Measurement Manual

TGP-698-OM-GM-001

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Role	Name	Signature	Date
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CONTENTS

Tables

Figures

1 SCOPE AND GENERAL

1.1 Scope

This manual provides a technical reference for the operation and maintenance of the Tasmanian Gas Pipeline Pty Ltd (TGPPL) gas measurement and monitoring systems on the Tasmanian Gas Pipeline (TGP).

Operation of a typical gas measurement and billing system includes the following processes:

- Equipment specifications
- Equipment calibration
- Data acquisition
- Data transmission
- Data, storage, manipulation and computation
- Data validation
- Billing procedures
- Discrepancy resolution and billing adjustments
- System auditing
- Gas Sales Contracts or Agreements.

The hardware used to implement this billing system includes:

- Gas Meters - Coriolis
- Gas Meters - Ultrasonic
- Flow Computers
- SCADA systems
- Gas Chromatograph
- Calibration Equipment and Instruments.

The manual includes general details on technical aspects of the overall measurement system and equipment. Other aspects of the measurement process such as billing procedures, system auditing, and billing adjustments are covered under separate procedures as part of the function of the Control Room and TGPPL commercial team. The manual is not intended to provide specific details of Gas Sales Contract terms and conditions.

The manual covers:

- General Information on validation of measurement data
- Specifications of measurement equipment
- Specifications of measurement tolerances and levels of uncertainty
- Details of calculations used for equipment calibration and data validation
- General procedures for calibration of measurement equipment
- Guidelines for adjustment of measured flow quantity.

1.1.1 Enquiries Regarding this Document

Any queries regarding this manual should be directed to:
The General Manager -Tasmanian Gas Pipeline Pty Ltd (TGPPL).

1.1.2 Copyright

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1.2 Application

The scope of the manual applies to all TGPPL operated custody transfer facilities on the Tasmanian Gas Pipeline extending from the receipt facility at Longford, Victoria to delivery facilities along the pipeline route in Tasmania. TGP Facilities' Map Figure 1 and Table 1 provide an overview of the measurement facilities maintained on the TGP at the time of issue of this manual.

Inspection and testing of both the fiscal and non-fiscal measurement equipment are addressed in the manual. For specific operational details, refer to TGPPL standard operating procedures.

The inspection and testing procedures for independently owned and operated measurement facilities on the TGP are not addressed in this manual.

Such independent facilities include:

- Receipt metering at Longford, Victoria.
- Receipt gas quality measurement at Longford, Victoria.
- TasHUB Metering Facility in Longford, Victoria.

1.3 Standards and Measurements

Document ID	Document title
AS/NZS 1376:1996	Conversion Factors
AS 4564-2011	Specification for general purpose natural gas
ISO 6976:1995	Natural Gas: Calculation of Calorific Values, Density, Relative Density and Wobbe Index from Composition
AS ISO 1000:1998	The International System of Units (SI) and its application
AS ISO 13443-2007	Natural Gas – Standard Reference Conditions
AGA Report No 3	Orifice Metering of Natural Gas and other related Hydrocarbon Fluids
AGA Report No 7	Measurement of Natural Gas by Turbine Meter
AGA Report No 8	Compressibility Factors of Natural Gas and Other related Hydrocarbon Gases
AGA Report No 9	Measurement of Gas by Multipath Ultrasonic Meters
AGA Report No 11	Measurement of Natural Gas by Coriolis Meter.

1.4 Definitions of Terms and Abbreviations

The terms and abbreviations used in this document are defined below.

Abbreviation / Term	Description
ABM	Australian Bulk Minerals
AGA	American Gas Association
AGC	Automatic Gain Control
Billing Period	The period from 0630 hours EST on the first day of each month to 0630 hours EST on the first day of the following calendar month
Calibration Gas	Refers to the gas used by a gas chromatograph to calibrate against known mole percentage values
Contract(s)	The various agreements for the transport of gas via the Tasmanian Gas Pipeline
Control	A function of TGPPL in monitoring the TGP via the SCADA system and in executing the necessary actions and directives to ensure the effective receipt, transportation and delivery of gas to the Shippers
Control Room	The place in which "Control" occurs. The central point for remotely monitoring and controlling the operations on the TGP
Custody Transfer	The transfer of responsibility for the care and keeping of the gas
Delivered	Gas having left the pipeline at the delivery point specified in the relevant contract as the point of transfer of custody of the gas from TGPPL to the relevant Shipper
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 pipeline system each billing period and the determination of the energy content of all such quantities of gas
Gas	A gaseous fuel consisting of a mixture of hydrocarbons of the alkane series, primarily methane but which may also include ethane, propane and higher hydrocarbons in much smaller amounts. It may also include some inert gases, plus minor amounts of other constituents including odorizing agents. Natural gas remains in the gaseous state under the temperature and pressure conditions normally found in service
Gas Used	The amount of gas calculated by TGPPL to have been consumed by the TGP in normal pipeline operations such as fuel for compressors, heaters, venting and instrument gas consumption
Gigajoule (GJ)	Is equal to 10^9 joules
GOFXL2008	American Gas Association software for the calculation of gas flow
Gross Heating Value (GHV)	The energy produced by the complete combustion of one cubic metre of gas with air, at a temperature of 15°C and at an absolute pressure of 101.325 kPa, with the water produced by combustion condensed to the liquid state. Also referred to as superior or higher heating value as referred to in AS 4564 and ISO 6976
Imbalance	Exists in relation to an agreement if there is a difference on any day between the quantities of gas received by the access provider at receipt points for a facility user's account and the quantities of gas delivered to or on account of the facility user at the delivery points

Abbreviation / Term	Description
Input Quantity	The total of all gas received into the pipeline for a given billing period, as measured by the inlet meter
Joule	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
Kilopascal (kPa)	Is one thousand Pascals. It is sometimes convenient for instrument calibration to use the term "kilopascal gauge". This means that the gauge reads zero at atmospheric pressure
Linepack	The calculated quantity of gas contained in the pipeline at a given point in time (which is necessary for physical operation of the pipeline, excluding System Use Gas)
Longford Compressor Station	The compressor station facility, located immediately prior to the beginning of the pipeline at Longford (Victoria)
Measurement Authority	Tasmanian Gas Pipeline Pty Ltd (TGPPL), the Pipeline Owner
Measuring Equipment	Includes, but is not limited to the pipeline owner's meters, temperature and pressure transmitters, flow computers and gas chromatographs
Megajoule (MJ)	10^6 joules
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
Off-specification Gas	Gas other than Sales Specification Gas
Output Quantity	The total amount of gas delivered by the pipeline in a given period as measured by the meters at pipeline outlet locations
Petajoule (PJ)	10^{15} joules
Pipeline	The natural gas transmission pipeline network (and associated infrastructure and equipment) known as the Tasmanian Gas Pipeline (the Pipeline) licensed under Pipeline Licence No. 1 issued by the State of Tasmania under the Gas *Pipelines Act 2000* (Tas), Offshore Tas Pipeline Licence No. 1 issued by the State of Tasmania under the *Petroleum (Submerged Lands) Act 1982* (Tas), Pipeline Licence No., 236 issued by the State of Victoria under the *Pipelines Act 1967* (Vic) and Offshore Vic Pipeline License No. 30 and 30 (v) issued by the State of Victoria under the *Petroleum (Submerged Lands) Act 1967* (Commonwealth), extending from Longford, Victoria to Port Latta and Bridgewater, Tasmania
Pipeline Controller	An employee (or a service provider working on behalf of Tasmanian Gas Pipeline Pty Ltd) working at the Control Room
Pipeline Inlet	The location(s) at which gas enters the pipeline, specified in the relevant contract as the point of transfer of custody of the gas from the relevant Supplier to the Shipper and simultaneously and instantaneously from the Shipper to the Pipeline owner
Pipeline Outlet	The location(s) at which gas leaves the pipeline specified in the relevant contract as the point of transfer of custody of the gas from the pipeline owner to the Shipper
Pipeline Owner	Tasmanian Gas Pipeline Pty Ltd (TGPPL)
Quantity	The quantity of gas measured in terms of its energy content
Received	Gas having passed the inlet delivery point specified in the relevant contract as the point of custody transfer from the Supplier to Tasmanian Gas Pipeline Pty Ltd.

