not password protected but the risk of unauthorised alteration is minimised by adherence to Jemena's standard permit to work system.

3.7.3 TRANSPORT AND STORAGE

Transport and storage of all metering equipment shall be in accordance with manufacturer's instruction and Jemena's transportation requirements as defined by the project.

Meters shall be firmly secured during transport and measures shall be taken to avoid mechanical damage. A detailed inspection of the meter shall be performed by Jemena personnel or Jemena authorised external contractor prior to installation of the meter. Site Acceptance testing will be performed to ensure that meter performance has not been degraded due to the transportation process.

3.8 ESTIMATED METER READING & METERING CORRECTIONS

If the metering facilities are out of service or registering inaccurately so that the quantity of gas Delivered during a period cannot be ascertained or computed from the readings from these facilities, the gas Delivered during such period will be determined upon a basis of the best data available, using any one of the following methods:

- By using the registration of any check or standby metering equipment, if installed, and accurately registering; or
- By correcting the error if the percentage of error is ascertained by calibration, test or mathematical calculations; or
- By estimating the quantity of deliveries during the preceding periods of demand under similar conditions when the metering facilities were registering accurately.

3.9 PROCEDURES ON METER FAILURE, INCORRECT OPERATION AND METER BYPASS

If the event of a meter failure or incorrect operation or if a meter is bypassed for maintenance purposes, an estimation of meter reading as per Section 3.8 Estimated Meter Reading & Metering Corrections will be performed, if a standby meter is unavailable.

The failed meter will be repaired and re-instated in service. A validation will be performed on the re-instated meter to ensure the meter performance is within acceptable tolerance of errors. On successful validation, the meter will be placed in operation.

3.10 TRAINING AND COMPETENCY REQUIREMENT

The field technicians performing meter validations will be suitably trained to perform the activities required to complete validations following the facility appropriate procedures. The staff will have to demonstrate competency in the required validation procedures, applicable equipment, and understanding of hazards before they are allowed to perform validations.

The validations are performed by an field technician and witnessed and checked by another field technician. This is recorded in the validation spreadsheets as shown in the Figure 2 Validation Witness Record. This process ensures that new field technicians will be trained by performing validations with experienced field technicians. This also provides an opportunity to perform site specific knowledge transfer and assess the competency of the field technicians before they are allowed to train other field technicians.

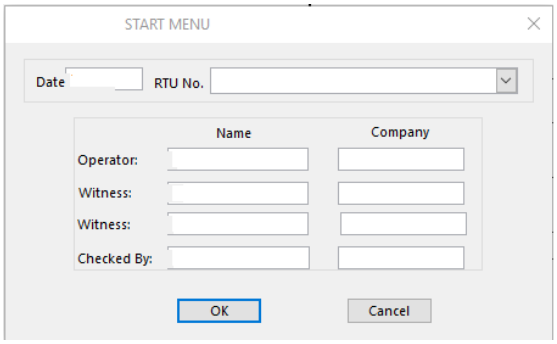

Figure 2 Validation Witness Record

In addition to the above, the field technicians will perform additional formal training sessions for e.g. Workplace inductions, Site specific induction, Manual handling etc.

Training covering the new meter installation shall be included after commissioning of any new meters. This training should be provided by the commissioning, project engineers or meter vendors and attended by field technicians working on the facility. A copy of the training records will be stored in ECMS.

3.11 RECORD KEEPING

All validation documents will be kept as records in Jemena's enterprise content management system (ECMS). Anomalies and complaints will be recorded in the validation documents as much as possible to ensure that consolidated records are maintained. If anomalies and complaints are present in other documents for e.g. email, they will also be kept as records.

All records will be kept for a duration of minimum 5 years from the date of creation.

4 GAS QUALITY MEASUREMENT

Gas entering the pipeline must meet certain specifications before it is transmitted through the pipeline. Jemena monitors the gas quality to ensure it meets these specifications. The natural gas specification must comply to the Australian standard AS 4564-2020 Specification for General Purpose Natural Gas.

The Contracts for services on the pipelines state the acceptable gas quality limits that apply to gas to be transported. Jemena is contractually obligated to flow, on behalf of its Shippers, only gas that meets the specification. It is the Shipper's responsibility to ensure that gas to be transported meets this specification at its Receipt Point(s). If the limits mentioned in facility specific Contracts differ to the Australian standard then the Contract limits will take precedence to the Australian standards.

