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- Via ECMS | Manager Gas Transmission
- Via ECMS | Asset Manager Metering

**Summary of Revisions:**

| REV. 15 | - Change of billing period definition to gas day, and general review.  
|         |   - Change of document number                                    |
| REV. 14 | - Formatting                                                       
|         |   - Updating information on WBH fuel gas meters:                  
|         |     - Mila CS WBH USM meter.                                       
|         |     - Vic Hub WBH meter.                                           |
| REV. 13 | - Update the current Eastern Gas Pipeline Map                     
|         |   - Update Smithfield and Hoskinstown with new details            
|         |   - Delete Bombala from Table 4 “Frequency of Validations” as it is not validated by Jemena  
|         |     - Add meter’s capacity to Table 1                              |
| REV. 12 | - Add Wilton Metering Station & Michelago Compressor Station      
|         |   - Add a fuel gas meter table                                     
<p>|         |   - Review the Procedures                                          |</p>
<table>
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| **REV. 11** | - Management of Validation activities if not performed on time.  
- The requirements to manage activities if not performed on time. |
| **REV. 10** | - Specify HART communications as the preferred communications to transmitters used for fiscal metering. |
| **REV. 9** | - Statements of compliance of the Jemena measurement equipment with the requirements of National Greenhouse and Energy Reporting (Measurement) Determination 2008 included.  
- Reference to the Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement added with regard to the measurement uncertainties in the Jemena gas custody transfer scheme.  
- Requirements for calibration of the validation equipment added.  
- The appendixes, i.e. the general validation procedures and validation report example deleted, a re-drafted set of general validation procedures added. |
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1 SCOPE AND GENERAL

1.1 Scope

This manual is to provide a technical reference for the operation and maintenance of the Jemena gas measurement and monitoring systems on the Eastern Gas Pipeline.

A typical gas measurement system consists of 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

This 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 GT Control. This manual is not intended to provide specific details of Gas Sales Contract terms and conditions.

The Manual includes:

- 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.

1.2 Application

JEMENA is the measurement authority for the EGP.

The scope of the manual applies to all JEMENA operated custody transfer facilities on the Eastern Gas Pipeline extending from the receipt facility at Longford to delivery facilities along the pipeline route and in Wollongong and Sydney. Map 1 and Table 1 provide an overview of the measurement facilities maintained on the Eastern Gas Pipeline at the time of issue of this Manual.

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

The inspection and testing procedures for independently owned and operated measurement facilities on the EGP are not addressed in this manual.
<table>
<thead>
<tr>
<th>Location</th>
<th>Status</th>
<th>Meter Assembly</th>
<th>Meter Runs</th>
<th>Meter Diameter mm</th>
<th>Pressure Range kPa</th>
<th>Meter Capacity SCMH@Min. Pressure</th>
<th>Flow Computer</th>
<th>Temp. Transducer</th>
<th>Pressure Transducer</th>
<th>SCADA Moisture Analyser</th>
<th>GC</th>
<th>Sulphur Analyser</th>
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<td>Longford Suction</td>
<td></td>
<td>Ultrasonic</td>
<td>Single</td>
<td>400</td>
<td>5,400-7,000</td>
<td>651,526</td>
<td>√</td>
<td>√</td>
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<td>√</td>
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<td>√</td>
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<td>√</td>
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<td>√</td>
<td>√</td>
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<td>10,000-14,000</td>
<td>30,000</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
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<td>25</td>
<td>10,000-14,000</td>
<td>4,000</td>
<td>√</td>
<td></td>
<td>√</td>
<td>√</td>
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<td>√</td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
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<tr>
<td>Nowra</td>
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<td>Coriolis</td>
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<td>25</td>
<td>8,000-14,800</td>
<td>11,800</td>
<td>√</td>
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<td>51,970</td>
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<td>Dual</td>
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<td>80,000</td>
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<td>3,800-14,895</td>
<td>38,503</td>
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<td>Ultrasonic</td>
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<td>200</td>
<td>95,500</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
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<td>Ultrasonic</td>
<td>Dual</td>
<td>200</td>
<td>6,000</td>
<td>181,218</td>
<td>√</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>Ultrasonic</td>
<td>Dual</td>
<td>150</td>
<td>1,750-3,700</td>
<td>45,677</td>
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### Table 1: Eastern Gas Pipeline Metering Facilities

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<th>Flow_rate</th>
<th>Capacity</th>
<th>Calibration Status</th>
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<tr>
<td>Wilton(APA)</td>
<td>Ultrasonic</td>
<td>Dual</td>
<td>200</td>
<td>6,000-12,000</td>
</tr>
<tr>
<td>Wilton(JGN)</td>
<td>Ultrasonic</td>
<td>Dual</td>
<td>200</td>
<td>6,000-12,000</td>
</tr>
<tr>
<td>Michelago</td>
<td>Ultrasonic</td>
<td>Single</td>
<td>400</td>
<td>5,200-14,895</td>
</tr>
</tbody>
</table>

Note 1 – Meter not owned and not validated by Jemena.

Note 2 – Meter owned by Jemena Gas Networks.
Jemena Eastern Gas Pipeline Map
1.3 Terminology and Definitions

1.3.1 TERMINOLOGY

Unless otherwise stated, all units and terminology used are in accordance with:

- Australian Standard AS ISO 1000-1998 “The International System of Units (The SI System) and Its Application” and regulations thereunder
- Commonwealth “Weights and Measures (National Standards) Amendment Act 1984 including Regulations
- Australian Gas Association publication “Metric Units and Conversion Factors for use in the Australian Gas Industry”

To ensure the technical integrity of various standards and software sourced internationally, conversion factors commonly used and accepted in the Australian gas pipeline industry are used.

1.3.2 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bairnsdale BPP</td>
<td>Meter Station located at the Bairnsdale Power Station.</td>
</tr>
<tr>
<td>Bairnsdale CG</td>
<td>Meter Station located at the Bairnsdale City Gate.</td>
</tr>
<tr>
<td>Bomaderry</td>
<td>The Sales Offtake located in the Bomaderry MLV site.</td>
</tr>
<tr>
<td>Calibration Gas</td>
<td>The gas used by a Gas Chromatograph to calibrate against known mole percentage values</td>
</tr>
<tr>
<td>GT Control</td>
<td>Gas Transmission Control</td>
</tr>
<tr>
<td>Check gas</td>
<td>The gas with a known concentration of H2S used to check that the flame in the Sulphur Gas Chromatograph flame is alight</td>
</tr>
<tr>
<td>Contract(s)</td>
<td>The various agreements for the transport of gas via the Eastern Gas Pipeline.</td>
</tr>
<tr>
<td>Control</td>
<td>Is 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 Shippers.</td>
</tr>
<tr>
<td>Cooma</td>
<td>Meter Station located at the Cooma.</td>
</tr>
<tr>
<td>Custody Transfer</td>
<td>Is the transfer of responsibility for the care and keeping of the gas.</td>
</tr>
<tr>
<td>Delivered</td>
<td>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 JEMENA to the relevant Shipper.</td>
</tr>
<tr>
<td>ECMS</td>
<td>Enterprise Content Management System</td>
</tr>
<tr>
<td>Energy</td>
<td>The volume of gas in standard cubic metres multiplied by the Gross Heating Value (GHV). Standard units are Gigajoules (GJ).</td>
</tr>
<tr>
<td>Energy Accounting</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Gas</strong></td>
<td>Shall mean 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.</td>
</tr>
<tr>
<td><strong>Gas Day</strong></td>
<td>Is the Gas day starting at 6am AEST and ending 24 consecutive hours later at 6am AEST.</td>
</tr>
<tr>
<td><strong>Gas Used</strong></td>
<td>The amount of gas calculated by JEMENA to have been consumed by JEMENA in normal pipeline operations such as fuel for compressors, heaters, venting and instrument gas consumption.</td>
</tr>
<tr>
<td><strong>Gigajoule (GJ)</strong></td>
<td>Equal to $10^9$ Joules.</td>
</tr>
<tr>
<td><strong>Gross Heating Value (GHV)</strong></td>
<td>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).</td>
</tr>
<tr>
<td><strong>Imbalance</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Input Quantity</strong></td>
<td>The total of all gas received into the pipeline for a given Gas Day, as measured by the inlet meters.</td>
</tr>
<tr>
<td><strong>ISO 6976</strong></td>
<td>Natural Gas calculation of Calorific values, density, relative density, and Wobbe index from Composition.</td>
</tr>
<tr>
<td><strong>JEMENA Owned Gas</strong></td>
<td>The quantity (in GJ) of gas in the pipeline equal to the sum of line-pack and imbalance.</td>
</tr>
<tr>
<td><strong>JGN</strong></td>
<td>Jemena Gas Network</td>
</tr>
<tr>
<td><strong>Joule</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>HART</strong></td>
<td>The HART Communications Protocol (Highway Addressable Remote Transducer Protocol) a digital industrial automation protocol.</td>
</tr>
<tr>
<td><strong>Horsley Park</strong></td>
<td>The facility, at the termination of the main section of the pipeline at Horsley Park.</td>
</tr>
<tr>
<td><strong>Hoskinstown</strong></td>
<td>The facility providing metering and pressure reduction for the lateral supplying gas to Canberra.</td>
</tr>
<tr>
<td><strong>Kilopascal (kPa)</strong></td>
<td>Is 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”. This means that the gauge reads zero at atmospheric pressure.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Linepack</td>
<td>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).</td>
</tr>
<tr>
<td>Longford Compressor Station Suction/TGP/EGP</td>
<td>The compressor station facility, constructed by the pipeline owner at the beginning of the main section of the pipeline at Longford.</td>
</tr>
<tr>
<td>Measurement Authority</td>
<td>Is the Pipeline Owner.</td>
</tr>
<tr>
<td>Measuring Equipment</td>
<td>Includes but is not limited to the pipeline owner’s meters, temperature and pressure transmitters, flow computers and gas chromatographs.</td>
</tr>
<tr>
<td>Megajoule (MJ)</td>
<td>$10^6$ Joules.</td>
</tr>
<tr>
<td>Month</td>
<td>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.</td>
</tr>
<tr>
<td>Nowra</td>
<td>Refers to the Sales Offtake located in the Nowra MLV Site.</td>
</tr>
<tr>
<td>Orbost</td>
<td>Meter Station located at the Orbost.</td>
</tr>
<tr>
<td>Off-specification Gas</td>
<td>Gas other than Sales Specification Gas.</td>
</tr>
<tr>
<td>Output Quantity</td>
<td>The total amount of gas delivered by the pipeline in a given period as measured by the meters at pipeline outlet locations.</td>
</tr>
<tr>
<td>Petajoule (PJ)</td>
<td>$10^{15}$ joules.</td>
</tr>
<tr>
<td>Pipeline</td>
<td>The pipeline licensed under Victorian Pipeline Licence No. 232 and NSW Pipeline Licence No. 26 pursuant to the Petroleum Act.</td>
</tr>
<tr>
<td>Pipeline Controller</td>
<td>An employee of JEMENA working at the GT Control Room.</td>
</tr>
<tr>
<td>Pipeline Inlet</td>
<td>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.</td>
</tr>
<tr>
<td>Pipeline Outlet</td>
<td>The location 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.</td>
</tr>
<tr>
<td>Pipeline Owner</td>
<td>JEMENA.</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>The facility, at the termination of the Lateral section of the pipeline at Port Kembla.</td>
</tr>
<tr>
<td>Quantity</td>
<td>The quantity of gas measured in terms of its energy content.</td>
</tr>
<tr>
<td>Received</td>
<td>Refers to gas having passed the inlet delivery point specified in the relevant contract as the point of custody transfer from the supplier to JEMENA.</td>
</tr>
<tr>
<td>Reconciliation</td>
<td>The process through which JEMENA conducts an energy balance at the end of each Gas Day, and allocates any System Use Gas in an agreed manner.</td>
</tr>
<tr>
<td><strong>Sales Specification Gas</strong></td>
<td>Gas that meets all of the agreed requirements for content and properties.</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>SCADA</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Shipper</strong></td>
<td>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).</td>
</tr>
<tr>
<td><strong>Smithfield</strong></td>
<td>The Meter station located in the boundary of the operating company of Marubeni Energy.</td>
</tr>
<tr>
<td><strong>Specific Gravity</strong></td>
<td>The density of dry gas divided by the density of dry air, both at 15 C and at a pressure of 101.325 kPa.</td>
</tr>
<tr>
<td><strong>Speed of Sound</strong></td>
<td>The speed of sound for a particular gas composition.</td>
</tr>
<tr>
<td><strong>Standard Cubic Metre of Gas</strong></td>
<td>The unit of volume of gas free from water vapour which would occupy a volume of one (1) cubic metre at a temperature of 15 degrees Celsius and an absolute pressure of 101.325 kilopascals.</td>
</tr>
<tr>
<td><strong>Standard Measurement Conditions</strong></td>
<td>Defined as 101.325 kPa and 15 C</td>
</tr>
<tr>
<td><strong>Super compressibility</strong></td>
<td>A factor expressing a deviation of a gas from perfect gas laws.</td>
</tr>
<tr>
<td><strong>Supplier</strong></td>
<td>The party contracted by a shipper to supply gas at any of the pipeline inlets for transport in the Eastern Gas Pipeline.</td>
</tr>
<tr>
<td><strong>System Use Gas</strong></td>
<td>The quantity of gas used in the operation of the pipeline, including, fuel gas and lost or unaccounted for gas.</td>
</tr>
<tr>
<td><strong>Tallawarra</strong></td>
<td>Meter Station located at the Tallawarra, Power Station and Injection point.</td>
</tr>
<tr>
<td><strong>Terajoule</strong></td>
<td>$10^{12}$ joules.</td>
</tr>
<tr>
<td><strong>Validation or Verification</strong></td>
<td>The process of periodically checking and servicing the measurement equipment to ensure that it continues to function within agreed levels of accuracy.</td>
</tr>
<tr>
<td><strong>Wilton(APA)</strong></td>
<td>Wilton Meter Station measuring gas from EGP to APA</td>
</tr>
<tr>
<td><strong>Wilton(JGN)</strong></td>
<td>Wilton Meter Station measuring gas from EGP to JGN</td>
</tr>
<tr>
<td><strong>Wobbe Index</strong></td>
<td>The calorific value of the gas on a volumetric basis, at specified reference conditions, divided by the square root of the relative density of the gas at the same specified metering reference conditions.</td>
</tr>
</tbody>
</table>