Abbreviation / Term	Description
Remote Telemetry Unit (RTU)	Monitors the field digital and analogue parameters and transmits all the data to the SCADA system
Reconciliation	The process through which TGPPL conducts an energy balance at the end of each billing period and allocates any System Use Gas in an agreed manner
Sales Specification Gas	The gas that meets all of the agreed requirements for content and properties as set out in Section 3.2
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
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)
Specific Gravity	The density of dry gas divided by the density of dry air, both at 15°C and at a pressure of 101.325 kPa
Standard Cubic Meter of Gas	The unit of volume of gas free from water vapor which would occupy a volume of one cubic meter at a temperature of 15°C and an absolute pressure of 101.325 kPa
Standard Measurement Conditions	Defined as 101.325 kPa and 15°C (same as standard reference conditions as per AS ISO 13443)
Super compressibility	A factor expressing a deviation of a gas from perfect gas laws
Supplier	The party contracted by a Shipper to supply gas at any of the pipeline inlets for transport in the Tasmanian Gas Pipeline (TGP)
System Use Gas	The quantity of gas used in the operation of the pipeline, including fuel gas and lost or unaccounted for gas
Tasmanian Gas Pipeline Pty Ltd (TGPPL)	Tasmanian Gas Pipeline Pty Ltd (TGPPL) is the owner and licensee of the Tasmanian Gas Pipeline (TGP).
TGPPL owned gas	The quantity (in GJ) of gas in the pipeline equal to the sum of linepack and imbalance owned by TGPPL
Terajoule	10^{12} joules
Validation or Verification	The process of periodically checking and servicing the measurement equipment to ensure that it continues to function within agreed levels of accuracy
VOS	Velocity of sound
Wobbe Index	The gross heating value of the gas on a volumetric basis at standard reference conditions, divided by the square root of the relative density of the gas at the same standard reference conditions

1.5 TGP Facilities Map and Delivery Measurement Equipment

The TGP facilities are shown on the map in Figure 1 below.

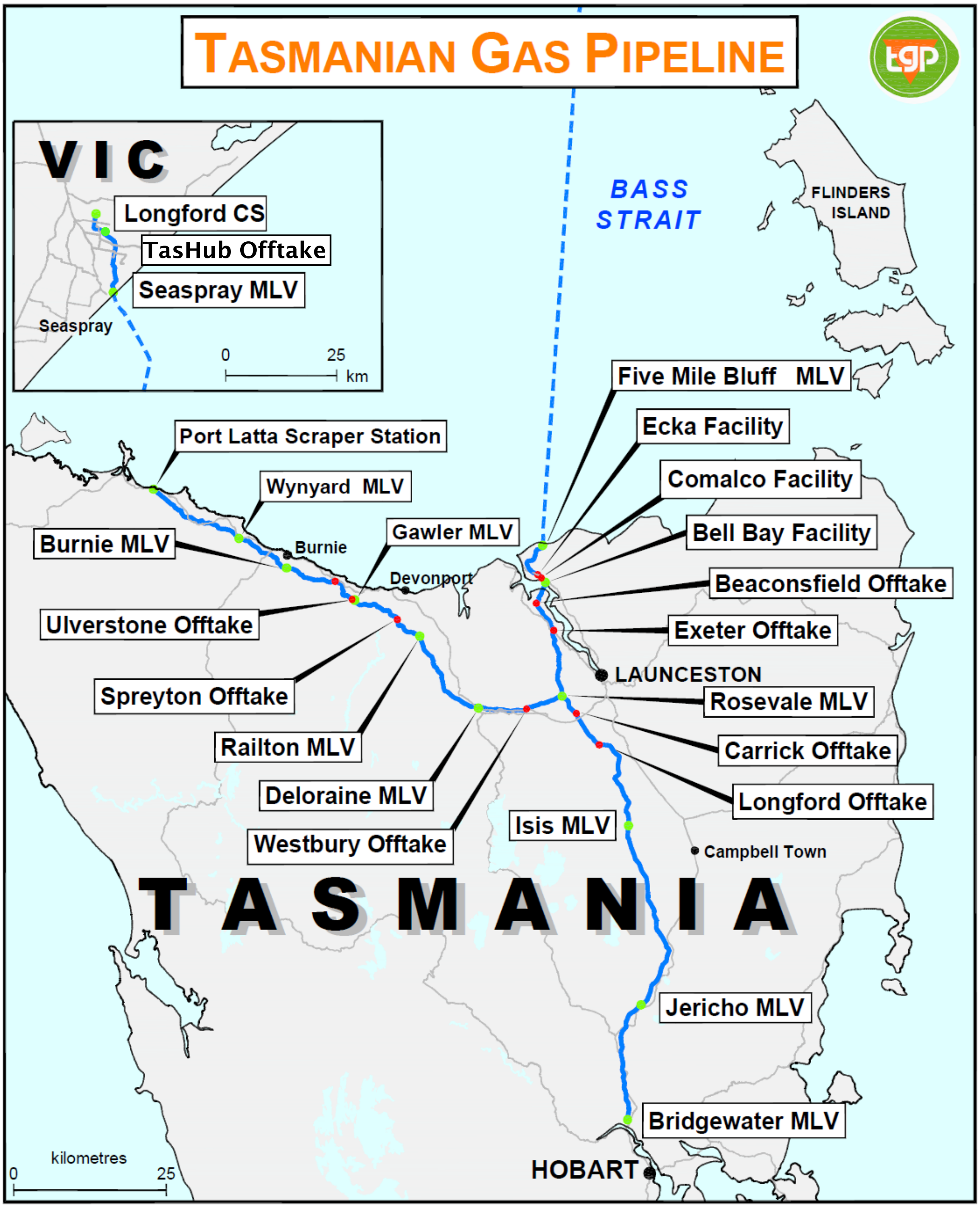


Figure 1: TGP Facilities Map

Each facility's delivery measurement equipment is listed in Table 1 below.

Table 1: Delivery Measurement Equipment

Location	Meter Assembly	No. Off-Meter Runs	Meter Diameter (mm)	Flow Computer	Temp & Press Measurement	SCADA	Gas Analyser (GC only)
Longford Compressor Station	-	-	-	✓	✓	✓	✓
Bell Bay (FT8) GTG	Coriolis	2 Series or parallel	80 x 1	✓	✓	✓	✓
Bell Bay (RR) OCGT	Coriolis	2 Series or parallel	50 x 1	✓	✓	✓	✓
Bell Bay (Mitsubishi) CCGT	Ultrasonic	2 Series or parallel	200 x 2	✓	✓	✓	✓
Bell Bay Comalco	Coriolis	2 Series or parallel	25 x 2	✓	✓	✓	×
Bell Bay ECKA	Coriolis	2 Series	50 x 1	✓	✓	✓	×
Launceston (Carrick)	Coriolis	2 Series or parallel	50 x 2	✓	✓	✓	×
Longford	Coriolis	2 Series or parallel	25 x 1	✓	✓	✓	×
Bridgewater	Coriolis	2 Series or parallel	50 x 2	✓	✓	✓	×
Westbury	Coriolis	2 Series or parallel	25 x 1	✓	✓	✓	×
Westbury BOC	Coriolis	2 Series of Parallel	50 x 1	✓	✓	✓	×
Devonport (Spreyton)	Coriolis	2 Series or parallel	50 x 1	✓	✓	✓	×
Ullverstone	Coriolis	2 Series or parallel	25 x 2	✓	✓	✓	×
Burnie	Coriolis	2 Series or parallel	25 x 1	✓	✓	✓	×
Wynyard	Coriolis	2 Series or parallel	25 x 1	✓	✓	✓	×
Port Latta	Coriolis	2 Series or parallel	50 x 2	✓	✓	✓	×
TasHUB (*)	Ultrasonic	1 Series	300 x 1	✓	✓	✓	×

(*) Owned and Operated by APA

2 GAS VOLUME MEASUREMENT

2.1 General and Overview

Tasmanian Gas Pipeline Pty Ltd (TGPPL) is the measurement authority for the Tasmanian Gas Pipeline (TGP) with responsibility for measurement and reconciliation of all gas received and delivered by the TGP. TGPPL owns, operates and maintains, gas quality measuring equipment at the receipt points and at selected delivery points on the pipeline. Generally, flow measurement facilities are maintained by TGPPL at each receipt point and delivery point. Where receipt or delivery point measurement equipment is owned or operated by a third party, they will be maintained in accordance with this manual and TGPPL requirements.