Live monitoring of the gas quality is enabled via the SCADA system. Output from the on-site measurement equipment is linked to the Melbourne Control Centre. Alarms are triggered should the measured or calculated gas properties approach the limits specified. On facilities, where a Gas Chromatograph (**GC**) is not installed on-site, Gas Quality information shall be sourced from a Gas Chromatograph at another location proven to be representative of the gas passing through the meters in this facility.

4.1 ON SITE ANALYSIS

Gas Chromatographs sample line gas and separate the inert and hydrocarbon components to C6+ and are used to analyse the gas stream. Gas composition, specific gravity, heating value and Wobbe Index of the gas are determined.

Moisture analysers are used to continuously sample the gas stream to establish its water dew point.

4.1.1 CHROMATOGRAPHS

A small gas sample is retrieved from the pipeline at nominal intervals of 3 – 6 minutes. The sample is separated into its basic components and is analysed by the C6+ gas chromatograph, returning the following:

- Hexane Plus (C6+)
- Propane (C3)
- I-Butane (I-C4)
- N-Butane (N-C4)
- Neo-Pentane (Neo-C5)
- I-Pentane (I-C5)
- N-Pentane (N-C5)
- Nitrogen (N2)
- Methane (C1)
- Carbon Dioxide (CO2)
- Ethane (C2)

A microprocessor calculates the gas composition concentrations, Specific Gravity (real), Compressibility Factor, Higher Heating Value (real; dry basis), and the Wobbe Index. The basis of these calculations is GPA 2172 or ISO 6976. These figures are supplied to the flow computers for correcting the meter data to standard volume conditions and calculating energy.

The chromatograph automatically calibrates itself every 24 hours using a reference gas custom-blended to be similar to the gas being transported. This reference gas is supplied with a certification of analysis. The certified mole% of each gas is entered into the chromatograph to allow self-adjustment on calibration. The chromatograph is checked as part of routine validations of metering equipment.

All gas chromatographs are factory tested and calibrated with use of the gravimetric methods in accordance to Australian legal units of measurement.

4.1.2 MOISTURE ANALYSER

The Moisture Analyser draws a continuous sample stream from the gas flow and provides an indication of water content. An analogue output signal and alarm is provided.

The analysers covers the overall range from 0 to 100ºC (32ºF to 212ºF); analyser performance is immune to changes in sample gas, sensibility of 0.1 ppmv or 1% of reading, whichever is greater.

The analogue output of the analyser is connected to the SCADA system and is alarmed and monitored.

The moisture analyser(s) are calibrated as part of routine verifications of gas analysis and Energy Accounting equipment.

5 REFERENCE AND LOCAL CONDITIONS

5.1 REFERENCE CONDITIONS

The standard reference conditions utilised by Jemena for the gas measurement is as below. These standards are also Industry accepted reference conditions within Australia.

Measurement Reference Temperature	15°C (288.15K)
Measurement Reference Pressure	101.325 kPa (abs)
Standard Gravitational Acceleration (gs) at sea level and 45 latitude	9.80665 m/s
Density of Air at standard temperature and pressure	1.2255 kg/m3

5.2 LOCAL CONDITIONS

The local gravitational acceleration and atmospheric pressure at each site varies. A universal strategy must be established for determination of the local conditions to allow conversion to “Standard Conditions”.

5.2.1 LOCAL GRAVITATIONAL ACCELERATION

Local gravitational acceleration at each site is calculated in accordance with equation 3-A-10 of AGA3-1992. The local gravity is dependent on the latitude and elevation of the site.

5.2.2 LOCAL ATMOSPHERIC PRESSURE

Local atmospheric pressure is also calculated for each site. It is calculated using the following equation and is dependent on the elevation only.