1.3.3 **REFERENCE DOCUMENTS**

1.3.3.1 **Measurement Standards:**

1. American Gas Association
   Transmission Measurement Committee Report No. 7
Measurement of Gas by Turbine Meters 1996.

2. American Gas Association
   Transmission Measurement Committee Report No 8
   Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases

3. American Gas Association
   Transmission Measurement Committee Report No 9,

4. American Gas Association
   Transmission Measurement Committee Report No 11,
   Measurement of Gas by Coriolis Meter October 2003

5. AS1376 – 1973 Conversion Factors

6. ASTM D1072 – Standard Test Method for Total Sulphur in Fuel Gases by Combustion and
   Barium Chloride Titration

7. ASTM D1142 – Standard Test Method for Water Vapor Content of Gaseous Fuels by
   Measurement of Dew-Point Temperature


9. ASTM D3588 – Standard Practice for Calculating Heat Value, Compressibility Factor, and
   Relative Density of Gaseous Fuels

10. ISO 6326 – Natural Gas: Determination of sulphur compounds

11. ISO 6974 – Determination of composition and associated uncertainty by gas chromatography

12. ISO 6975 – Natural Gas: Extended analysis – Gas chromatographic method

13. ISO 6976 - Natural Gas: Calculation of Calorific Values, Density, Relative Density and Wobbe
    index from composition.
2 GAS VOLUME MEASUREMENT

2.1 General and Overview

JEMENA is the Measurement Authority for the Eastern Gas Pipeline with responsibility for measurement and reconciliation of all gas received and delivered on the Eastern Gas Pipeline. JEMENA owns, operates and maintains gas quality measuring equipment at the Receipt Point(s) and at selected Delivery Points on the pipeline. Generally flow measurement facilities are maintained by JEMENA at each Delivery Point(s) and Receipt Point(s). Where Delivery or Receipt Point measurement equipment is owned or operated by a 3rd party, they are maintained in accordance with this manual and JEMENA requirements.

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

Measured flow is corrected for temperature and pressure 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. In conjunction with line pack calculations, the accumulated quantities from each meter are used for the daily reconciliation and balancing of the pipeline.

Shipper delivery points are equipped with Ultrasonic meters, Coriolis meters or Turbine meters. Diaphragm meters are used for heater fuel gas measurement at the meter and compressor stations. Coriolis meters are used as fuel gas meters at the Longford, Mila and Michelago compressor stations.

The Data obtained from the flow computers of each meter is used to calculate the flow over the Gas Day.

2.2 Meter Assembly

The meter assembly measures dynamic flow properties for use in the calculation of volumetric flow. Three styles of meter assembly are in service on the pipeline. JEMENA receipt points use ultrasonic flow meters. At the Delivery Points, a mixture of Ultrasonic, Coriolis and Turbine meters are employed. Coriolis meters are also used to measure the fuel usage at Longford and Mila Compressor Stations.

2.2.1 ULTRASONIC METERS

The 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 1), 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 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.
Ultrasonic meters are installed, operated and maintained as per the requirements of the American Gas Association (AGA) Report No. 9, second edition April 2007, 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. This includes 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. Checks and calibration of temperature and pressure transmitters are also carried out 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 JEMENA field staff. Metered data validations will be initiated to prove metering at any site as dictated by the field investigation.

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

The following brands/types of ultrasonic meters are used on the EGP metering facilities:

- Daniel SeniorSonic Mark III,
- Sick Maihak FlowSick600
- Instromet Q-Sonic

The measurement uncertainties for these ultrasonic meters do not exceed 0.23% of their measurement range (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement). Consequently, all ultrasonic meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.35.

### 2.2.2 TURBINE METERS

The turbine meter has a turbine rotor, which rotates as gas passes through it. Permanent magnets attached to the rotor tips turn with the rotor and produce magnetic currents in a coil causing a voltage pulse. Every time a magnet passes the coil a pulse is recorded and the total amount of gas that has gone through the meter is calculated. Straightening vanes are inserted in the upstream section.
of the meter tube to aid in eliminating the turbulent flow patterns induced by the upstream piping allowing a concise meter reading as shown in Figure 2.

![Figure 2: Turbine Meter Schematic](image)

Turbine meters are installed, operated and maintained as per the current requirements of the AGA Report No. 7, second edition 1996 and the manufacturer’s installation, operating, and maintenance manual.

Temperature and pressure transmitters are located with each meter and are used to calculate the volumetric flow at “Standard Measurement Conditions”.

At regular intervals agreed on by both JEMENA and the site customer, the in-service turbine meter is placed in series with another laboratory-calibrated meter. The throughput of each meter is measured and recorded. The results of the comparison must be within the required tolerance for continued use of the in-service turbine.

The flow computer receives data from the meter, pressure and temperature transmitters and live gas quality data from a gas chromatograph, which enables calculation of gas volume and energy flow rates at standard conditions.

Jemena EGP gas measurement facilities include one (1) site, equipped with the turbine meter, i.e. Smithfield Meter Station. The station is fitted with the Instromet type SM-R1-X meter.

The meter is designed for the custody transfer applications in demanding industrial environment and it is manufactured and tested in accordance with the relevant International Standards, e.g. OIML R-137-1 and ISO 9951.

The typical uncertainty of the SM-R1-X turbine meter can be defined as ± 0.5% for 0.2*Qmax to Qmax (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).

Consequently, the turbine meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.35.

### 2.2.3 CORIOLIS METER

The Coriolis meter uses an obstruction less 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).
Figure 3: Coriolis Meter Schematic

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.

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.

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 enables calculation of gas volume and energy flow rates at standard conditions.

The Micromotion ELITE series H Coriolis sensor is typically used in the Coriolis measurement applications on EGP. The series R is also used but only for small fuel gas metering installations for power generator sets.

The sensor is typically interconnected to the RF9739 or Series 2000 Coriolis transmitter.

The uncertainty of the mass flow measurement for the above combination of the equipment is declared by the manufacturer as 0.5 % of rate, although the equipment calibration certificates indicate significantly better performance in the range of 0.15-0.20 %.

Following the manufacturer’s statement the uncertainty for the Coriolis gas custody transfer measurement is assumed to be 0.5% (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).

Consequently, the Coriolis meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.35.

2.3 Transmitters, Sensors and RTD’s

Transmitters, Sensors and Resistance Temperature Detectors (RTD) are mounted with each meter assembly depending on site requirements. They are used in the calculation of the correction factor that converts the ‘actual’ metered flow to a net volume at standard measurement conditions.

2.3.1 Static Pressure Sensor

The static pressure transmitter is comprised of a simple diaphragm of which one side is exposed to 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. The flow computer display pressures are then compared to known test values.

Accuracy of the Static pressure sensor and flow computer inputs is checked periodically as part of routine validations.

The transmitter is calibrated across its range using a Dead Weight Tester (DWT) or an electronic pressure calibrator. A known pressure is applied to the transmitter. The pressure reading (kPa) from the flow computer display is compared to a known value.

The DWT and electronic pressure calibrator is regularly bench calibrated at a NATA certified facility.

Allowance is made for local gravity, barometric pressure head of oil and temperature for the DWT.

For both the Ultrasonic and Turbine meters, pressure sensors 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.

A pressure sensor is also mounted on the Coriolis meters for pressure compensation of the sensor tube. For the Coriolis meters of the size of CMF100 and smaller, which are used on EGP, the pressure compensation does not affect the accuracy of meter readings thus the calibration checks on these pressure instrumentation may be carried out as non-fiscal.

The following two brands of pressure transmitters are commonly used on EGP:

- Honeywell ST 3000 Smart Transmitter - the declared manufacturer's total uncertainty for the transmitter amounts to ±0.0375 URL.
- Rosemount 3051 series Smart Pressure Transmitters – the declared base uncertainty of the transmitter measurement is ±0.04 URL.

Both transmitters have the ability to transfer their sensor reading digitally. However the ST 3000 digital signal is proprietary with limited RTU compatibility. In contrast the open HART protocol found in Rosemount series transmitters has a larger support base. HART communications of pressure transmitter increase metering accuracy by reducing uncertainties introduced by the isolating barriers and RTU A/D modules. For this reason HART communications is the preferred communications protocol for fiscal pressure transmitters.

For the purposes of the transmitter validation tolerance calculations the uncertainty of the pressure transmitter measurement is assumed to be ±0.1 URL to allow for stability deterioration over time and to set reasonable validation targets (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).

Consequently, all pressure transmitters, used on the Eastern Gas Pipeline Metering sites are compliant with the transmitter accuracy requirements, as defined in the National Greenhouse and Energy Reporting (Measurement) Determination 2008, refer Chapter 2, Part 2.3 Division 2.3.6 Section 2.32, and Chapter 1, Part 1.1A, Division 1.1A.2, Section 1.10F.

2.3.2 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 a conductor is proportional 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 calibrated using a water bath and a multi meter. 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.

The following types of the temperature transmitters are commonly used on EGP:

- **Honeywell STT350 Smart Temperature Transmitter** - the declared manufacturer's total uncertainty is 0.01 °C, for the transmitter operating in the DE digital mode and in the range of 0-100 °C with Pt100 sensor. For the transmitter operating in analog 4-20 mA mode the uncertainties are in the range of ± 0.025%, i.e. 0.025 °C.

- **Rosemount 3144 series Smart Temperature Transmitters** – the declared base accuracy of the transmitters varies, depending on the variation of the Transmitter/Sensor arrangement, type of the sensor and the signal transmission techniques used. The declared manufacturer's total uncertainty is 0.1 °C, for the transmitter operating as 4-20 mA in the range of 0-100 °C with Pt100 sensor. The manufacturer's declared ambient temperature effect for the transmitter operating with Pt100 in the 0-100 °C is 0.015 °C

Both transmitters have the ability to transfer their sensor reading digitally. However the STT350 digital signal is proprietary with limited RTU compatibility. In contrast the open HART protocol found in Rosemount series transmitters has a larger support base. HART communications of temperature transmitter increase metering accuracy by reducing uncertainties introduced by the isolating barriers and RTU A/D modules. For this reason HART communications is the preferred communications protocol for fiscal temperature transmitters.

For the purposes of this manual the uncertainty of ± 0.1%, i.e. 0.1 °C have been assumed for all temperature transmitters, installed at the pipeline metering facilities (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).