Data transfer from on-site RTUs to the SCADA system achieves remote monitoring of flow and gas quality. Land communications link the Control Room to on-site measurement equipment at receipt and key delivery points.

Measured flow is corrected for temperature, pressure, and gas composition to produce instantaneous volumetric and energy based flow rates at standard conditions in the on-site flow computer. The flow computer also calculates and maintains an accumulated record of volume and energy passing through the meter assembly. In conjunction with Linepack calculations, the accumulated quantities from each meter are used for the daily reconciliation and balancing of inflows and outflows of the Pipeline.

Shipper delivery points have either ultrasonic or Coriolis meters.

The data obtained from the flow computers of each meter assembly is used to calculate the flow over the billing period.

2.2 Meter Assembly

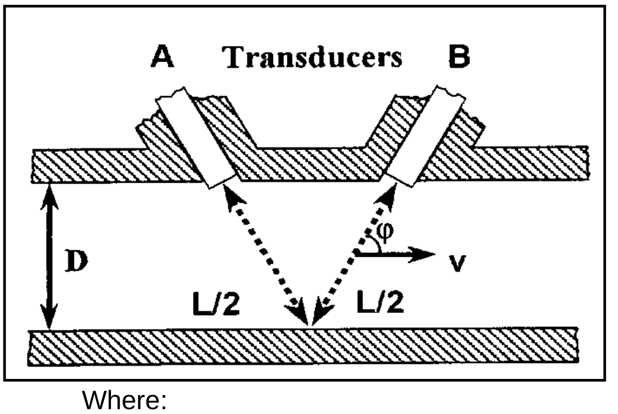
The meter assembly measures dynamic flow properties for use in the calculation of volumetric flow. There are two styles of meter assembly in service on the TGP pipeline.
The first style of meter assembly is ultrasonic and they are used at one location at the Bell Bay facility.

The second style of meter assembly is Coriolis and they are used at delivery points e.g. the Comalco, Bridgewater and Port Latta facilities.
For specific operating details for each meter assembly, refer to the site specific Design Basis Manual and/or Facility Operating Principles documents.

1.1.3 Ultrasonic Meters

An ultrasonic meter measures the difference in time taken for sound waves to travel in the gas stream between up and downstream paired transducers. Ultrasonic sound pulses are launched in each direction (as shown in Figure 2) from a number of pairs of transmitters/ receivers and their time of transit is measured, and the difference can be related to the speed of flow in the pipe. Ultrasonic meters have several sound wave paths through the gas in the pipe. Algorithms are used to derive the average flow velocity and to determine if swirl or turbulence is present. The actual volumetric flow rate is calculated from the average velocity and the internal diameter of the meter.

The flow computer converts the actual volumetric flow rate to volumetric flow rate at standard conditions and energy flow rate using inputs from pressure and temperature sensors and gas quality data.



Where:
D = Diameter of pipe
L = Ultrasonic wave path distance
A & B = Transducers
φ = Angle between pipe axis and acoustic path
v = Velocity of gas

Figure 2: Ultrasonic Meter Schematic

Ultrasonic meters are installed, operated and maintained as per the requirements of the AGA XQ0701:2007- AGA Report No. 9 - ***Measurement Of Gas By Multipath Ultrasonic Meters*** and the manufacturer's installation, operating and maintenance manual.

Periodic checks, called validations, are carried out to confirm the accuracy and integrity of the meter set. These include checks of the automatic gain and level control, correct ultrasonic pulse rate and velocity of sound. This data indicates if any of the ultrasonic paths are fouled, the meter is subject to external noise or any of the ultrasonic transducers are deteriorating. Monitoring of the measured velocity of sound will show if there is any change in a critical dimension or the reference clock has drifted. Temperature and pressure transmitters are also checked for calibration during a validation.

On-line diagnostics continuously monitor the performance of the meter. These diagnostic checks help to locate any metering discrepancies. Once identified, a discrepancy is investigated by TGPPL. Metered data validations will be initiated to prove metering at any site as dictated by the field investigation.

Where possible, receipt point meters will be operated in series with a nominated duty meter and a stand-by meter.

1.1.4 Coriolis Meter

A Coriolis meter uses a U-shaped tube as a sensor. Inside the sensor housing, the sensor tube vibrates at its natural frequency. The sensor tube is driven by an electromagnetic drive coil located at the centre of the bend in the tube and vibrates similar to that of a tuning fork (Figure 3).

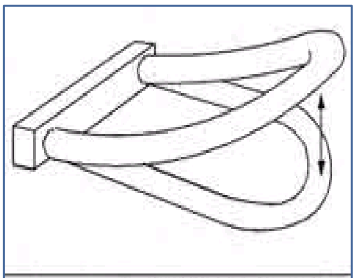
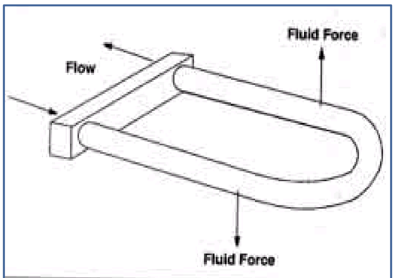

Vibrating Coriolis Sensor Tube.

Figure 3: Vibrating Coriolis Sensor Tube

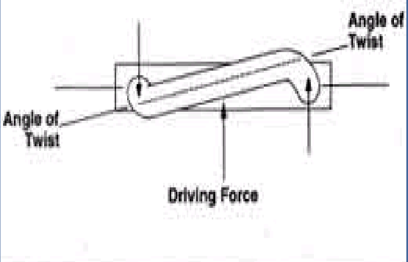
The fluid flowing into the sensor tube is forced to take on the vertical momentum of the vibrating tube. When the tube is moving upward during half of its vibration cycle, the fluid flowing into the sensor resists being forced upward by pushing down on the tube (Figure 4).



Fluid Forces in a Coriolis Sensor Tube.

Figure 4: Fluid Forces in a Coriolis Sensor Tube

The fluid flowing out of the sensor has an upward momentum from the motion of the tube. As it travels around the tube bend, the fluid resists changes in its vertical motion by pushing up on the tube. The difference in forces causes the sensor tube to twist. When the tube is moving downward during the second half of its vibration cycle, it twists in the opposite direction. This twisting characteristic is called the Coriolis Effect (Figure 5).



Coriolis Effect.

Figure 5: Coriolis Effect

The amount of sensor tube twist is directly proportional to the mass flow rate of the fluid. Electromagnetic velocity detectors located on each side of the flow tube measure the velocity of the vibrating tube. Mass flow is determined by measuring the time difference exhibited by the velocity detector signals. During zero flow conditions no tube twist occurs, resulting in no time difference between the two velocity signals. With flow, a twist occurs with a resulting time difference between the two velocity signals. This time difference is directly proportional to mass flow.

The flow computer receives data from the meter in terms of pulses/kg and live gas quality data from a gas chromatograph. This enables calculation of gas volume and energy flow rates at standard conditions.

2.3 Pressure and Temperature Measurement

Pressure transmitters and resistance temperature detectors (RTDs) are mounted with each meter (Ultrasonic meters only) assembly depending on site requirements. They are used in the calculation of the correction factor which converts the ‘actual’ metered flow to a net volume at standard measurement conditions.

1.1.5 Static Pressure Transmitter

The static pressure transmitter comprises a simple diaphragm of which one side is exposed to operating pressure. The amount of pressure placed on this diaphragm provides a corresponding distortion, which can be measured to give a static pressure reading.