$$P_{local} = 101.325 - \frac{h * density\ air * gs}{1000}$$

H	=	elevation (m)
density air	=	1.2255 kg/m^3
Gs	=	9.80665 m/s^2

6 ABBREVIATIONS AND DEFINITIONS

Term / Abbreviation	Definition
AGA	American Gas Association
AGPF	Atlas Gas Processing Facility
ALP	Atlas Lateral Pipeline
AS	Australian Standard
CTW	Condabri/Talinga/Wallumbilla
GLNG	Gladstone Liquified Natural Gas
Calibration	To determine the accuracy of a measurement instrument
Control	A function of Jemena in monitoring the Pipeline via the SCADA system and in executing the necessary actions and directives to ensure the effective receipt, transportation and delivery of gas to the Purchasers.
Custody Transfer	The transfer of responsibility for the care and keeping of the gas.
DDP	Darling Downs Pipeline
DDPS	Darling Downs Power Station
Delivered	Gas having left the pipeline at the Delivery Point/s specified in the relevant contract as the point of transfer of custody of the gas from Jemena to the relevant Shipper.
Delivery Point	A defined location for gas to leave the pipeline
ECMS	Enterprise Content Management System
Energy	The volume of gas in standard cubic metres multiplied by the Gross Heating Value (GHV). Standard units are Gigajoules (GJ).
Energy Accounting	The determination of all quantities of gas added to or subtracted from and remaining in the Jemena Pipeline system each Gas Day and the determination of the energy content of all such quantities of gas.
FAT	Factory Acceptance Test

Term / Abbreviation	Definition
FC	Flow Computer
Gas	Any naturally occurring mixture of one or more hydrocarbons in a gaseous state, and zero or more of the gases hydrogen sulphide, nitrogen, helium and carbon dioxide, and the residue gas resulting from the treating or processing of the natural gas.
Gas Day	Is the Gas day starting at 6am AEST and ending 24 consecutive hours later at 6am AEST.
GC	Gas Chromatograph
GEA	Gas Engine Alternator
Gigajoule (GJ)	10^9 Joules
Gross Heating Value(GHV)	Higher Heating Value (HHV) shall mean the energy produced by the complete combustion of one cubic metre of gas with air, at a temperature of 15 degrees Celsius and at an absolute pressure of 101.325 kPa, with the gas free of all water vapour, and the products of combustion cooled to 15 degrees Celsius, the water vapour formed by combustion condensed to the liquid state, expressed in MJ per standard cubic meter (MJ/scm).
gs	Standard gravitational acceleration
Melbourne Control Centre	The place where gas transmission control occurs.
HP	High Pressure
ISO	International Organisation for Standardisation
Joule (J)	The energy expended or the work done when a force of one Newton moves the point of application a distance of one metre in the direction of that force.
K	Kelvin
Kilopascal(kPa)	One thousand pascals and is by definition a measure of absolute pressure. It is sometimes convenient for instrument calibration to use the term “kilopascal gauge” (kPag). This means that the gauge reads zero at atmospheric pressure.
kg	Kilogram

Term / Abbreviation	Definition
LP	Low Pressure
Megajoule(MJ)	10^6 Joules
ml	millilitre
Month	A period extending from the beginning of the first day in a calendar month to the beginning of the first day in the next calendar month.
NATA	National Association of Testing Authorities
NGP	Northern Gas Pipeline
NT	Northern Territory
P&G Act 2004	Petroleum and Gas (Production and Safety) Act 2004
Petajoule(PJ)	10^{15} joules
Pipeline	The pipeline licensed under Pipeline Licence No. pursuant to the Petroleum Act
ppmv	Parts per million volume
QGP	Queensland Gas Pipeline
QLD	Queensland
QLD P&G regulation 2017	Queensland Petroleum and Gas regulation 2017
Qmax	highest flow rate at which the meter can still maintain an accuracy
Qmin	lowest flow rate at which the meter can still maintain an accuracy
Qt	Transitional Flowrate
Quantity	The quantity of gas measured in terms of its energy content.
Received	Gas having entered the pipeline at the inlet receipt point specified in the relevant contract as the point of custody transfer from the supplier to the Shipper.
RNP	Roma North Pipeline
RNGPF	Roma North Gas Processing Facility

Term / Abbreviation	Definition
RTD	Resistance Temperature Detector
SCADA	Supervisory Control and Data Acquisition and refers to the electronic means of receiving remote data and of sending remote control signals and data to pipeline facilities from the Melbourne Control Centre.
SGW	Spring Gully - Wallumbilla
Shipper	An entity receiving transportation service on the pipeline pursuant to an effective Transportation Service Agreement (also known as the “facility user” or, in certain circumstances, “access provider” under the Pipeline Access Principles).
SI	International System of Units
Terajoule(TJ)	10^{12} joules
TMS	Talinga Meter Station
TPCF	Talinga Pipeline Compressor Facility
USM	Ultra-Sonic Meter