Consequently, all temperature transmitters, used on the Eastern Gas Pipeline Metering sites are compliant with the transmitter and accuracy requirements, as defined in the National Greenhouse and Energy Reporting (Measurement) Determination 2008, refer Chapter 2, Part 2.3 Division 2.3.6 Section 2.32, and Chapter 1, Part 1.1A, Division 1.1A.2, Section 1.10F.

### 2.4 Flow Computers

The flow computer performs three main functions:

- Computation of volume, mass, energy flow-rate and super compressibility
- Calculation of flow Accumulation registers.
- Data transfer

Each ultrasonic and turbine meter is connected to a local electronic flow computer, which receives and records the instantaneous values for all primary measurement inputs, i.e. volume flow signals from the meter as well as pressure and temperature information from the transmitters. From these inputs and along with the gas analysis, the flow computer continuously calculates the following:

- Instantaneous uncorrected volumetric flow
- Instantaneous corrected volumetric flow
- Instantaneous energy flow
- Cumulative uncorrected volumetric flow
- Cumulative corrected volumetric flow
- Cumulative energy flow
- Super compressibility factor.
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 the specific gravity of the gas provided by a gas chromatograph. From these inputs and along with the gas analysis, the flow computer continuously calculates the following:

- Instantaneous mass flow
- Instantaneous corrected volumetric flow
- Instantaneous energy flow
- Cumulative mass volumetric flow
- Cumulative corrected volumetric flow
- Cumulative energy flow
- Super compressibility factor.

Consequently, the flow computers, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.36. 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
- Meter specific data

Inputs manually programmed into the flow computers are:

- Site specific Atmospheric Pressure
- Contract Base Pressure
- Contract Base Temperature

SCADA outputs from the computer are:

- Pressure
- Temperature
- Flow Rate
- Energy Rate
- Accumulated Flow
- Accumulated Energy
- Specific Gravity
- Heating Value
- Gas componentry data
- Yesterday's energy
- Yesterday's volume
• Contract volume accumulator
• Contract energy accumulator

Flow calculations are carried out as per the AGA standard appropriate to the metering apparatus and calculation of super compressibility for the purpose of flow correction as per the requirements of the AGA Report No. 8, second edition 1992.

All functions of the flow computer are checked using electronic test instrumentation. Performing a flow calculation using measured properties substituted into custom software, and comparing the result with that from the flow computer assesses calculation accuracy.

Details on Flow computer validation spread sheets can be found in Section 4.

2.5 Measurement Uncertainties

The uncertainties in the Jemena custody transfer measurement system have been estimated and the results of the calculations are presented in the GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

The “Wholesale Market Metering Uncertainty Limits and Calibration Requirements Procedures” document, as produced in accordance with the requirements of the National Gas Rules 2008 (Version 18) by AEMO (Australian Energy Market Operator), was adopted for the assessment and benchmarking of the performance of the Jemena measurement facilities.

On the basis of the calculations, all Jemena custody transfer facilities on Eastern Gas Pipelines can be declared as compliant with the AEMO uncertainty requirements for the volume and energy flow categories.

3 FUEL GAS MEASUREMENT

Fuel gas is used on the EGP facilities to power the following equipment:

• Compressor Units
• Emergency Power Generators (GEA)
• Water Bath Heaters
• Hot Water Heaters

The consumption of fuel gas at all facilities is measured and recorded. The Coriolis type meters are typically used for the compressor unit and GEAs and the diaphragm meters for the water bath and hot water gas heaters. As estimated, in excess of 80% of the fuel gas is consumed by the compressor units and the remaining less than 20% is shared between the GEAs and gas heaters.

<table>
<thead>
<tr>
<th>Location</th>
<th>Meter Type</th>
<th>Reading</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longford</td>
<td>Coriolis</td>
<td>Flow Computer T610</td>
<td>Compressor Units</td>
</tr>
<tr>
<td></td>
<td>Diaphragm</td>
<td>Manual read</td>
<td>Water Bath Heater</td>
</tr>
<tr>
<td></td>
<td>Diaphragm</td>
<td>Manual read</td>
<td>Vic Hub Water bath heater</td>
</tr>
<tr>
<td>Bairnsdale</td>
<td>Diaphragm</td>
<td>Manual read</td>
<td>Water Bath Heater</td>
</tr>
<tr>
<td></td>
<td>Diaphragm</td>
<td>Manual read</td>
<td>Water Bath Heater</td>
</tr>
<tr>
<td>Orbost</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
3.1 Fuel Gas Measurement with Coriolis Meters

The Coriolis mass flow meter operating principle involves inducing a vibration of the flow tube through which the fluid passes. The vibration, though it is not completely circular, provides the rotating reference frame which gives rise to the Coriolis Effect. While specific methods vary according to the design of the flow meter, sensors monitor and analyse changes in frequency, phase shift, and amplitude of the vibrating flow tubes. The changes observed represent the mass flow rate and density of the fluid. Measurement accuracy of the Coriolis meter is a function of fluid mass flow rate independent of operating temperature, pressure, or composition. However, pressure drop through the sensor is dependent upon operating temperature, pressure, and fluid composition.

All Jemena fuel gas Coriolis meter measurement applications are selected, installed and operated in accordance with the American Gas Association Report No 11 “Measurement of natural gas by Coriolis meters”. The field maintenance is performed on the meters, as per the Report. The maintenance consists of monitoring and evaluating metering conditions, as well as the diagnostic information as produced by the transmitter and the ancillary devices, to identify possible changes in the system performance and the causes of the changes. The evaluation is used to determine the need for the meter performance tests. The tests include the following:

- Zero check
- Sensor diagnostic check
- Transmitter diagnostic check

The consumption of the fuel gas, as measured by the Coriolis meters, is processed and corrected in the flow computers. The resulting information on the volumetric and energy consumption is monitored and recorded on continuous basis via the Jemena SCADA facilities.

The Coriolis type primary sensors, typically Rosemount Elite, R-style or F-style, are used on Jemena facilities for measurement of fuel gas consumption on the compressor units and GEAs. The sensors are typically paired with the RF9739 or Series 2000 Coriolis transmitters.

The uncertainty of the fuel gas consumption measurement for the above combination of the equipment is declared by the manufacturer as 0.5 % of rate, although the equipment calibration certificates indicate significantly better performance in the range of 0.15-0.20 %.

Following the manufacturer’s statement the uncertainty for the Coriolis gas custody transfer measurement is assumed to be 0.5% (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).
Consequently, the Coriolis meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.35.

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 the specific gravity of the gas provided by a gas chromatograph. From these inputs and along with the gas analysis, the flow computer continuously calculates the following:

- Instantaneous corrected volumetric flow
- Accumulative corrected volumetric flow
- Super compressibility factor

All flow computers accumulate volume and energy totals.

Consequently, the flow computers, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.36.

3.2 Fuel Gas Metering with Diaphragm Meters

Diaphragm meters are positive displacement type of the measuring device, which have fixed-volume measurement compartments formed by two-sided convoluted diaphragm. A small pressure drop across the meter causes it to cycle so these compartments alternatively fill with gas at the inlet and then empty at the outlet. By counting the number of cycles, the meter provides a measure of gas volume.

The AL series of diaphragm meters is used at Jemena for measurement of fuel gas consumption. The meters are housed in the aluminium alloy case, which is cast in one piece thus eliminating joints and gaskets and the resulting possibilities of internal leaks and malfunctions due to component aging process. The meter has been designed with aim to provide a long term accurate and maintenance free operation by eliminating or minimising friction of the moving parts and the use of self-lubricating joints.

The diaphragm meters are commonly used in the gas distribution networks with millions of applications around the world. However, the application of the meters in the gas transmission facilities is, with regard to the nominal pressure and the measuring range of the meter, limited only to the fuel gas measurement. Consequently, the diaphragm meters, used at Jemena, can be classified as the distribution type meters.

Calibration & Replacement of these types of meters must be in accordance with Jemena’s Metering Strategies, which includes:

- a new meter is placed in service
- After any repairs, maintenance or recalibration performed on a meter then placed back into service

The typical uncertainty of the AL1000 or equivalent diaphragm meter can be defined as ± 1.0% for Qmin to Qmax (Ref. Jemena document GTS-599-JJ-004 Uncertainty Calculations for Gas Measurement).

Consequently, the diaphragm meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.35.

Each diaphragm meter is connected to a local electronic flow computer, which receives and records the instantaneous values for all primary measurement inputs, i.e. volume flow signals from the meter as well as pressure and temperature information from the transmitters. From these inputs and along with the gas analysis, the flow computer continuously calculates the following:

- Instantaneous corrected volumetric flow
• Cumulative corrected volumetric flow
• Instantaneous uncorrected volumetric flow
• Cumulative uncorrected volumetric flow
• Super compressibility factor.

Consequently, the flow computers for the diaphragm meters, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.36.
4 GAS QUALITY

4.1 General
Gas entering the pipeline must meet certain specifications before it is transmitted through the line. JEMENA monitor the gas quality to ensure it meets these specifications.

The gas quality equipment currently installed on EGP is as per the following table:

<table>
<thead>
<tr>
<th>Location</th>
<th>Measurement Type</th>
<th>Brand</th>
<th>Model No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longford</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 500 + 2350A Controller</td>
</tr>
<tr>
<td>Longford</td>
<td>C9 Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 590 + 2350A Controller</td>
</tr>
<tr>
<td>Longford</td>
<td>H2S Analyser</td>
<td>Daniel</td>
<td>Danalyser 1000 + 2350A Controller</td>
</tr>
<tr>
<td>Longford</td>
<td>Moisture Analyser</td>
<td>Spectra Sensors</td>
<td>SS2000</td>
</tr>
<tr>
<td>Orbost</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 500 + 2350A Controller</td>
</tr>
<tr>
<td>Orbost</td>
<td>C9 Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 590 + 2350A Controller</td>
</tr>
<tr>
<td>Orbost</td>
<td>H2S Analyser</td>
<td>Daniel</td>
<td>Danalyser 1000 + 2350A Controller</td>
</tr>
<tr>
<td>Orbost</td>
<td>H2S Analyser</td>
<td>Daniel</td>
<td>Danalyser 1000 + 2350A Controller</td>
</tr>
<tr>
<td>Orbost</td>
<td>Moisture Analyser</td>
<td>Ametek</td>
<td>30-50-OLV (Primary)</td>
</tr>
<tr>
<td>Orbost</td>
<td>Moisture Analyser</td>
<td>Ametek</td>
<td>5100 HD (under review)</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 571 + 2350A Controller</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 571 + 2350A Controller</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>H2S Analyser</td>
<td>Daniel</td>
<td>Danalyser 1000 + 2350A Controller</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>H2S Analyser</td>
<td>Daniel</td>
<td>Danalyser 1000 + 2350A Controller</td>
</tr>
<tr>
<td>Smithfield</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 500 + 2350A Controller</td>
</tr>
<tr>
<td>Smithfield</td>
<td>C6+ Gas Chromatograph</td>
<td>Daniel</td>
<td>Danalyser 500 + 2350A Controller</td>
</tr>
<tr>
<td>Wilton (APA)</td>
<td>C9 Gas Chromatograph</td>
<td>ABB</td>
<td>NGC8209</td>
</tr>
</tbody>
</table>

Table 2: EGP Gas Quality Equipment

4.2 Specifications
The JEMENA Standard Terms and Conditions for the Eastern Gas Pipeline state the acceptable gas quality limits that apply to gas to be transported. Those requirements are restated in Table 3 below.

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).