The static pressure sensing lines are leak tested and the transmitter is calibrated across its range during routine validations using a dead weight tester (DWT) or electronic pressure calibrator. The flow computer display pressures are compared to known test values during calibration.

The DWT and electronic pressure calibrator are regularly bench calibrated at a National Association of Testing Authorities (NATA) certified facility.
Allowance is made for local gravity, barometric pressure head of oil and temperature for the DWT.

For ultrasonic meters, pressure transmitters are mounted on each meter assembly. The static pressure is used in the calculation, which converts the ‘actual’ metered volumetric flow to a volume flow at standard conditions.

For Coriolis meters, pressure transmitters are mounted on the meters for pressure compensation of the sensor tube.

1.1.6 Resistance Temperature Detectors & Temperature Transmitters

The operating principle of the resistance temperature detector (RTD) is relatively simple. A platinum wire is fixed within a probe positioned mid-stream in the pipe. The resistivity of the platinum is related to its temperature. Hence, variation in gas temperature can be inferred from the variation in the measured resistance across the platinum wire. A temperature transmitter monitors the resistance across the platinum wire and converts it to a digital signal for use in flow calculations.

Accuracy of the RTD and flow computer inputs is checked periodically as part of routine validations.

The RTD temperature probes are verified using a water bath and a calibration instrument. The measured resistivity is compared to that of a NATA certified temperature probe.
The temperature transmitters are calibrated using a certified resistance device. A known resistance is placed on the input to the transmitter and the expected temperature is compared to that indicated on the flow computer.

2.4 Flow Computers

The flow computer performs three main functions:

- Computation of volume, mass, energy flow rate and super-compressibility;
- Updating of flow accumulation registers; and
- Data transfer.

Each ultrasonic meter is connected to a local electronic flow computer, which receives volume flow signals from the meter. It also receives pressure and temperature information from the transmitters. From these inputs, and along with the gas analysis, the flow computer continuously calculates the corrected volume and energy flow through the meter. The two ultrasonic meters at the Bell Bay CCGT use a Bristol Babcock Controlwave Micro as the flow computer.

Each Coriolis meter is connected to a local electronic flow computer, which receives a mass flow signal from the meter. Volume at standard conditions and energy flow rates through the meter are calculated from this signal and gas quality data provided by a gas chromatograph. Flow computers are combined in the Station RTUs which were installed during 2015-2017. Flow computers for all Coriolis meters are implemented using the Honeywell RTU 2020 device. All flow computers accumulate volume and energy totals.

All calculations done by the computer are in accordance with recognised industry standards. Gas quality data electronically downloaded to each flow computer includes:

- Gross heating value
- Relative density
- Nitrogen content
- Carbon dioxide content
- Hydrocarbon components

Inputs manually programmed into the flow computers are:

- Site specific atmospheric pressure
- Contract base pressure
- Contract base temperature

SCADA outputs from the flow computer are:

- 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

Flow calculations are carried out as per the AGA standard appropriate to the metering apparatus. Calculation of super-compressibility for the purpose of flow correction is in accordance with the requirements of the *AGA Report No. 8 - Compressibility Factor of Natural Gas and Related Hydrocarbon Gases*.

All functions of the flow computer are checked using electronic test equipment. A flow calculation is performed using measured properties substituted into custom software (GOFXL 2008) and comparing the result with that from the flow computer.

For specific operating details for each meter assembly, refer to the TGPPL site specific Design Basis Manual and/or Facility Operating Principles documents.

3 GAS QUALITY

3.1 General

Gas entering the pipeline shall meet certain specifications before it is transmitted through the line. TGPPL monitors the gas quality to ensure it meets specifications via data received upstream at Longford Compressor Station and then secondly via the gas chromatograph at the Bell Bay facility.

3.2 Specifications

The Tasmanian Gas Pipeline Pty Ltd (TGPPL) Gas Transportation Agreement (GTA) *Standard Terms and Conditions* for the TGP states the acceptable gas quality limits that apply to gas to be transported. The gas condition is generally dry and clean and must meet the requirements specified in AS 4564 "Specification for General Purpose Natural Gas". Table 2 below specifies the gas quality minimum and maximum parameters recognised as an industry standard.

TGPPL 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.

TGPPL shall notify the Shipper when off-specification gas has been delivered into the TGP. Steps as outlined in the TGPPL "*Emergency Response Management Plan (NM2-002PA-ERMP)*" may be taken by TGPPL in the event that unauthorised off-specification gas has been delivered into the TGP. However, this action, nor the knowledge of the presence of off-specification gas by personnel acting on behalf of TGPPL, relieve the Shipper from its contractual obligation for providing gas meeting specifications, or liability for any consequential damage incurred by Shippers directly or indirectly due to the acceptance of off-specification gas on behalf of a Shipper.

Table 2: Gas Specification

Parameter	Units	Minimum	Maximum	Test Method
Delivery temperature	˚C	2	50	
Hydrocarbon dew point (at 3,500kPa)	˚C	-	2	C9+ GC Calculation
Oxygen	mol %	-	0.2	ISO 6974 & ISO 6975; or ASTM D1945 - 03
Water	mg/m³	-	62	ASTM D1142 - 95(2006)
Total Sulphur	mg/m³	-	50	ASTM D1072 - 06
Hydrogen Sulphide	mg/m³	-	5.7	ISO 6326
Mercaptan sulphur	mg/m³	-	5.0	ISO 6326
Higher heating value	MJ/m³	36.5	42.3	
Wobbe Index	MJ/m³	46.0	52.0	ISO 6976 ASTM D3588 - 98(2003)

3.3 On Site Analysis Equipment

Gas chromatographs provide on-site gas analysis and heating value. A natural gas sample is extracted from the flowing pipeline, transported to the analyser, processed for particle removal and phase integrity and injected onto the gas chromatograph where component separation occurs. The sample is then vented and results are stored in memory and communicated to TGPPL's SCADA system.

The resulting information consists of mole percent (%mol) values for the gas components. The following data in Table 3 is available from the Bell Bay (C9+) Gas Chromatograph:

Table 3: Bell Bay (C9+) Gas Chromatograph Data

Gas Component	Units
Methane (C1)	% mol
Ethane (C2)	% mol
Propane (C3)	% mol
N-Butane (N-C4)	% mol
I-Butane (I-C4)	% mol
Neo Butane (Neo-C4)	% mol
N-Pentane (N-C5)	% mol
I-Pentane (I-C5)	% mol
Hexane (C6)	% mol
Heptanes (C7)	% mol
Octane (C8)	% mol
Nonanes (C9+)	% mol
Nitrogen (N_2)	% mol
Carbon Dioxide (CO_2)	% mol
Hydrocarbon Dew Point (at 3,500kPa)	°C
Specific Gravity	-
Heating Value	MJ/sm^3
WOBBE Index	MJ/sm^3
Total mol	%

The gas analyser at Bell Bay Meter Station measures a C_9+ peak. Additional information is calculated from the gas composition. The basis of these calculations is ISO 6976.
Calculated values include:

- Real relative density (specific gravity)
- Heating value
- Wobbe Index
- Hydrocarbon Dewpoint

These calculated values and gas composition data are supplied to the flow computers for correcting the meter data to standard volume and energy conditions.

The gas chromatograph is checked as part of routine validations of metering equipment. Details on the Gas Chromatograph validation report can be found in Section 1.1.12 below.

3.4 Analysis Equipment by Others

Gas quality measurements are also made at the inlet to the pipeline at Longford, Victoria. Currently this equipment is operated by Jemena and data provided to the TGPPL via the SCADA system.

For the purposes of custody transfer, this equipment consists of a C9+ Gas Chromatograph providing calculated heating value data, relative density, Wobbe index, and hydrocarbon dewpoint.

Other gas quality measurement equipment is installed at the inlet to the pipeline including:

- Sulphur Analysers
- Moisture Analysers
- Oxygen Analysers.

These are also owned and operated by Jemena.