JEMENA will immediately notify the Shipper and Supplier when gas is not meeting specifications as identified by JEMENA gas quality measuring devices at the Receipt Point(s). Steps as outlined in Section 4 of the Standard Operating Procedure – EGP Red Alarms Gas Quality Procedure (GTS-500-PR-PC-001) may be taken by JEMENA in the event of off-specification gas. However, neither this action, nor the knowledge of the presence of off-specification gas by JEMENA personnel 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.
4.2.1 **NATURAL GAS SPECIFICATION**

This specification requires that the Natural Gas:

1. Be commercially free from sand, dust, gums, gum forming constituents, crude oil, impurities or other objectionable substances; and

2. Have measured or calculated values for certain parameters within the stated tolerances; and

3. Does not cause damage to the Pipeline and associated infrastructure, and does not interfere with:
   i) The transmission of the Natural Gas through the Pipeline; or

The commercial use of the Natural Gas by you and other Users.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SPECIFICATION</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Temperature</td>
<td>2° C</td>
<td></td>
</tr>
<tr>
<td>Maximum Temperature</td>
<td>50° C</td>
<td></td>
</tr>
<tr>
<td>Wobbe Index</td>
<td>Minimum 46.0</td>
<td>ISO 6976; OR ASTM D3588</td>
</tr>
<tr>
<td>3.02</td>
<td>Maximum 52.0</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>Maximum 0.2% by volume</td>
<td>ISO 6974 AND ISO 6975; OR ASTM D1945</td>
</tr>
<tr>
<td>Total Inerts</td>
<td>Maximum 7% by volume</td>
<td>ISO 6974 AND ISO 6975; OR ASTM D1945</td>
</tr>
<tr>
<td>Hydrocarbon Dewpoint</td>
<td>Maximum 2° C</td>
<td></td>
</tr>
<tr>
<td>3.02</td>
<td>At 3500 kPa g</td>
<td></td>
</tr>
<tr>
<td>Water Dew Point</td>
<td>0° C @ MAOP</td>
<td>ASTM D1142</td>
</tr>
<tr>
<td>(See Water Content to cover this.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Content</td>
<td>Maximum water dew point of 0° C at MAOP. This is equivalent to a maximum 3.02 water content of 75 mg/m³ at 14,895kPa g and 70 mg/m³ at 16,550kPa g</td>
<td>ASTM D1142</td>
</tr>
<tr>
<td>Hydrogen Sulphide</td>
<td>Maximum 5.7 mg/m³</td>
<td>ISO 6326</td>
</tr>
<tr>
<td>Total Sulphur (excluding odorant)</td>
<td>Maximum 25 mg/m³</td>
<td>ASTM D1072</td>
</tr>
</tbody>
</table>

**Notes:**

1. All values measured or specified at 15° C and 101.325 kPa unless otherwise stated.
2. Wobbe Index means the Higher Heating Value divided by the square root of the relative density of the gas, both measured at the same time.
3. For the purposes of this clause, carbon dioxide and nitrogen shall be deemed to be inert gases.
4. The gas shall not contain:
   a. material, dust and other solid or liquid matter, waxes, gums, gum forming constituents, and unsaturated or aromatic hydrocarbons to an extent which might cause damage to, or interfere with the proper operation of pipes, meters, regulators, control systems, equipment or appliances;
   b. Unsaturated or aromatic hydrocarbons to an extent which causes unacceptable sooting;
   c. Other substances to the extent that they cause damage to, or problems in the operation of, pipelines or appliances or that cause the products of combustion to be toxic, or
hazardous to health, other than substances that are usually found in natural gas combustion products.

4.3 On Site Analysis Equipment

Gas Chromatographs that sample line gas and separate the inert and hydrocarbon components to C6+ and C9+ 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.

RTD probes measure the gas temperature.

Sulphur GC’s analyses the Sulphur components of the Gas.

The table below lists the properties measured and calculated from the on-site analysis.

<table>
<thead>
<tr>
<th>MEASURED ON-LINE</th>
<th>CALCULATED ON-LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocarbon breakdown to C6+</td>
<td>Gross Heating Value</td>
</tr>
<tr>
<td>Hydrocarbon breakdown to C9+</td>
<td>Specific Gravity</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>Wobbe Index</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Hydrocarbon Dew Point</td>
</tr>
<tr>
<td>Moisture Dew Point</td>
<td></td>
</tr>
<tr>
<td>Gas Temperature</td>
<td></td>
</tr>
<tr>
<td>Total Sulphur &amp; Mercaptans</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Outputs from On-Site Analysis

Live monitoring of the gas quality is enabled via the SCADA system. Output from the on-site measurement equipment is linked to the GT Control. Alarms are triggered should the measured or calculated gas properties approach the limits specified.

4.3.1 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)

The C9+ chromatograph system analyses for the following components:
- Hexane (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)
- Nonane+ (C9)
- Octanes (C8)
- Heptanes (C7)

Figure 4: Daniel 500 Chromatograph Systems

Component analysis, in general terms, is achieved by passing the sample gas through a separation system. A thermal conductivity detector located at the outlet of the separator senses the change in conductivity as each component elutes from the column and outputs an electrical signal, proportional to the quantity and concentration passing across the sensor.

A microprocessor calculates the gas composition concentrations, Specific Gravity (real), Compressibility Factor, Gross Heating Value (real; dry basis), and the Wobbe Index. The basis of these calculations is 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 spare calibration gas bottles are maintained to ensure a timely replacement of the empty bottles.

In addition, the chromatograph is checked as part of routine validations of metering equipment.

Hydrocarbon Dew Point is calculated in the Daniel 500 C9 + Gas chromatograph(s). The calculations are based on two empirically derived equations of state (Redlich Kong Soave and Peng Robinson) to predict the hydrocarbon dewpoint from the gas composition. The algorithms return the hydrocarbon dew point maximum temperature (cricondentherm) and the temperature at 4 other pressures.

Daniel Danalyser Model 500 series with the Model 2350A Gas Chromatograph Controller is commonly used on EGP. Uncertainties in the results of the Chromatograph analysis are defined as precision or repeatability, in line with the ISO 6976 Standard. The repeatability of the equipment is declared by the manufacturer as 0.025 % - 0.05 % over the complete temperature range for different models. All gas chromatographs, installed on EGP, are factory tested and calibrated with use of the gravimetric methods in accordance to Australian legal units of measurement.

Consequently, the gas chromatographs, used on EGP, comply with the National Greenhouse and Energy Reporting (Measurement) Determination 2008 Chapter 2, Part 2.3 Division 2.3.6 Section 2.37.

### 4.3.2 Sulphur Analyser

The analysers utilise a Flame Photometric Detector to identify sulphur constituents in process gas. They operate by detecting characteristic light waves emitted by combustion of sulphur in the flame cell. Individual components are eluted from separation columns into the flame cell. The GC's resolve the sulphur compounds into Hydrogen Sulphate (H2S), Carbonyl Sulphite (COS), Tertbutyl Mercaptan (TBM) and Tetrahydrothiophene (THT).

The analysers are validated by testing the equipment with use of the gas of known composition. The calibration gas bottles are supplied by NATA accredited laboratories. The gas is prepared with use of gravimetric methods traceable to recognised national standards to achieve predetermined composition. Appropriate certificates are provided with the bottles for traceability purposes. The certified composition of the Calibration Bottles in form of the composite mole percentage values is entered into the Validation Spreadsheet for the specific locations of the chromatographs.

The calibration gas contains small quantities of H2S, COS, TBM and THT, blended in methane with traces of Propane, Ethane and Nitrogen.

Daniel Danalyser Model 1000 series with the Model 2350A Gas Chromatograph Controller is used on EGP at Longford, Orbost and Port Kembla. Uncertainties in the results of the Chromatograph analysis are defined as precision or repeatability, in line with the ISO 6976 Standard. The repeatability of the equipment is declared by the manufacturer as 0.025 % - 0.05 % over the complete temperature range for different models. Further details on the uncertainty of the analysers can be found in the GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

### 4.3.3 Moisture Analysers

SpectraSensors SS2000 Gas Analyser is installed at Longford Compressor Station. An Ametek 5100 Gas Analyser is installed at Orbost. The operation of these analyser is based on a diode laser absorption spectrometer principle. It consists of the tunable diode laser light source, sample cell and the detector specifically configured to enable high sensitivity measurement of a particular component within the presence of other gas phase constituents in the stream.

The tunable diode laser analysers is capable of detecting moisture concentration in natural gas with uncertainty of ± 2% of reading or ± 4 ppmv. The SpectraSensors range is 10-422 ppmv while the Ametek is 0.1-2500 ppmv
Ametek 30-50-OLV Moisture Analyser is installed at Orbost Meter Station. The analyser is based on the quartz crystal oscillator microbalance technology, where the crystal’s coating selectively absorbs moisture from the gas stream, which changes the natural resonance frequency of the oscillator.

The Analyser is capable of detecting moisture concentration in natural gas within the range of 0.1 - 2500 ppmv with the uncertainty of ±10% of reading.

The moisture analyser(s) are calibrated as part of routine verifications of gas analysis and energy accounting equipment, using the calibration gas of known composition the Moisture Analyser Calibration Bottles is filled in NATA accredited laboratories gravimetrically using weights traceable to recognised national standards to achieve predetermined composition. Appropriate certificates are provided with the bottles for traceability purposes. The certified composition of the Calibration Bottles in form of the composite mole percentage values is entered into the Validation Spreadsheet for the specific locations of the Moisture Analysers.
5 VALIDATION

5.1 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.

5.1.1 VALIDATION OVERVIEW
Validations shall be periodically performed to ensure the accuracy of the gas quality and energy accounting equipment at each pipeline Meter Stations. The validations purpose is to access the conditions of measurement equipment in order for it to function within agreed tolerances. Commissioning and First Yearly Validations

New meter assemblies requiring commissioning shall have measurement equipment validated within one week of initial operation and then continually validated for six weekly intervals for one year of service.

5.1.2 CONTINUAL PERIODIC VALIDATIONS
The required frequency of periodic validations is shown in table 4 (refer 5.1.4).

5.1.3 OWNERS AND REPRESENTATIVES RESPONSIBILITIES
The validation tests are conducted on regular intervals as scheduled.

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 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.

In the event that validations have to be re-scheduled, the new schedule would be at a date and time agreed by both operations staff and affected witnesses.

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 EGP operations base and at the Jemena Gas Operations ECMS system.

In the event of equipment failure, damage or accuracy drift, the Pipeline Owner 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.

5.1.4 FREQUENCY OF VALIDATIONS
Refer to Table 4 below for frequency of validation for all facilities on the EGP.

Exceptions to Table 4
Val 52: Ultrasonic Diagnostic Check - Velocity of Sound.

If Ultrasonic Meter fails its VOS calculation check in reference to the nearest GC data then a local gas sample shall be taken and sent for analysis at least annually to complete VOS validation.

### Table 4: Frequency of Validations

<table>
<thead>
<tr>
<th>Meter Location</th>
<th>Meter Assembly</th>
<th>First Yearly Req’mts (See Clause 5.1.2)</th>
<th>Continuous Req’mts (See Clause 5.1.3)</th>
<th>Validation Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longford</td>
<td>Ultrasonic</td>
<td>6</td>
<td>6</td>
<td>✓✓✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Bairnsdale</td>
<td>Coriolis</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Orbost</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Bombala</td>
<td>Coriolis</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Cooma</td>
<td>Coriolis</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Hoskinstown</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Nowra</td>
<td>Coriolis</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Bomaderry</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Tallawarra</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Albion Park</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Port Kembla</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Horsley Park</td>
<td>Ultrasonic</td>
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<td>12</td>
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<tr>
<td>Smithfield</td>
<td>Turbine</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Wilton(APA)</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
<tr>
<td>Wilton(JGN)</td>
<td>Ultrasonic</td>
<td>6</td>
<td>12</td>
<td>✓✓✓✓✓✓</td>
</tr>
</tbody>
</table>

Notes:
1. Single meters sites have the provision for a temporary meter to be installed so Val 62 can be performed.
2. Stations ordered by geographic location
3. Note: Refer to the EGP Master Validation spreadsheet for the validation numbers.
4. These three stations are maintained 6 weekly validation check frequency due to the contract agreement with BHP.
5.2 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 51 – Test Equipment
- VAL 52 – Ultrasonic Diagnostic Check
- VAL 53 – Pressure Transmitter Tolerance Check
- VAL 54 – Temperature Transmitter Tolerance Check
- VAL 55 – Ultrasonic Meter Flow Computer V’s GOF Check
- VAL 56 – Gas Chromatograph Tolerance Check
- VAL 57 – Moisture Analyser Tolerance Check
- VAL 58 – Coriolis Meter Flow Computer V’s GOF Check
- VAL 60 – Turbine Meter Flow Computer V’s GOF Check
- VAL 61 – Sulphur Gas Chromatograph Check
- VAL 62 – Meter Comparison Check
- VAL 63 – Data transfer check
- VAL 64 – Smithfield RTU Data Comparison

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

Each calibration form will contain the relevant calibration tolerance for the test.

5.2.1 VAL 51 TEST EQUIPMENT
Val 51 Test equipment is registered for all certified test equipment used during a validation. At the commencement of each validation, the model number, serial number, date 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.

5.2.2 VAL 52 ULTRASONIC DIAGNOSTIC CHECK
Val 52 Ultrasonic Diagnostic Check is used to assess ultrasonic meter operational status. Data accessible via a computer is 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 52 Ultrasonic Diagnostics Check.

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

**Sample rate:** The sample rate is used to determine that all ultrasonic pulses sent by the emitting transducer are being collected by the receiving transducer. The Sample rate for all Jemena 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 calculating 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, is an output 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 can produce ultrasonic noise such as pressure regulators. In these noisy environment 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 meter diagnostic report, as produced by the diagnostic software supplied with each brand of the meter, is obtained and analysed in the course of the validation process. The diagnostic report is attached to the Validation Report for records. Any potential malfunctions or underperformance indications, if shown in the diagnostic report, are investigated and rectified as a part of the post validation engineering actions.

### 5.2.3 Val 53 Pressure Transmitter

The Pressure Transmitter form is used to validate the accuracy of the Pressure transmitter.

The type of pressure calibrating equipment to be used for the pressure test is selected either Dead Weight Tester (DWT) or 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 53. From the flow computer the pressures are then viewed on data view and entered into the “As Found kPa” table.

Once all pressures are applied and entered into the "As Found kPa" 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" and Val 53 Pressure transmitter tolerance check is completed.

If the transmitter is found to be out of tolerance a transmitter calibration is carried out. Upon completion all pressures are reapplied and re-entered into the "As Left kPa".

The transmitter is replaced if it cannot be calibrated to within tolerance.

The validation process is described in Appendix D General Procedure for Validation of Pressure Transmitter. The uncertainties of the pressure transmitter validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

### 5.2.4 Val 54 Temperature Transmitter

The Temperature Transmitter report 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 54 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 0°C".

Once all Temperatures are dialled and entered into the "As Found 0°C" they are automatically compared to the "Required 0°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" values are copied into the "As Left 0°C" and Val 54 Temperature transmitter tolerance check is completed.

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 on Val 54.

The transmitter is replaced if it cannot be calibrated to within tolerance.

The validation process is described in Appendix E General Procedure for Validation of Temperature Transmitter. The uncertainties of the temperature transmitter validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

RTD Probes

The RTD temperature probes are checked once every 6 months and using a certified RTD probe, a water bath and a multi meter. Both the RTD to be validated and 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 54 and automatically 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 calibration are copied to the As Left RTD calibration and the RTD calibration is complete.

If the RTD being validated is found to be out of tolerance then the RTD is replaced and the 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 calibration.

5.2.5 Val 55 Ultrasonic Meter FC V’s GOF

Val 55 Ultrasonic meter FC V’s GOF check is used to determine if the flow computer is correctly calculating the actual and standard flow accumulators, energy flow accumulators and the Supercompressibility (Fpv). The check also confirms that the correct numbers of pulses are being recorded.

At the commencement of the check via the flow computer data view, toggle the list 50 validation flag to place the forward flow in validation mode. Validation mode will ensure that constant values are retained for the entire check for pressure, temperature and GC data. If the Flow computer is NOT a control wave series RTU the pressure and temperature will need to be individually control inhibited to achieve the same result. 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 then entered in the pulses cell on Val 55 and the actual, standard and energy flow rates along with the FPV automatically calculate.

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 55 of the validation spread sheet.

The validation process is described in Appendix A General Procedure for Validation of Ultrasonic Meters. The uncertainties of the flow computer validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

5.2.6  **VAL 56 GAS CHROMATOGRAPH TOLERANCE CHECK**

Val 56 Gas Chromatograph tolerance check is used to verify the accuracy of the Gas Chromatograph outputs.

Firstly the GC Serial number is selected on Val 56 along with the calibration bottle to be used for the validation. Once these two parameters have been selected the calibration bottle gas composite mole percents are automatically entered into the certified mole % column of Val 56.

Using the GC Mon program to talk to the Gas chromatograph the gas stream is changed from line gas to calibration gas and let run for three cycles to insure all line gas is purged from the system.

Once the three cycles are complete the GC Mon 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 56 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 copy into the GC_AL tab in the validation spread sheet and the Val 56 Gas Chromatograph validation is complete.

If the Gas Chromatograph is found to be out of tolerance then a calibration is required. Once the calibration is complete a copy of the results page of GC Mon is taken and pasted into the GC_AL tab in the validation spread sheet.

The validation process is described in Appendix F General Procedure for Validation of Gas Chromatographs. The uncertainties of the gas chromatograph validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

5.2.7  **VAL 57 MOISTURE ANALYSER TOLERANCE CHECK**

Val 57 Moisture Analyser tolerance check is used to verify the accuracy of the Moisture Analyser output.

Firstly the gas stream is changed from line gas to calibration gas and let run to ensure all line gas is purged from the system. Once the readings have stabilised (confirmed using SCADA or a communicator), the Moisture analyser the mg/m³ are compared to the concentration in the certified calibration bottle. The mg/m³ that the analyser is reading and the ppm of the calibration bottle are entered on Val 57 "As found". Once entered the variance between the analyser and the calibration bottle is automatically calculated. This is then compared to the allowable variance.

If the analyser is found to be in tolerance the "As Found" data is copied to the "As left" and the Moisture Analyser tolerance check is complete.

If the analyser is found to be out of tolerance then the Moisture analyser is calibrated and new data taken after the calibration is placed into the Val 57 “As Left”.

The validation process is described in Appendix G General Procedure for Validation of Moisture Analyser. The uncertainties of the moisture analyser validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.
5.2.8 **VAL 58 CORIOLIS METER FC CHECK**

The Val 58 Coriolis meter FC V’s GOF check is used to determine if the flow computer is calculating the correct accumulators for mass, standard flow rate and energy flow rate. The check also confirms that the correct numbers of pulses are being recorded.

At the commencement of the check via the flow computer data view, toggle the list 50 validation flag to place the forward flow in validation mode. Validation mode will ensure that constant values are retained for the entire check for GC data. If the Flow computer is NOT a control wave series RTU the SG and Heating Value will need to be individually control inhibited to achieve the same result. A Pulse generator is 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 then entered in the pulses cell on Val 58 and the calculated mass, standard and energy flow accumulators are 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 58 of the validation-spread sheet.

The validation process is described in Appendix C General Procedure for Validation of Coriolis Meters. The uncertainties of the flow computer validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

5.2.9 **VAL 60 TURBINE METER FC V’S GOF**

The Val 60 Ultrasonic meter FC V’s GOF check is used to determine if the flow computer is calculating the correct actual and standard flow accumulators, energy flow accumulator and Fpv. The check also confirms that the correct numbers of pulses are being recorded.

At the commencement of the check via the flow computer data view, toggle the list 50 validation flag to place the forward flow in validation mode. Validation mode will ensure that constant values are retained for the entire check for pressure, temperature and GC data. If the Flow computer is NOT a control wave series RTU the pressure and temperature will need to be individually control inhibited to achieve the same result. 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 flow-induced 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 then entered in the pulses cell on Val 60 and the calculated actual, standard and energy flow accumulators along with the Fpv are automatically calculate.

These calculated values are compared to the flow computers calculated values and a percentage variance derived.

This variance is then compared to the allowable variance as indicated on Val 60 of the validation-spread sheet.

The validation process is described in Appendix B General Procedure for Validation of Turbine Meters. The uncertainties of the flow computer validation process, as well as calculations of the
5.2.10 Val 61 Sulphur Gas Chromatograph Tolerance

The Val 61 Sulphur Gas Chromatograph tolerance check is used to verify the accuracy of the Gas Chromatograph outputs.

Firstly the calibration bottle to be used for the validation is selected in the spreadsheet. Once the selection has been made the calibration bottle gas composite mole percents are automatically entered into the certified ppm column of Val 61.

The Calibration gas stream is selected for analysis using the GC Mon software. The Sulphur GC then conducts three cycle runs to completely purge the system of line gas. Once the three cycles are complete the GC Mon report data taken from the third cycle is copied and pasted into the “Sul GC_AF” tab in the validation spread sheet. The data from the “Sul GC_AF” tab automatically updates to Val 61 and is compared to the calibration bottles certified known THT, TBM, H2S and COS to give a total variance.

The variance is then compared to the allowable tolerances to determine if the Sulphur GC readings are within the set tolerances.

If the THT, TBM, H2S and COS are found to be within tolerance the data pasted into the “Sul GC_AF” tab can be copy into the “Sul GC_AL” tab in the validation spread sheet and the Sulphur Gas Chromatograph validation is complete.

If the Sulphur Gas Chromatograph is found to be out of tolerance then a calibration is required. Once the calibration is complete a copy of the results page of GC Mon is taken and pasted into the “Sul GC_AL” tab in the validation spreadsheet.

The Sulphur GC is placed back on line gas and a Sulphur GC to SCADA system data transfer test is conducted. This test is to confirm that the Sulphur GC results are being correctly transferred to the SCADA system.

Firstly a GC Mon report data is copied from GC Mon and pasted into the “Sul GC_Data” tab in the validation spread sheet. Then, in quick succession, a copy of Sulphur GC values is taken from the SCADA system and pasted into the SCADA “Sul GC_Data Trans” tab in the validation spread sheet. The SCADA data is then entered by hand into Val 61. Once entered the variance automatically updates to give a variance in ppm. This variance is then compared to the set tolerance.

The validation process is described in Appendix H General Procedure for Validation of Sulphur Gas Chromatograph. The uncertainties of the sulphur analyser validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”.

5.2.11 Val 62 Meter Comparison

The Val 62 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 Experion 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 62.

Once entered the variance between the two meters is automatically calculated and is then compared to the acceptable variance between the two meters.
The uncertainties of the series meter comparison validation process, as well as calculations of the validation tolerances are presented in GTS-599-RP-004 “Calculation of Measurement Uncertainties”. The description of the validation process can be found in the general procedures for the validation of the respective type of meter.

5.2.12 Val 63 Data Transfer Check

The Val 63 Data transfer check is used to determine if the data that is constantly being transferred to and from meter station is being done correctly.

Firstly the Type of GC must be selected using the selection box on Val 63 (“No GC on site” can also be selected for sites that have no GC).

The data transfer check can be broken up into three main areas

1. Sites with a Gas Chromatograph
2. Sites without a Gas Chromatograph (Excluding Coriolis sites)
3. Coriolis sites

Sites with a Gas Chromatograph:

If a GC is on site then a data transfer from GC to Flow computer to SCADA system check is conducted. This check comprises of three steps.

Step 1: Data from GC. This is copied from GC Mon and pasted into the “GC Data” tab in the validation-spread sheet. This data automatically updates to Val 63.

Step 2: Data from FC. This data is copied via the flow computer 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 63.

Step 3: 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” tab is then entered by hand into Val 63.

The variance between the three data down loads is automatically calculated and compared to the tolerance to insure correct operational status.

Sites without a Gas Chromatograph: (Excluding Coriolis sites)

If a GC is not on site then a data transfer SCADA system to Flow computer check is conducted. This check comprises of only two steps.

Step 1: Data from SCADA. This data is copied from the GC data page of the site where the Gas analysis in conducted. 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 63.

Step 2: Data from FC. This data is copied via the flow computer 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 63.

The variance between the two data down loads is automatically calculated and compared to the tolerance to ensure correct operational status.

Coriolis sites:

The Coriolis sites, due to the Coriolis meter being a mass flow meter, only require the SG and GHV for operation. Due to this fact, on Coriolis sites only the SG and GHV required to be proved in the data transfer check. This check comprises of only two steps.

Step 1: Data from SCADA. This data is copied from the GC data page of the site where the Gas analysis in conducted. 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 63.

**Step 2** Data from FC. This data is copied via the flow computer 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 63.

5.2.13 VAL 64 SMITHFIELD RTU DATA COMPARISON
The Val 64 Smithfield RTU Data Comparison is used for Smithfield Metering Station only. This station is set up with two RTUs (one primary, another ) monitoring the same meter on each run. This validation form is used to determine the variance in real time data acquired over the same time period between primary and backup RTUs. This check can only be carried out on sites where set up the two meters in series.

From the SCADA Experion system a snapshots of flow accumulation were taken at the start, copied and pasted into the RTU Data Start comp tab of the validation spread sheet.