4 VALIDATION

4.1 Validation Overview

Validation is the process of ensuring the accuracy of the gas quality and energy accounting equipment. Validations are performed at each of the pipeline metering stations. The validation tests are conducted at regular intervals based on throughput as set out in Table 4 below:

Table 4: Meter Validation Schedule

Meter Type	Schedule
Ultrasonic Meters	12-weekly basis
Coriolis Meters (Including Bell Bay)	12-weekly basis

Representatives of each of the parties having a direct interest in the accounting of quantities of gas passing through a given meter are given at least 48 hours' notice in writing of the proposed date and time of the tests so that they may witness the tests. Witnesses are given the opportunity to sign report forms at the site to signify their witnessing of, and agreement with the validation result.

In the event that any or all of the invited witnesses do not attend, the test results will nevertheless be deemed to be an accurate statement of current performance and shall be accepted by all parties. One copy of each of the completed test reports will be forwarded to the relevant parties within 14 days of the test being completed. A copy of each report is filed at the TGPPL office. In the event of equipment failure, damage or accuracy drift, the Pipeline Owner TGPPL may conduct interim validations without witnesses, but shall, where possible, give prior notice to the relevant parties that an interim validation is to be undertaken.

In any case, all interested parties will receive full written details of the validation results and any adjustments made as a result of the findings, including changes to manually programmed input data in flow computers.

Any party may request that a validation be conducted between scheduled dates. In the event that the equipment is found to be within specified tolerances, the requesting party is required to pay the costs of conducting the extra validation.

Where possible, any maintenance will be done during a scheduled validation to be witnessed by all parties. Calibration of validation equipment is carried out according to the table shown in Appendix 2. Examples of validation check data can also be found in Appendix 2.

4.2 Validation Spreadsheet

An Excel spreadsheet is used to assist in the validation process. It helps to ensure that the process is consistent between different sites. Following is a list of all relevant validation forms within the spreadsheet.

- VAL 601 – Test Equipment
- VAL 602 – Ultrasonic Diagnostic Check
- VAL 603 – Pressure Transmitter Tolerance Check
- VAL 604 – Temperature Transmitter Tolerance Check
- VAL 605 – Ultrasonic Meter Flow Computer vs GOF Check
- VAL 606 – Gas Chromatograph Tolerance Check
- VAL 608 – Coriolis Meter Flow Computer Check
- VAL 609 – Data Transfer Check
- VAL 620 – Meter Comparison Check
- PROLINK Flow Meter Zero– Meter Diagnostics

Note: GOF is proprietary software (GOFXL2008) that is "called" from the spreadsheet to calculate gas flow data in accordance with the AGA standards.

1.1.7 Val 601 Test Equipment

Val 601 Test Equipment - is a register for all certified test equipment used during a Validation. At the commencement of each Validation, the model number, serial number, data of last certification and accuracy of each piece of equipment is entered onto the sheet. The sheet is then printed and signed for acceptance that the information entered is correct.
An example of Val 601 is shown in Appendix 2.

1.1.8 Val 602 Ultrasonic Diagnostic Check

Val 602 Ultrasonic Diagnostic Check - is used to assess ultrasonic meter operational status. Data accessible via a computer are used as key indicators of meter performance, and the nature of problems affecting that performance.
There are five main indicators of meter performance found on Val 602 Ultrasonic Diagnostics Check.

- Sample rate
- Velocity of sound
- Stability
- AGC Levels
- AGC Limits

Sample rate - Used to determine that all ultrasonic pulses sent by the emitting transducer are being collected by the receiving transducer. The sample rate for all ultrasonic meters is 15 Hz with a tolerance of + or – 1 Hz.

Velocity of Sound or (VOS) - is output as an average value of all pulse paths in the meter (m/s). The VOS calculated by the meter is compared against that calculated from gas quality, pressure and temperature using VOS calculated using proprietary software. This comparison is then used to determine whether there is any performance faults with the meter. A tolerance of 1.5 m/s is set for VOS comparison.

Stability - This measures the status of axial path, swirl path, flow and swirl. A value up to 4 represents correct functioning.

AGC Levels - The AGC levels or automatic gain control levels are outputs from each transducer. The ultrasonic meter relies on the transit time from when one transducer emits an ultrasonic pulse until when the receiving transmitter "hears" that pulse. Certain devices commonly used on standard meter stations such as pressure regulators can produce ultrasonic noise. In such noisy environments, gain levels increase to enable the detection of each transmitted pulse. The meter automatically adjusts the gain of each transducer to achieve optimal metering capability.

AGC Limits - AGC limits are also outputs from each transducer. The limits are adjusted automatically by the signal processing unit and are defaulted to a maximum level.
The AGC characteristics are best represented as a ratio of AGC limits to AGC levels. A ratio of 3:1 is a minimum requirement, with ratios of up to 10:1 being typical.
The information required for Val 602 Ultrasonic Diagnostic Check is obtained from the site Flow Computer List 50 and 51 Data View and is pasted into the diagnostics tab in the validation spread sheet.
If a Qsonic data link fault is present on the meter to be validated, information contained in List 50 will not be "live" data. In this instance the meter data log file is the source of the data entered into the list on the diagnostics tab.
An example of Val 602 is shown in Appendix 2.

1.1.9 Val 603 Pressure Transmitter Tolerance Check

Val 603 Pressure Transmitter Tolerance Check - is used to validate the accuracy of the pressure transmitter.

The type of pressure calibrating equipment to be used for the pressure test selected is either a dead weight tester (DWT) or an electronic pressure calibrator. If the DWT is selected, the oil temperature and hydraulic head are entered to give a corrected "required kPa".
Pressures are applied across the pressure transmitter's range in steps of 10%, 40%, 60% and 90% of site maximum pressure, as displayed on Val 603. From the flow computer, the pressures are then viewed on the relevant SCADA screen and entered into the "As Found kPa" Table.
Once all pressures are applied and entered into the "As Found kPa" Table, they are automatically compared to "required kPa" and an error shown. This error is then compared to the acceptable variance to determine whether the transmitter is within tolerance.
If the transmitter is found to be within tolerance, the "as found kPa" values are copied into the "As Left kPa" Table and the Val 603 Pressure Transmitter Tolerance Check is complete.
If the transmitter is found to be out of tolerance a transmitter calibration is carried out. Upon completion all pressures are re-applied and re-entered into the "As Left kPa" Table. It the transmitter does not calibrate correctly it will be replaced. An example of Val 603 is shown in Appendix 2.

1.1.10 Val 604 Temperature Transmitter Tolerance Check

Val 604 Temperature Transmitter Tolerance Check - is used to validate the accuracy of the temperature transmitter.
The temperature transmitter is calibrated across its range using a decade box. Different resistances are applied to simulate an RTD at different temperatures.
The temperature or resistance indicated on Val 604 is dialled on the decade box. The corresponding temperature in the flow computer is viewed on the List 50 Data View. This value is then entered into the "As Found °C" Table.
Once all temperatures are dialled and entered into the "As Found °C" Table, they are automatically compared to the "required °C" and an error shown. This error is then compared to the acceptable variance to determine whether the transmitter is within tolerance.
If the transmitter is found to be within tolerance, the "as found kPa" values are copied into the "As Left °C" Table and the Val 604 Temperature Transmitter Tolerance Check is complete.
If the transmitter is found to be out of tolerance, a transmitter calibration is required. Once completed all temperatures are again stepped through and re-entered into the As Left °C" Table on Val 604.
The transmitter is replaced if it cannot be calibrated to within tolerance.

Resistance Temperature Detector (RTD) Probes
The RTD probes are checked using a certified RTD probe, a water bath and a multimeter. Both the RTD to be validated and the NATA certified RTD are placed in the same water bath and their resistances measured. These resistances are entered into the "As Found RTD" calibration on Val 604 and the variance is automatically calculated. This variance is then compared to the variance limit to determine if the RTD is functioning correctly.
If the RTD being validated is found to be in tolerance, the results entered in the “As Found RTD” Table are copied to the “As Left RTD” Table and the RTD calibration is complete.
If the RTD being validated is found to be out of tolerance, then the RTD is replaced and a new RTD compared to the NATA certified RTD in the water bath. The resistance of the new RTD and NATA certified RTD are entered into the “As Left RTD” Table.
An example of Val 604 is shown in Appendix 2.