Then pick a value 1 hour after the start period. Copy and paste the snapshot in the RTU Data End Comp tab of the validation spreadsheet.

The data from the two tabs is then manually entered into Val 64.

Once entered the variance between two RTUs is automatically calculated and is then compared to the acceptable variance.

5.3 Calibration of the Validation Equipment
A standard set of equipment for the meter validations comprises the following items:

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

The equipment is periodically checked and its accuracy verified by the NATA accredited laboratories. Appropriate calibration certificates are obtained in the verification process.

The instruments and gauges, used for the validation of gas flow meters, must be verified in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Validation Instrument</th>
<th>Examples of Instruments Used</th>
<th>Required Accuracy level</th>
<th>Re-Calibration Period Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifunction Calibrator</td>
<td>Beamex Advanced Calibrator</td>
<td>≤0.2Hz/0.01ohms or ≤1Cnt/0.03ohms</td>
<td>every 12 months</td>
</tr>
<tr>
<td></td>
<td>Druck Unimat Calibrator</td>
<td>≤0.025%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Druck Modular Calibrator</td>
<td>≤0.025%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Druck Advanced Modular Calibrator</td>
<td>≤1Cnt/0.03ohms</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Dead Weight Tester</td>
<td>Ametek PK II</td>
<td>≤0.012% or ≤0.015% (PKMS)</td>
<td>Every 36 months</td>
</tr>
<tr>
<td>Mercury in Glass Thermometer</td>
<td>AMA</td>
<td>≤0.1 deg.C</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>Decade Resistance Box</td>
<td>RTS 24</td>
<td>≤0.08% (PKMS) or ≤0.08 deg.C (Horsley Park)</td>
<td>Every 12 months</td>
</tr>
<tr>
<td>Certified RTD</td>
<td></td>
<td>≤0.03 deg.C or ≤0.058 deg.C (PKMS)</td>
<td>Every 12 months</td>
</tr>
</tbody>
</table>

6 METER CALIBRATION

All ultrasonic, Coriolis and turbine meters, installed on the EGP, must be flow-calibrated prior to their installation on site. This flow calibration must be adequate for the meter for the conditions where the meter will be installed. The Calibration certificates for these flow meters must be available for verification.

All flow meters, purchased for the new meter stations or as a replacement for the existing sites, are subject to the same calibration and certification requirements.

The Jemena Policy for the maintenance of metering equipment will specify flow meters replacement and/or re-calibration intervals. The replacement/re calibration intervals will be in accordance with the Jemena Engineering Assessments, relevant Australian and International Standards, and meter manufacturers recommendations.
The ultrasonic and Coriolis type of flow meters are equipped with extensive self-diagnostic capabilities, which, in combination with the regular meter validations, allow detection of any loss or drift of accuracy over time. The malfunctioning meter, once identified, is to be replaced with a suitably calibrated one.

The validation of turbine meters includes proving of the meter’s readings against readings of a calibrated meter, connected in series. This method is considered sufficient for verification of the turbine meter accuracy. The meters are investigated and the meters, which accuracy is not within the acceptable tolerances, are replaced with the calibrated meters.

7 REFERENCE AND LOCAL CONDITIONS

7.1 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. Industry accepted reference conditions within Australia are:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Temperature</td>
<td>15.0 C</td>
</tr>
<tr>
<td>Reference Pressure</td>
<td>101.325 kPa (abs)</td>
</tr>
<tr>
<td>Standard Gravitational Acceleration (gs)</td>
<td>At sea level and 45° latitude</td>
</tr>
<tr>
<td></td>
<td>9.80665 m/s</td>
</tr>
</tbody>
</table>

7.2 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”.

7.2.1 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.

7.2.2 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.

\[ P_{local} = 101.325 - \frac{h \times \text{density air} \times \text{gs}}{1000} \]

- \( h \) = elevation (m)
- \( \text{density air} \) = 1.2255 kg/m³
- \( \text{gs} \) = 9.80665 m/s²

All Local Reference Conditions can be found in Table 5.

<table>
<thead>
<tr>
<th>KP</th>
<th>Site</th>
<th>Latitude (deg)</th>
<th>Longitude (deg)</th>
<th>Elevation (m)</th>
<th>Local Gravity (m/s²)</th>
<th>Local Atmos. Pres. (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Longford</td>
<td>-38.20465</td>
<td>147.15785</td>
<td>73</td>
<td>9.800456</td>
<td>100.448</td>
</tr>
<tr>
<td>62.0</td>
<td>Bairnsdale</td>
<td>-37.83292</td>
<td>147.55062</td>
<td>27</td>
<td>9.800278</td>
<td>101.001</td>
</tr>
<tr>
<td>145.1</td>
<td>Orbost</td>
<td>-37.74731</td>
<td>148.39257</td>
<td>54</td>
<td>9.800121</td>
<td>100.676</td>
</tr>
<tr>
<td>KP</td>
<td>Site</td>
<td>Latitude (deg)</td>
<td>Longitude (deg)</td>
<td>Elevation (m)</td>
<td>Local Gravity (m/s²)</td>
<td>Local Atmos. Pres. (kPa)</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td>----------------</td>
<td>-----------------</td>
<td>---------------</td>
<td>----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>224.2</td>
<td>Cann River</td>
<td>-37.56400</td>
<td>149.09039</td>
<td>124</td>
<td>9.799748</td>
<td>99.835</td>
</tr>
<tr>
<td>289.1</td>
<td>Mila</td>
<td>-37.09572</td>
<td>149.20595</td>
<td>861</td>
<td>9.797074</td>
<td>90.977</td>
</tr>
<tr>
<td>308.1</td>
<td>Bombala</td>
<td>-36.92992</td>
<td>149.21025</td>
<td>709</td>
<td>9.797401</td>
<td>92.804</td>
</tr>
<tr>
<td>392.2</td>
<td>Cooma</td>
<td>-36.24267</td>
<td>149.16358</td>
<td>842</td>
<td>9.796406</td>
<td>91.206</td>
</tr>
<tr>
<td>456.0</td>
<td>Michelago</td>
<td>-35.68937</td>
<td>149.18950</td>
<td>742</td>
<td>9.796246</td>
<td>92.408</td>
</tr>
<tr>
<td>495.8</td>
<td>Molonglo</td>
<td>-35.44419</td>
<td>149.38908</td>
<td>735</td>
<td>9.796061</td>
<td>92.492</td>
</tr>
<tr>
<td>504.1</td>
<td>Hoskinstown</td>
<td>-35.40097</td>
<td>149.43497</td>
<td>744</td>
<td>9.795996</td>
<td>92.384</td>
</tr>
<tr>
<td>560.2</td>
<td>Oallen/Nerriga</td>
<td>-35.18229</td>
<td>149.96058</td>
<td>607</td>
<td>9.796235</td>
<td>94.030</td>
</tr>
<tr>
<td>638.1</td>
<td>Nowra</td>
<td>-34.89687</td>
<td>150.54399</td>
<td>48</td>
<td>9.797720</td>
<td>100.748</td>
</tr>
<tr>
<td>648.6</td>
<td>Bombaderry</td>
<td>-34.82177</td>
<td>150.59684</td>
<td>29</td>
<td>9.797715</td>
<td>100.976</td>
</tr>
<tr>
<td>689.2</td>
<td>Albion Park</td>
<td>-34.61372</td>
<td>150.79563</td>
<td>80</td>
<td>9.797384</td>
<td>100.364</td>
</tr>
<tr>
<td>702.2</td>
<td>Tallawarra</td>
<td>-34.52556</td>
<td>150.77761</td>
<td>16</td>
<td>9.796870</td>
<td>101.13</td>
</tr>
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Appendix A – Procedure for Validation of Ultrasonic Meters

Latest revision of the GTS-500-PR-VC-001 Ultrasonic Meter Run Verification standard operating procedure, as issued by EGP Field Manager, shall be used as guidance for the validation process on the metering sites, equipped with the ultrasonic meters.

Below is a guideline of the steps to be completed.

1. Tools/Requirements

   The following equipment and tools are necessary to complete the validation process at the metering site:
   - The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through Jemena Enterprise Content Management System (ECMS).
   - The respective meter diagnostic and interface software tools, i.e. MEPAFLOW600 CBM for SICK Maihak meters.
   - The RTU Programming and Interface software tools, i.e. BSI Tools, Control Wave Tools
   - The latest revisions of GOFXL software and SonicWare software
   - The reference documentation, e.g. the respective meter Installation and Operation Manual, Jemena Measurement Manual, the pressure and temperature transmitter Manuals.
   - Dead Weight Tester
   - Multifunction calibrator, e.g. DRUCK, BEAMEX
   - Mercury Thermometer
   - Resistance Decade Box
   - Certified RTD

   Note 1: All instruments, used for the validation, must have the current calibration certificate, as issued by the NATA accredited calibration facility.

   Note 2: A NATA certified Pressure Calibrator with a nitrogen bottle and the regulator can be used instead of the Dead Weight Tester.

2. Preparation for Validation

   - Select the meter run to be validated and notify GT Control Room
   - Open BSI Tools and retrieve data from the Flow Computer’s Dataview table List 50.
   - Open validation spreadsheet and create file for Meter Run/Flow Computer.
   - Create AS FOUND list dump, List 50 (List 52 for reverse) for the meter run. Paste in the AF US sheet of the validation spreadsheet.

3. Pressure Transmitter Test

   - Carry out Pressure Transmitter Verification as per the relevant Jemena Standard Operating Procedure.

   Note: The Dead Weight Tester or the Pressure Calibrator can be used to complete the validation.

4. Temperature Transmitter Test
• Carry out Temperature Transmitter/RTD Verification as per the relevant Jemena Standard Operating Procedure.

5. Gas Chromatograph Verification

• Ensure the Flow Computer VALID.REM is in “OFF” mode. (Selected via Dataview table List 50)
• Carry out Gas Chromatograph Verification as per the relevant Jemena Standard Operating Procedure.

Note: to be carried out if applicable for the site.

6. Sulphur Gas Chromatograph Verification

• Carry out Sulphur Gas Chromatograph Verification as per the relevant Jemena Standard Operating Procedure.
• Note: to be carried out if applicable for the site.

7. Flow Computer Test

• Place the Flow Computer for the meter being tested in validation mode by ensuring that the Flow Validation Flag (Dataview List 50) is in “FORVAL” mode. This will also freeze the GC inputs so that a constant supercompressibility factor can be achieved over the validation time. Also, Control Inhibit the temperature and pressure values displayed in the Dataview table List 50.
• Connect the gated pulse generator (Druck calibrator) to the flow computer pulse input card by means of the open collector and set the pulse output. Typically 300000 pulses @ 5000Hz Baud rate & 10V Amplitude. Refer to respective site drawings for connection test points.
• Copy List 50 to clipboard and paste into the Start Accum sheet of the Validation Spreadsheet.
• Send 300000 pulses into the Flow Computer.
• Once finished counting, ensure that the whole page of List 50 is updated i.e. Scroll to page end, before copying into the End Accum sheet of the Validation Spreadsheet.
• Compare the results from the Flow Computer Spreadsheet (Val 55) between that of the flow computer (volume and energy accumulators), and calculated values.
• The variance should be no more than 0.10%. If the error is greater, ensure that all instantaneous values have been entered correctly. Report any discrepancies or rerun the test as required.
• If successful, disconnect the open collector and reconnect the Flow meter Pulse input to the flow computer.
• In the Dataview List 50, Control Enable the Pressure and Temperature values and return to “NORMAL” mode. Check on SCADA that the FORWARD VALIDATION flag no longer exists and the Pressure and Temperature figures correspond to the billing run.
• Copy an AS LEFT list dump of List 50 (List 52 for reverse) for the meter run. Check against the AF US sheet for discrepancies and if correct, paste in the AL US sheet of the validation spreadsheet.

8. Meter Diagnostic Test
8.1 Carry out on-line diagnostics from the Flow Computer to ensure functionality of all transducers.

8.2 Obtain a copy of the appropriate Dataview table that includes the Diagnostics, List 51. Paste into the Diagnostics sheet of the validation spreadsheet. Immediately, copy Dataview’s List 50, and paste into the Diagnostics sheet of the validation spreadsheet. Compare the diagnostic values with those of AGA 9 recommendations.

8.3 Carry out a speed of sound comparison between the value calculated from the ultrasonic flow meter (List 51) and that of theoretical calculated value. The theoretical value is obtained by using the Sonicware program. Enter the Gas Composition, Pressure and Temperature data of Dataview’s List 50 to the software. Save and print a copy of the calculation. Insert the calculated SOS value into the Meter Diagnostic spreadsheet (Val 52). If the VOS discrepancy is within +/- 1.5m/s continue to Step 8.4. If not return to Step 8.1 and repeat.

8.4 Using the meter diagnostic software, print out a Log File of the ultrasonic meter. Insert into the Meter Diagnostic Report into the Validation Report (Val 52).

8.5 Check meter set up parameters from the Log File with those of the latest calibration certificate data. Information includes path lengths, spool inside diameter, frequency output ranges etc.

8.6 Check all diagnostic data from the Log File with those of previous validations and in particular notice any variable trends that could be occurring.

9. Flow Meter Comparison Test

- The test is to compare the two Ultrasonic Meter in series over the last 24 hours Gas Day.
- Open up SCADA and view/copy the Standard Accumulated Flow Trend of both ultrasonic meters.
- Pick the value after 0630 hours on the day before the validations and paste into Start Flow Comp sheet, and the value approaching 0630 hours on the morning of the validations & paste into End Flow Comp sheet.
- Manually enter the accumulated flow values into the Meter Comparison Spreadsheet (Val 62).
- If Meter Comparison is greater than 1.5%, notify Engineering.

Note: The test is to be carried out for the sites as per the Table 4.

10. Test Completion

- If both Meter Runs and all analysers have been successfully validated, restore the NORMAL configuration of meters and GCs.
- Save all updated spreadsheets, print out validation reports and have signed by witnesses.
- Notify GT Control Room operator on completion of work.
- Record all work in the station diary.
- Save all updated spreadsheets. Hand over the signed off Validation Certificate to the Kembla Grange base for filing on ECMS.
Appendix B – Procedure for Validation of Turbine Flow Meters

Latest revision of the GTS-594-PR-VC-001 Turbine Meter Run Verification standard operating procedure, as issued by EGP Field Manager, shall be used as guidance for the validation process on the metering sites, equipped with the turbine meters.

Below is a guideline for the tools and steps required for the validation:

1. **Tools/Requirements**
   - The following equipment and tools are necessary to complete the validation process at the metering site:
     - The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through the communication facilities from the Jemena shared drives.
     - The RTU Programming and Interface software tools, i.e. BSI Tools, Control Wave Tools
     - The latest revision of GOFXL software
     - The reference documentation, e.g. the respective meter Installation and Operation Manual, Jemena Measurement Manual, the pressure and temperature transmitter Manuals, etc.
     - Dead Weight Tester
     - Multifunction calibrator, e.g. DRUCK
     - Unimat frequency generator
     - Mercury Thermometer
     - Resistance Decade Box
     - Certified RTD
   - **Note 1:** All instruments, used for the validation, must have the current calibration certificate, as issued by the NATA accredited calibration facility.
   - **Note 2:** A NATA certified Pressure Calibrator with a nitrogen bottle and the regulator can be used instead of the Dead Weight Tester.

2. **Preparation for Validation of the Meter Run.**
   - Notify GT Control Room of the intended validation to begin
   - Open validation spreadsheet and create file for Meter Run/Flow Computer.
   - Advise the Customer (if applicable) that the meter run is to be validated.

3. **Pressure Transmitter Test**
   - Carry out Pressure Transmitter Verification as per the relevant Jemena Standard Operating Procedure.
   - **Note:** The Dead Weight Tester or the Pressure Calibrator can be used to complete the validation.

4. **Temperature Transmitter Test**
   - Carry out Temperature Transmitter/RTD Verification as per the relevant Jemena Standard Operating Procedure.

5. **Gas Chromatograph Verification**
• Ensure the Flow Computer is in “NORMAL” mode. (Selected via Dataview table List 50)
• Carry out Gas Chromatograph Verification as per the relevant Jemena Standard Operating Procedure.

6. Moisture Analyser Validation Check
• Carry out the validation of the moisture analyser as per the relevant Jemena Standard Operating Procedure.
  Note: to be carried out if applicable for the site.

7. Flow Computer Test
• Place the Flow Computer for the meter being tested in the Validation mode. This freezes the GC inputs in order to achieve a constant super compressibility factor over the validation time.
• Disconnect the Turbine Meter from the pulse amplifier and connect the Frequency Generator in its place.
• Copy the List 50 from the Flow Computer and pasted into the Validation Spreadsheet to record the test start accumulator values.
• Set the Frequency Generator to inject 300,000 at 5,000 Hz frequency full amplitude (100,000 at 1,000Hz frequency @ 10V amplitude for Smithfield Metering Station).
• Copy the List 50 from the Flow Computer and pasted into the Validation Spreadsheet to record the test stop accumulator values.
• Create an As Left list dump of List 50 for the Meter Run. Paste in the “AL Turbine” page of the Validation Spreadsheet.
• The alternative method, i.e. GOFXL software package, of the volume and energy flow calculations is then applied to the results of the test to verify correctness of the calculations, which have been performed by the Flow Computer.

8. Flow Meter Comparison Test
• Ensure the pressure transmitter on the Check Run has been validated.
• Temporarily isolate the metering facility to reconfigure the arrangement of the isolation valves on the metering skid and place the main meter and the check meter in series configuration.
• Pick a value of accumulated flow from the Flow Computer data accumulator registers at the start of period in which the meters were in series, copy and paste in the Start Flow Comp tab of the Validation Spreadsheet.
• Re-enable the flow of process gas through the metering facility.
• Check the Flow Computer main meter and check meter accumulator values to ensure, the flow data is accounted for in both accumulators.
• Carry out the Series Comparison test for at least 24 hrs.
• On return to the site the following day, copy and paste the test completion values of the main and check meter accumulators in to the end Flow Comp tab of the Validation Spreadsheet

9. RTU Data Comparison Check
• Open SCADA and view “Trend 631”.
• Pick a value at the start of period in which the meters were in series, copy and paste in the “RTU Data Start Comp” tab of the validation spreadsheet. Now pick a value 1
hour after the start period, copy and paste in the “RTU Data End Comp tab” of the validation spreadsheet.
• Manually enter accumulated flow values into the validation spreadsheet Val 64.
• If the RTU Data Comparison is greater than 1.5% notify Engineering.
  Note: to be carried out on Smithfield Metering Station only.

10. Data Transfer Check
Data Transfer Test is relevant only for the sites, equipped with the Bristol Babcock Flow Computer.
  1. Look up the GC data on the SCADA screen and enter the respective information into the SCADA Data tab in the Validation Spreadsheet
  2. Access the Flow Computer data view list 50, copy it and paste into the FC Data tab in the Validation Spreadsheet
  The two sets of data are compared automatically in the Validation Spreadsheet and the variances assessed with regard to the allowable tolerances.

11. Completion of the Validation
• Restore the metering run configuration to Normal
• Save all updated spreadsheets, print out validation reports and have signed by witnesses.
• Advise GT Control Room and the Customer (if applicable) that the validations are complete
• Record all work in the station diary.
• Save all updated spreadsheets. Hand over the signed off Validation Certificate to for filing on ECMS.
Appendix C – Procedure for Validation of Coriolis Flow Meters

Latest revision of the GTS-500-PR-VC-006 Coriolis Meter Run Verification standard operating procedure, as issued by EGP Field Manager, shall be used as guidance for the validation process on the metering sites, equipped with the Coriolis meters.

Below is a guideline for the tools and steps required for the validation:

1. Tools/Requirements

   The following equipment and tools are necessary to complete the validation process at the metering site:
   
   - The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through the communication facilities from the Jemena shared drives.
   - The RTU Programming and Interface software tools, i.e. BSI Tools, Control Wave Tools
   - The reference documentation, e.g. the respective meter Installation and Operation Manual, Jemena Measurement Manual.
   - Dead Weight Tester
   - Multifunction calibrator, e.g. DRUCK
   - Mercury Thermometer
   - Resistance Decade Box
   - Certified RTD

   Note 1: The pressure and temperature validation equipment is only necessary if non-fiscal calibration of the transmitters is being carried out with the meter validation.

   Note 2: All instruments, used for the validation, must have the current calibration certificate, as issued by the NATA accredited calibration facility.

   Note 3: A NATA certified Pressure Calibrator with a nitrogen bottle and the regulator can be used instead of the Dead Weight Tester.

2. Preparation for Validation

   - Select the meter run to be validated and notify GT Control Room. If there are more than one meter run, ensure meter run/flow computer being validated is not the duty meter.
   - Open BSI Tools and retrieve data from the Flow Computer’s Dataview table List 50.
   - Open validation spreadsheet and create file for Meter Run/Flow Computer.
   - Create AS FOUND list dump, List 50 for the meter run. Paste in the AF US sheet of the validation spreadsheet.
   - If applicable, advise the Customer that the meter validation is to take place.

3. Pressure Transmitter Test (Non-Fiscal)

   - If required, carry out Pressure Transmitter Verification as per the relevant Jemena Standard Operating Procedure.
   
   Note: The Dead Weight Tester or the Pressure Calibrator can be used to complete the validation.

4. Temperature Transmitter Test (Non-Fiscal)
5. Coriolis Meter Zero Test
   • Make sure that the pressure and temperature as seen in the process variable menu in the Hart communicator are close to flowing conditions.
   • Open bypass valve around the flowmeter. Close the upstream meter isolation valve and the downstream meter isolation valve.
   • Ensure that zero flow is seen in list 50 and copy into the zero test page on the validation spread sheet.
   • If zero flow is not seen check the isolation valves for passing. If still showing flow, zero the meter as per the RFT9739 manual section 6.4.

6. GC Data Update Checks
   1. Validating the values downloaded from remote GC via SCADA to FC.
   2. Note: The Data in the FC should match the GC data exactly. The GC data in the FC’s List will not match GC data if the validation flag is set or the GC is not the “duty” GC.
      • Check that the HV and SG values on the SCADA screen of site where GC information is coming from correspond to the values obtained from list 50 in the RTU.
      • If they are the same copy the SCADA page by pressing the alt and printscreen keys and copy into the GC or SCADA page on the validation spread sheet.
      • Then copy List 50 into the FC LIST 50 page of the validation spreadsheet.

7. Flow Computer Test
   • Control inhibit the Heating Value and SG Value in the List 50.
   • Connect the gated pulse generator (Druck TRX calibrator) to the flow computer pulse input card by means of the open collector and set the pulse output to 300000 pulses at a baud rate of (5000 Hz) and 10V.
   • Copy List 50 and paste into the Start Accum page of the validation spreadsheet.
   • Send 300000 pulses into the flow computer.
   • Take a second copy of List 50 and paste End Accum page of the validation spreadsheet.
   • Compare the results from the Flow Computer with those of the Calculated volume and energy accumulators after entering the pulse count Coriolis flow computer validation sheet (Val58).
   • Assess errors against the validation tolerances.
   • Disconnect the pulse generator and reconnect the RTU to the flowmeter
   • Control enable the Heating Value Value and SG Value
   • Create AS LEFT list dumps (list 50) for the meter run. Paste in the As Left page of the validation spreadsheet.
   • If applicable, repeat the test for the second metering run.

8. Completion of the Validation
   • Record all work in the station diary.
   • Notify GT Control Room on completion of work.
   • Print out validation report and have signed by witnesses.
   • Save all updated spreadsheets. Hand over the signed off Validation Certificate to the Kembla Grange base for filing on ECMS.
Appendix D – General Procedure for Validation of Pressure Transmitters

Local procedures will be used for the validation.

Below is a guideline for the tools and steps required for the validation:

1. **Tools:**
   - The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through the communication facilities from the Jemena shared drives.
   - The reference documentation, e.g. the respective meter Installation and Operation Manual, Jemena Measurement Manual, the pressure and temperature transmitter Manuals.
   - Dead Weight Tester or Pressure Calibrator
   - Multifunction calibrator, e.g. DRUCK
   - Mercury Thermometer

   **Note 1:** All instruments, used for the validation, must have the current calibration certificate, as issued by the NATA accredited calibration facility.

   **Note 2:** A NATA certified Pressure Calibrator with a nitrogen bottle and the regulator can be used instead of the Dead Weight Tester.

2. **Validation of Pressure Transmitters**

   **With use of the Dead Weight Tester**

   2.1 Place Meter Run in “FORVAL” mode via List 49 (Locking-in the last GC values). Check on SCADA that the correct/non billing meter is displaying FORWARD VALIDATION.