1.1.11 Val 605 Ultrasonic Meter Flow Computer vs GOF Check

Val 605 Ultrasonic Meter Flow Computer vs GOF Check - is used to determine if the flow computer is correctly calculating the actual and standard flow accumulators, energy flow accumulators and the super-compressibility (Fpv). The check also confirms that the correct number of pulses is being recorded.
At the commencement of the check via the flow computer data view, list 50 is placed in “Forval” (forward validation) mode and the pressure and temperature control inhibited to insure constant values are retained for the entire check. The pulse generator is also connected to the pulse input line of the flow computer. A copy of list 50 is then taken and pasted into the “Start Accum” tab in the validation spread sheet.
Once the data has been copied into the “Start Accum” tab successfully, pulses are injected into the flow computer from the pulse generator to simulate pulses from a meter. Once the pulse injection is complete, another copy of list 50 is taken from the flow computer and pasted into the “End Accum” tab in the validation spread sheet.
The number of pulses injected into the flow computer is entered in the pulses cell on Val-605 and the actual, standard and energy flow rates along with the FPV is then automatically calculated.
These calculated values are compared to the flow computers calculated values and a percentage variance determined.
This variance is then compared to the allowable variance as indicated on Val 605 of the validation spread sheet.
An example of Val 605 is shown in Appendix 2.

1.1.12 Val 606 Gas Chromatograph Tolerance Check

Val 606 Gas Chromatograph Tolerance Check - is used to determine the gas chromatograph's operational status.
Firstly the gas chromatograph serial number is selected on Val 606 along with the calibration bottle to be used for the validation. Once these two parameters have been selected, the calibration bottle gas composite mole percentages are automatically entered into the certified mole % column of Val 606.
Using proprietary software the gas stream is changed from line gas to calibration gas and let run for three cycles to ensure all line gas is purged from the system.
Once the three cycles are complete, the report data is taken from the third cycle and pasted into the GC_AF tab in the validation spread sheet. The data from the GC_AF tab automatically updates to Val 606 and is compared to the calibration bottles certified known SG, HV and compressibility to give a total variance.
The variance is then compared to the allowable tolerance to determine if the GC readings are within the set tolerances.
If the SG, HV and compressibility are found to be within tolerance, the data pasted into the GC_AF tab is copied into the GC_AL tab in the validation spread sheet and the Val 606 GC validation is complete.
If the GC is found to be out of tolerance, then a calibration is required. Once the calibration is complete, a copy of the results page is taken and pasted into the GC_AL tab in the validation spread sheet.
An example of Val 606 is shown in Appendix 2.

1.1.13 Val 608 Coriolis Meter Flow Computer Check

Val 608 Coriolis Meter Flow Computer vs GOF Check - is used to determine if the FC is calculating the correct accumulators for mass, standard flow rate and energy flow rate. The check also confirms that the correct number of pulses is being recorded.
At the commencement of the check (via the FC data view), update of the SG and HV are control inhibited to ensure constant values are retained for the entire check(Ultrasonic meters only).
A pulse generator is connected to the pulse input line of the FC. A copy of the validation data is then exported from the SCADA system using the validation function.
Once the data has been copied into the "Start Accum" tab successfully, pulses are injected into the FC from the pulse generator to simulate pulses from a meter. Once the pulse injection is complete, another copy of the validation data is taken from the SCADA system and pasted into the "End Accum" tab in the validation spread sheet.
The number of pulses injected into the FC is then entered in the pulses cell on Val 608 and the calculated mass, standard and energy flow accumulators are automatically calculated.
These calculated values are compared to the FC calculated values and a percentage variance determined.
This variance is then compared to the allowable variance as indicated on Val 607 of the validation spread sheet.
An example of Val 608 is shown in Appendix 2

1.1.14 Val 620 Meter Comparison Check

Val 620 Meter Comparison Check - is used to determine the variance in standard flow rate over a set period of time between two meters. This check can only be carried out on sites where series flow through two meters occurs.
From the SCADA system, a snapshot of flow accumulation taken from just after the daily accumulator test is copied and pasted into the "Start Flow Comp" tab in the validation spread sheet.
Then the same step is completed in the same accumulation period just before the accumulators reset. This snapshot is copied and pasted into the "End Flow Comp" tab in the validation spread sheet.
The data from the two tabs is then entered into Val 620.

Once entered the variance between the two meters is automatically calculated and is then compared to the acceptable variance between the two meters.
An example of Val 620 is shown in Appendix 2.

Val 609 Data Transfer Check - is used to determine if the data that is constantly being transferred to and from meter stations is being done correctly.
Firstly the type of Gas Chromatograph must be selected using the selection box on Val 620. The selection box can also be used for sites that have no GC.

Sites with Ultrasonic Meters Only:
If a gas chromatograph is on site then a data transfer from GC to Flow Computer to SCADA system check is conducted. This check comprises three steps:
Data from GC. This is copied from and pasted into the GC Data Tab in the validation spread sheet. This data automatically updates to Val 620.
Data from FC. This data is copied via the FC data view list 50. Once copied, the data is pasted in the FC list 50 data trans tab in the validation spread sheet. This data automatically updates to Val 620.
Data from SCADA. This data is copied from the GC data page for the validation site. Once copied, the data is pasted into the SCADA GC data trans tab in the validation spread sheet. The data from the SCADA GC data trans is then entered by hand into Val 620.
The variance between the three data down loads is automatically calculated and compared to the tolerance to insure correct operational status.

PROLINK Flow Meter Zero– Meter Diagnostics
Utilising Prolink Software the flow meter live zero reading and diagnostic values can be evaluated to verify if the meter requires a field zero performed or not.
Note: The live zero value is not affected by the low flow cutoff values used on each flow meter. The flow meter zero is verified by shutting in the upstream and downstream valves so that there can be no gas flow through the meter as the live zero value is being verified within Prolink software. A screen shot of the results of the live zero value is taken and pasted into the As Found validation page and if the values are within tolerance this is also pasted into the As Left validation page, if they are not within tolerance a re-zero is performed and the final results pasted into the As Left Validation page.

An example of the screen shot is shown in Appendix 2.

5 REFERENCE AND LOCAL CONDITIONS

5.1 Reference Conditions

In order to be able to equate flows at differing pressures and temperatures, a common reference needs to be established. Defining the base conditions and converting all volumes to these "standard conditions" achieves this. The Australian standard reference conditions for natural gas (AS ISO 13443) are:

- Reference Temperature = 15˚C (288.15 K)
- Reference Pressure = 101.325 kPa (abs)

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".

1.1.15 Local Gravitational Acceleration

Local gravitational acceleration at each site is calculated in accordance with Equation 3-A-10 of AGA Report No. 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids (1992).
The local gravity is dependent on the latitude and elevation of the site. For basic calculations the standard acceleration due to gravity (g) is 9.80665 m/s^2.

1.1.16 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.

$$P\ local = 101.325 - \frac{(h^{*}\ density\ air \times g)}{1000}$$

h = elevation (m)
density air = 1.22541 kg/m^3 (15 ˚C, 101.325 kPa abs)
g = 9.80665 m/s^{-2}

All local reference conditions are listed in Table 5 below.