   2.2 Set up the Dead Weight Tester, and connect to Pressure Transmitter.

   2.3 Enter DWT oil reservoir temperature from mercury-in-glass thermometer and record on the Pressure Transmitter section (Val 53) of the Validation Spreadsheet. The Hydraulic head shall also be measured and recorded.

   2.4 Using the calibrated weights, set the pressure on the transmitter to the desired value (as per the nominated values shown in Val 53). Compare the reading on the DWT with the Flow Computer’s Dataview List 49 and manually enter the Pressure Figure into “As Found” data in Val 53.

   2.5 Repeat previous step for all desired pressures.

   2.6 Calibrate and/or replace transmitter if above is not within tolerance. If calibration is required carry out in accordance with the relevant Jemena Standard Operating Procedure.

   2.7 Repeat Step 2.4-2.5 and manually enter the Pressure Figures into “As Left” data in Val 53 of the validation spreadsheet.

   2.8 Disconnect the DWT from the transmitter, reconnect the impulse line and slowly re-pressurise the transmitter.

   **With use of the Pressure Calibrator**

   a) Place Meter Run in validation mode by turning ON signal VALID.REM via List 49.

   b) Connect the Pressure Calibrator, bottle and regulator to the Pressure Transmitter.

   c) Set the pressure on the transmitter to the desired value (as per nominated values shown in the Pressure Transmitter section (Val 53) of the Validation Spreadsheet. Compare the reading with the Dataview’s List 49 and enter into As Found data in the Val 53.

   d) Repeat previous step for all desired pressures.

   e) Calibrate and/or replace transmitter if above is not within tolerance.
f) Repeat Step c&d and manually enter the Pressure Figures into As Left data in Val 53 of the validation spreadsheet.

g) Disconnect the Druck Pressure Calibrator from the transmitter, reconnect the impulse line and slowly re-pressurise the transmitter.

Appendix E – General Procedure for Validation of Temperature Transmitter
Local procedures will be used for the validation.

Below is a guideline for the tools and steps required for the validation:

1. **Tools:**
   - The reference documentation, e.g. the respective meter Installation and Operation Manual, Jemena Measurement Manual, the pressure and temperature transmitter Manuals.
   - Multifunction calibrator, e.g. DRUCK
   - Mercury Thermometer
   - Resistance Decade Box
   - Certified RTD

   **Note 1:** All instruments, used for the validation, must have the current calibration certificate, as issued by the NATA accredited calibration facility.

2. **Temperature Transmitter Validation:**
   - **2.1** At the field transmitter, disconnect the RTD from it and connect the certified resistance device.
   - **2.2** Select the desired temperature reading on the resistance device. Obtain the temperature reading from the Flow Computer's Dataview table List 49 and manually enter into “As Found” data in the Temperature Transmitter section (Val 54) of the validation spreadsheet.
   - **2.3** Repeat the previous step to the desired values (as per nominated values shown in the Temperature transmitter section (Val 54) of the validation spreadsheet).
   - **2.4** Calibrate and/or replace transmitter if not within tolerance. If calibration is required carry out in accordance with the relevant Jemena Standard Operating Procedure.
   - **2.5** If transmitter is calibrated, repeat Steps 2.2 & 2.3 and manually input “As Left” data in the Temperature Transmitter section (Val 54) of the validation spreadsheet.

3. **RTD Test (to be carried out every 6 months)**
   - Remove the RTD from the meter run thermowell.
   - Place the probe in a flask of water together with a certified RTD.
   - Using the Druck Multifunction Calibrator, measure the resistance of the RTD using the 4 wire RTD input. Compare with the Certified RTD.

   If the resistance value for the probe is within the acceptable limits, refit the probe to the meter run. Replace the probe if the reading is outside the acceptable limits.
Appendix F – Procedure for Validation of Gas Chromatographs

Latest revision of the GTS-500-PR-VC-002 Gas Chromatograph/Data Transmission Verification standard operating procedure, as issued by EGP Field Manager, shall be used as guidance for the validation process on the metering sites, equipped with the Gas Chromatographs.

Below is a guideline for the tools and steps required for the validation:

1. Tools/Requirements
   The following equipment and tools are necessary to complete the validation process at the metering site:
   
   - Calibration gas bottle for gas chromatograph with known and NATA certified composition and the current validity date.
   - The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through the communication facilities from the Jemena shared drives.
   - The RTU Programming and Interface software tools, i.e. BSI Tools, Control Wave Tools
   - The reference documentation, e.g. the respective equipment Installation and Operation Manual, Jemena Measurement Manual.
   - Daniel MON software

   Note: Ensure that the details of the Calibration Gas Bottle, which is intended to be used for the validation, match the details of the bottle in the Validation Spreadsheet for the site. This concerns in particular, the calibration cylinder serial number, calibration date, the calibration gas composition. Ensure the calibration of the cylinder falls into the validity period.

2. Preparation for Validation
   
   - Notify GT Control Room of the validation activity
   - Open a new and latest revision of validation spreadsheet.
   - Enable Flow computer communication using BSI tools
   - Enable GC communication using Daniel MON.
   - Ensure correct operation of SCADA displays and printer.
   - To maintain accurate billing, ensure that the GCs are not in or about to commence their auto calibration.

3. Chromatograph Verification
   
   - Connect the PC to the Mon controller and establish communications. Select File / Program Settings and ensure that all boxes are checked, except Enable display in PPM, then OK.
   - Ensure that the GC to be validated / tested is not “Duty” and that the Flow Computer is in “Normal” mode. (As opposed to ‘Val’ mode).
   - Open the verification spreadsheet and on Val 56 select the appropriate Calibration Bottle from the selection scroll-down menu (eg. Port Kembla Bottle 1 C6 GC). Confirm that the Bottle No. and its Composition matches the attached component certificate and all is correctly displayed in the spreadsheet. Also ensure that the correct GC Serial No. is entered via the scroll-down menu provided.
   - Using Mon, Halt the current on-line analysis. Select Control / Halt and wait until the analyser finishes the cycle.
• Request an analysis of stream 1, to give the "As Found" values. Do this by going to the Control menu, select Single Stream / Stream 1 / Purge time 60 secs and select Continuous then OK.

• The GC will then conduct an analysis using the Cal bottle. Note the commence time and allow 3 cycles to be completed.

• Using the results from the third cycle select Chromatogram viewer / GC Archive / Last Analysis Stream 1 / Results / Yes to control flags. Copy to clipboard and paste gas composition results to the GC_AF spreadsheet tab.

• Check Val 56 for variance to the Certified mole % (Cal gas bottle), and that the chromatograph controller calculation tests for 'Z', 'SG' and 'GHV'. If within tolerance copy the results from the GC_AF tab into the GC_AL tab and proceed to step 10.

• If the results are out of tolerance save and print a Chromatogram of the Last Analysis of Stream 1 and carefully assess the discrepancies. Refer to previously filed Chromatograms for further indications. Do Not Calibrate until definite of fault / cause. If it is determined that maintenance of the GC is required return to the Validation Spreadsheet and copy the out of tolerance GC_AF data into the GC_AL tab. Make comment in the Remarks section of Val 56 and obtain witness’ signature. Do Not make this the billing GC until all issues are resolved.

10. Return the GC to “normal” operation. i.e. HALT the current analysis, then

• Control / Auto Sequence / Continuous / Purge 60 secs, then OK.

11. Watch one cycle to ensure correct operation (via MON).

• i.e. Auto Anly & Stream 2 is displayed and there are no outstanding alarms.

• Similarly on SCADA, the difference of GHVs and Total Mol% between GCA & B will be minimal, indicating that the unit is back on-line.

4. Data Transfer Validation

Data Transfer with ON-SITE GC.

• Log onto SCADA and select the appropriate meter for the GC data to be displayed.

• Boot up BSI tools / Netview / Dataview for the appropriate meter, ensuring that list 50 data can be read.

• Disconnect Netview by selecting COM1 / Line / Stop. The COM1 port can now be used for the MON program.

• Open Mon and connect to the appropriate on-line/ billing GC. Wait for the end of the cycle, and the next cycle to start. The time factor now begins as the data will only be available for 1 cycle. To paste the GC results in the spreadsheet select Chromatogram viewer / GC Archive / Last Analysis Stream 2 / Results / Yes to control flags. Copy to clipboard then paste in the GC Data tab of the validation spreadsheet.

• Shutdown MON and, and Start Netview. Read LIST 50 of the selected flow computer, then copy and paste onto FC LIST 50 GC Data Trans tab of the spreadsheet.

• Observe the current analysis on SCADA. Ensure all values are identical in the GC READ & GC SELECTED columns. If correct, copy and paste the SCADA data image into the Scada GC Data Trans tab of the spreadsheet. Print the image.

• From the printout manually enter the SCADA data into Val 6 of the Spreadsheet and confirm the tolerance is 0.000.
• Print out **Val 6** and all supporting documents, check and witnesses to sign.

*Data Transfer with OFF-SITE GC.*

• Boot up BSI tools / Netview / Dataview for the appropriate meter. Obtain a LIST 50, copy and paste into FC List 50 GC Data Trans tab of the spreadsheet.

• Observe the current analysis on SCADA. Ensure all values are identical in the GC READ & GC SELECTED columns. If correct, copy and paste the Scada data image into Scada GC Data Trans tab of the spreadsheet. Print the image.

• From the printout manually enter the SCADA data into Val 63 of the Spreadsheet and confirm the tolerance is 0.000.

• Print Val 63 and all supporting documents, check and witnesses to sign.

5. **Completion of the Validation**

• Record all work in the station diary.

• Notify GT Control Room of completion of work.

• Notify Engineering of any defects found ASAP.

• Print out validation report and have signed by witnesses.

• Save all updated spreadsheets. Hand over the signed off Validation Certificate to the Kembla Grange base for filing on ECMS.
Appendix G – General Procedure for Validation of Moisture Analysers

Local procedures will be used for the validation.

Below is a guideline for the tools and steps required for the validation:

1. Tools/Requirements

The following equipment and tools are necessary to complete the validation process at the metering site:

- Calibration gas bottle for moisture analyser with known and NATA certified composition and the current validity date.
- The latest revision of the Validation Spreadsheet, installed on the technician’s standard laptop or accessible through the communication facilities from the Jemena shared drives.
- The RTU Programming and Interface software tools, i.e. BSI Tools, Control Wave Tools
- The reference documentation, e.g. the respective equipment Installation and Operation Manual, Jemena Measurement Manual.

Note: Ensure that the details of the Calibration Gas Bottle, which is intended to be used for the validation, match the bottle details as contained in the Validation Spreadsheet for the site. This concerns in particular, the cylinder serial number, calibration date, the gas composition in the bottle etc. Ensure the calibration date of the cylinder falls into the validity period.

2. Preparation for Validation Run 1

- Notify GT Control Room of the validation activity
- Open a new and latest revision of validation spreadsheet.
- Ensure correct operation of SCADA displays and printer.
- To maintain accurate billing, ensure that the GCs are not in or about to commence their auto calibration.

3. Moisture Analyser Verification

- Verify the Calibration Bottle ppm concentration as entered in the Validation Spreadsheet moisture analyser table. Confirm that the gas composition and the bottle serial number are as per the calibration bottle label.
- Isolate the process gas sample inlet at the gas sample handling box of the moisture analyser.
- Open the Calibration Gas inlet into the analyser at the sample handling box.
- The analyser will begin to conduct the analysis using the calibration bottle gas. Wait until the operation of the analyser stabilises and the results are consistent.
- Read the result of the analysis in ppm and mg/Nm3 from the meter display and from the SCADA display.
- Confirm the moisture concentration, as indicated by the moisture analyser is comparable to the calibration gas bottle composition within the required tolerances.
- Enter the results of the validation into the Validation Spreadsheet.

4. Data Transfer Validation

- Confirm that the results of the analysis, as displayed on the meter and the SCADA screen are identical.
• On completion of the validation restore the analyser to the Normal configuration of the gas sample intakes.
Appendix H – Procedure for Validation of Sulphur Gas Chromatographs

Latest revision of the GTS-500-PR-VC-003 Sulphur Gas Chromatograph/Data Transmission Verification standard operating procedure, as issued by EGP Field Manager, shall be used as guidance for the validation process on the metering sites, equipped with the Gas Chromatographs.