Table 5: Local Reference Conditions

Site	Latitude (˚)	Longitude (˚)	Elevation (m)	Local Gravity (m/s^2).	Local Atmospheric Pressure (kPa)
Bell Bay	41.1428014054	146.902223264	7.22	9.803215	101.238
Comalco	41.1298086266	146.886859047	39.70	9.803103	100.848
Bridgewater	42.7201476603	147.228691112	63.00	9.804428	100.568
Port Latta	40.8580087536	145.379827047	14.40	9.802943	101.152

Appendix A Validation Check Data & Tolerances

Validation Check Type	Tolerance
VAL 602 & 608 – Ultrasonic Meter Check	
Complete Test:	
Gross Flow, deviation compared to other calibrated Meter	+/- 1.0%
Sample Rate	15 +/-1
Velocity of Sound	+/- 1.50 m/s
Automatic Gain Control (AGC) Level	AGC Limit to Level ratio >2
Automatic Gain Control (AGC) Limit	>40000
VAL 603 - Line Pressure Check	
Partial Test: (single point)	
Transmitter Range: 16000 kPa	16 kPa
Transmitter Range: 10000 kPa	10 kPa
Full Test:	
Flow Computer Tolerance (0.01% of input range):	0.1%
VAL 604 - Temperature	
Partial Test: (single point)	
Transmitter Tolerance:	0.5C
Full Test:	
Total Display Tolerance	0.2C
Point Test:	
RTD Comparison	0.08C
VAL 605 - Flow Computer	
Total Computational Accuracy:	+/- 0.10%
VAL 606 - Gas Chromatograph	
GC – FC DAC Accuracy:	0.02%
VAL 608 - Coriolis Meter	
Flow Computer Computation Accuracy	+/- 0.10%
VAL 609– Data transfer check	
Data transfer	0.000%
VAL 620 – Meter comparison	
Ultrasonic and Coriolis Meters	0.8%

FLOW COMPUTER TOLERANCES

The basis of the accuracy limits is shown below for the different segments of the flow computer.

Analogue Inputs

Analogue to digital conversion:	± 0.02% of span
Test voltmeter (DC Range)	± 0.02% of reading
Precision 10 ohm resistor	± 0.02%
Total analogue input limit	± 0.06% of span

The exception to the above calculation is the temperature (resistance), where:

Resist to digital conversion	± 0.1% of span
Total resistance box	± 0.02%
Total temperature limit	± 0.12% of span
Computation tolerance	± 0.05%

The flow computer accuracy is added arithmetically to the above limits for the purpose of determining an acceptable instantaneous error limit. Note that if the check computation is based on a flow compute displayed value, the only allowable error limit is the flow computer's computation accuracy.

Appendix B Validation Reports

Note:
Examples in this manual are closely indicative of the forms and reports that are generated for TGP validations.

Val 601 - Test Equipment

VALIDATION CERTIFICATE

Form No: Val 601

TEST EQUIPMENT Date : 07/04/2017

CERTIFIED TEST EQUIPMENT

	Model No.	Serial No.	Tested	Accuracy
Druck Calibrator	Genii	4007114	26/12/16	0.5hz
Druck Calibrator	DPI620	3688222	3/08/16	0.5hz
Thermometer	AMA	1476802	6/11/14	+0.04deg.C
Thermometer	AMA	1476823	6/11/14	+0.04deg.C
Decade Box	Beamex RTS24	5008	15/12/16	0.03deg.C
Dead Weight Tester	Budenburg	580/27544	22/12/14	0.25%
RTD PT100 Probe	ECEFAST	N2711	27/09/16	0.03deg.C

Remarks:

	Signature	Name	Company	Date
Tested By:		R Williams	Zinfra	07/04/2017
Witnessed By:		None		
Checked By:		J Harriss	Zinfra	7-4-17

Val 602 Ultrasonic Diagnostics

Tasmania Gas Pipeline

VALIDATION CERTIFICATE

Form No: Val 602

Bell Bay FY4150

RTU No : 108

ULTRASONIC METER DIAGNOSTICS

Date : 06-04-17

Meter Serial No: 01-371-Q308098
Electronics Part No./Se 1344
Atmos Pressure: 101.24 kPa
Transducers (1) 4810/4826 (2) 4821/4834 (3) 4742/4865

K Factor (pulses/m^3)		VOS (meter) (m/s)	431.63
Pulse Frequency (pulses/sec)		VOS (theoritical) (m/s)	431.77
Temperature (degC)			
Pressure (kPag)			

DIAGNOSTICS RESULTS

DIAGNOSTICS	*READING*	*LIMITS*	*STATUS*
Sample Rate	14	15 +/- 1	ok
Sound Velocity	431.63	+ or - 1.5 m/s	in limit
Stability	1.00	1,2,3&4	ok

	AGC Limit	AGC Level	*LIMITS*	*STATUS*
AGC Level 1A	65025.00	7140.00	Limit/level>2	ok
AGC Level 1B	65025.00	9180.00	Limit/level>2	ok
AGC Level 2A	65025.00	5125.00	Limit/level>2	ok
AGC Level 2B	65025.00	4800.00	Limit/level>2	ok
AGC Level 3A	65025.00	6885.00	Limit/level>2	ok
AGC Level 3B	65025.00	6885.00	Limit/level>2	ok

Note: Sound Velocity calculated using Sonicware & Gas Quality taken at same time of V.O.S reading from meter
Attached Log File Identification:
Remarks:

	Signature	*Name*	*Company*	*Date*
Tested By:	[signature]	R Williams	Zinfra	06-04-17
Witnessed By:		None present		
Checked By:	[signature]	J Harriss	Zinfra	20-4-17

Rev 20 Date 21/11/14

Val 603 - Pressure Transmitter

VALIDATION CERTIFICATE Form No: Val 603

Launceston FY6404 RTU No : 156

PRESSURE TRANSMITTER Date : 07/04/2017

Tag No. 627-PIT-6405
Transmitter Serial No 42804062103001
Pressure. Range 0 - 12000 (kPa)

Test Equipment Budenburg DWT Ser.No. 580/27544

Local Gravity (m/s^2) 9.803100 m/s^2
Std. Gravity (m/s^2) 9.806650 m/s^2
Local Temperature 19 °C
Local Head Height 0.10 m

FULL CALIBRATION

Acceptable Variance 0.03 mA 12.00 kPa

As Found

Nominal kPa	Required kPa	Required mA		kPa		Error kPa
2500.00	**2498.28**	7.331		2497.70		-0.58
5000.00	**4997.33**	10.663		4996.10		-1.23
10000.00	**9995.24**	17.327		9995.90		0.66
12000.00	**11994.33**	19.992		11992.50		-1.83

As Left

Nominal kPa	Applied kPa	Required mA		kPa		Error kPa
2500.00	**2498.28**	7.331		2497.70		-0.58
5000.00	**4997.33**	10.663		4996.10		-1.23
10000.00	**9995.24**	17.327		9995.90		0.66
12000.00	**11994.33**	19.992		11992.50		-1.83

As found kPa within tolerance

As left kPa within tolerance

Remarks:

	Signature	Name	Company	Date
Tested By:	[signature]	R Williams	Zinfra	07/04/2017
Witnessed By:		None		
Checked By:	[signature]	J Harriss	Zinfra	7-4-17

VAL 604 – TEMPERATURE TRANSMITTER

Tasmania Gas Pipeline

VALIDATION CERTIFICATE

Form No: Val 604

Bell Bay FY4150

RTU No : 108

TEMPERATURE TRANSMITTER

Date : 06-04-17

Transmitter Serial no./Tag No. "B056257137 / 615-TIT-3103 Range: degC 0 - 50

PARTIAL CALIBRATION

Thermometer (C)	n/a				
Flow Computer (C)	n/a	*Variance (C)*	0.0	*Limit (C)*	0.5

FULL CALIBRATION: Resistance Device

Acceptable Variance (C) 0.10

Required		*Flow Computer (C)*		*Variance (C)*	
Ohms	*C*	*As Found*	*As Left*	*As Found*	*As Left*
100.00	**0**	-0.005	-0.005	-0.01	-0.01
103.97	**10**	9.988	9.988	-0.01	-0.01
107.93	**20**	19.981	19.981	-0.02	-0.02
111.88	**30**	29.945	29.945	-0.05	-0.05
119.73	**50**	49.991	49.991	-0.01	-0.01

RTD CALIBRATION:

Variance Limit : 0.08ohm

As Found			*As Left*		
Certified RTD	*RTD reading*	*Variance*	*Certified RTD*	*RTD reading*	*Variance*
		0.00			0.00

Remarks:

	Signature	*Name*	*Company*	*Date*
Tested By:		R Williams	Zinfra	06-04-17
Witnessed By:		None present		
Checked By:		J Harriss	Zinfra	20-4-17

Rev 20 Date 21/11/14

Val 605 - Ultrasonic Meter Flow Computer vs GOF

Tasmania Gas Pipeline

VALIDATION CERTIFICATE

Form No: Val 605

Bell Bay FY4150

RTU No : 108

ULTRASONIC METER FC V's GOF

Date : 06-04-17

Meter Serial No: 01-371-Q308098
Electronics Part No./Serial No. 1344 Atmospheric Pressure: 101.24 kPa
Transducers (1) 4810/4826 (2) 4821/4834 (3) 4742/4865

K Factor (pulses/m^3)	4237.7600	Base Pressure kPa	101.325
Pulses	600000.00	Base Temperature C	15.00
Flowing Temperature (C)	39.52	Density dry air kg/scm	1.2255
Flowing Pressure (kPag)	4485.09		
Nitrogen	0.8360	Neo-Pentane	0.0000
Carbon Dioxide	1.1800	I-Pentane	0.0100
Methane	92.8410	N-Pentane	0.0050
Ethane	4.4360	Hexane	0.0080
Propane	0.6280	Heptane	0.0010
I-Butane	0.0270	Octane	0.0020
N-Butane	0.0280	Nonane	0.0020
Specific Gravity	0.5990		
GHV (MJ/scm)	38.7380		

RESULTS

VARIABLE	CALCULATED	FLOW COMP.	VARIANCE %
Start Actual Flow		891243.2500	
End Actual Flow		891384.7500	
Actual Flow m3	141.5842	141.5000	-0.06
Start corrected Flow		85072752.0000	
End correctedFlow		85079104.0000	
Corrected Flow scm	6353.2576	6352.0000	-0.02
Energy Flow GJ	246.11	246.062	-0.02
Fpv	1.04	1.037	-0.02
	Allowable Variance	0.10 %	

REMARKS:

	Signature	Name	Company	Date
Tested By:	[signature]	R Williams	Zinfra	06-04-17
Witnessed By:		None present		
Checked By:	[signature]	J Harriss	Zinfra	20-4-17

Rev 20 Date 21/11/14

SAMPLE

Val 606 - Gas Chromatograph

VALIDATION CERTIFICATE

Form No: Val 606

GAS CHROMATOGRAPH COMPOSITION ANALYSIS

Serial No: **GAS CHROMATOGRAPH** Date : 07/04/2017

Calibration Gas Cylinder No. QS11566 Certification Date. 29/10/2015

Component	*Certified Mole%*	*GC Mole%*	*Variance Mole%*
Propane	1.002	1.002	0.000
iso-Butane	0.300	0.300	0.000
Butane	0.300	0.300	0.000
neo-Pentane	0.100	0.100	0.000
iso-Pentane	0.100	0.100	0.000
Pentane	0.100	0.100	0.000
Nitrogen	2.497	2.497	0.000
Methane	89.489	89.489	0.000
Carbon Dioxide	1.001	1.001	0.000
Ethane	5.000	5.000	0.000
Hexane	0.060	0.060	0.000
Heptane	0.020	0.020	0.000
Octane	0.020	0.020	0.000
Nonane	0.010	0.010	0.000
Total	100	100	

CHROMATOGRAPH CONTROLLER CALCULATION TEST

	Allowable Tollerance	Calculated from Cal Bot	*GC*	*Variance*
Comp. (Z)	0.0001	0.9976	0.9976	0.0000
SG	0.0005	0.6267	0.6267	0.0000
GHV (MJ/m3)	0.020	39.482	39.482	0.001

Compressibility in tolerence.
SG in tolerence
GHV in tolerence.

Remarks:

	Signature	*Name*	*Company*	*Date*
Tested By:	R.Will	R Williams	Zinfra	07/04/2017
Witnessed By:		None		
Checked By:	[signature]	J Harriss	Zinfra	7-4-17

Val 608 - Coriolis Meter Flow Computer vs GOF

VALIDATION CERTIFICATE Form No: Val 608

Launceston FY6404 RTU No : 156

CORIOLIS METER FC V's GOF Date : 07/04/2017

Meter Serial No: 14410460 Atmospheric Pressure: 99.57 kPa
Flow Computer 156

K Factor (pulses/kg)	1600.0000	Base Pressure kPa	101.325
Pulses	300000	Base Temperature C	15.00
Specific Gravity	0.6117	Density dry air kg/scm	1.2255
GHV (MJ/scm)	39.4238129		

RESULTS

VARIABLE	*CALCULATED*	*FLOW COMP.*	*VARIANCE*
mass kg	187.5000	187.5000	0.00%
Corrected Flow scm	250.1245	250.1429	-0.01%
Energy Flow MJ	9.8609	9.8616	-0.01%

0.10% Allowable Variance

REMARKS:

	Signature	*Name*	*Company*	*Date*
Tested By:	[signature]	R Williams	Zinfra	07/04/2017
Witnessed By:		None		
Checked By:	[signature]	J Harriss	Zinfra	7-4-17

Val 609 - Data Transfer

Tasmania Gas Pipeline

VALIDATION CERTIFICATE

Form No: Val 609

Bell Bay FY4150

RTU No : 108

DATA TRANSFER TEST

Type of GC: Bell Bay GC - 6420

date: 06-04-17

GC Tag No.: GC-6420

Flow Computer tag No.: FY-4150

	GC to FC to SCADA			GC to FC	FC to SCADA
(Mole %)	GC	FLOW COMPUTER	SCADA	Variance	Variance
Nitrogen	0.8790	0.8790	0.8790	0.0000	0.0000
C'Dioxide	1.0190	1.0190	1.0190	0.0000	0.0000
Methane	93.4040	93.4040	93.4040	0.0000	0.0000
Ethane	4.2300	4.2300	4.2300	0.0000	0.0000
Propane	0.4040	0.4040	0.4040	0.0000	0.0000
I-Butane	0.0240	0.0240	0.0240	0.0000	0.0000
n-Butane	0.0250	0.0250	0.0250	0.0000	0.0000
neo-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000
I-Pentane	0.0070	0.0070	0.0070	0.0000	0.0000
N-Pentane	0.0030	0.0030	0.0030	0.0000	0.0000
Hexane	0.0050	0.0050	0.0050	0.0000	0.0000
Heptane	0.0010	0.0010	0.0010	0.0000	0.0000
Octane	0.0010	0.0010	0.0010	0.0000	0.0000
Nonane	0.0020	0.0020	0.0020	0.0000	0.0000
Total	100.0040	100.0040	100.0040		
SG	n/a	n/a	n/a	0.0000	0.0000
GHV (MJ/scm)	n/a	n/a	n/a	0.0000	0.0000

Tolerance = 0.000

CORIOLIS SITES DATA TRANSFER TEST :

Tolerance = 0.000

	SCADA	FLOW COMPUTER	Variance
SG		n/a	0.000
GHV (MJ/scm)		n/a	0.000

Remarks:

	Signature	Name	Company	Date
Tested By:	[signature]	R Williams	Zinfra	06-04-17
Witnessed By:		None present		
Checked By:	[signature]	J Harriss	Zinfra	20-4-17

Rev 20 Date 21/11/14

Val 620 – Series Meter Comparison

VALIDATION CERTIFICATE Form No: Val 620

Launceston FY6404 RTU No : 156

SERIES METER COMPARISON Date : 07/04/2017

	START		END		Flow
	date	time	date	time	
	06/04/2017	06:36			
Vol Accum Run 1	94.30		25,480.24		25,385.94
Vol Accum Run 2	94.36		25,524.31		25,429.95
				Variance %	0.17

Variance

Acceptable Variance: 0.80 %

SAMPLE

Meter flow comparison within tolerance

Remarks:

	Signature	Name	Company	Date
Tested By:	[signature]	R Williams	Zinfra	07/04/2017
Witnessed By:		None		
Checked By:	[signature]	J Harriss	Zinfra	7-4-17

Meter Diagnostics – As Found

Prolink flow meter zero AS FOUND: Launceston FY6404 07/04/2017