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Suruhanjaya Tenaga
Energy Commission

GUIDELINES

GUIDELINES FOR SETTING UP CUSTODY TRANSFER METERING STATION AT ENTRY AND EXIT POINT

Established pursuant to subsections 19(2) and (5) of Act 501 and section 4.1 of Third Party Access (TPA) Code

[GAS SUPPLY ACT 1993 (ACT 501)]

Document Control			
Version	**Date of Revision**	**Revised by**	**Organization**

Contents

1.0 Introduction

1.1 Source of Authority

The issuance of these Guidelines (as defined herein) by the Energy Commission of Malaysia (the "**Commission**") is for the purpose provided under subsections 19(2) and (5) of the Gas Supply Act 1993 [Act 501].

1.2 Objective & Purpose of the Guidelines

1.2.1 The objective of these Guidelines is to establish a harmonized framework in implementing the principles laid out under the TPA Codes in relation to the metering philosophy and metering requirements for the natural gas industry.

1.2.2 These Guidelines have been designed to provide broad, transparent and uniform principles to allow accurate, reliable and transparent process for the metering of quality and quantity of natural gas distributed through Regasification Terminal, Transmission Network and Distribution Network.

1.2.3 These Guidelines are intended:

a) to standardize measurement principles, data acquisition and accuracy inclusive of harmonize units and conversion factor across the gas value chains;

b) to identify technical requirements for Measuring Equipment and Metering Station dedicated between connected parties which measures gas movement into or out from the facilities;

c) to ensure technical and operational compatibility between connected facilities in transporting natural gas and execution of facilities operations; and

d) to synchronize technical, operational, communication and data exchange practices to facilitates operational and business-related barriers.

1.3 Requirements under TPA Codes

1.3.1 Under Section 4.1 of the TPA Codes, Regasification Terminal owner, Transmission Network Owner and Distribution Network owner ("**Licensee**") are required by the said codes to measure the quantity and quality of gas at each Entry Point and Exit Point.

1.3.2 Notwithstanding Section 1.3.1 above, Section 4.2 of the TPA Codes indicated that Licensees, having facilities connected with other Licensee's facilities, utilize the same Measuring Equipment in the Metering Station at the Entry Point.

1.3.3 Pursuant to the context specified in Section 4.2 of the TPA Codes, Licensees, which facilities connected with one another, shall recognize the metering station, connecting the two (2) networks, as the Custody Transfer Metering Station for both networks. The said station shall be the Exit Point for the delivering party from their network and the Entry Point for the other party receiving gas to their network.

1.3.4 In addition to Section 1.3.1, Section 4.1 of the TPA Codes also indicated that Licensees are required by the said codes to establish their own metering philosophy.

1.3.5 For the purpose of harmonizing the implementation of TPA Codes, in relation to the metering philosophy and metering requirements, these Guidelines for Setting Up Custody Transfer Metering Station at Entry and Exit points, as provided and defined herein, are developed with the objective and purpose as described in Section 1.2 above.

1.3.6 Each Licensee shall adopt these Guidelines as their Metering Philosophy.

1.3.7 With the adoption of these Guidelines as Licensee's Metering Philosophy, the affected Licensee shall be exempted from following:

a) Under Third Party Access Code for Regasification Terminal;

- Paragraph 4.1.1 (with regards to the Regasification Licensee's Metering Philosophy).

b) Under Third Party Access Code for Transmission Pipelines;

- Paragraph 4.1.1 (with regards to the Transportation Licensee's Metering Philosophy);
- Paragraph 4.1.3 (with regards to the measurement of natural gas quantity at each Transmission Network Entry Point); and
- Paragraph 4.1.4 (with regards to the measurement of natural gas quality at each Transmission Network Entry Point).

c) Under Third Party Access Code for Distribution Pipelines;

- Paragraph 4.1.1 (with regards to the Distribution Licensee's Metering Philosophy);
- Paragraph 4.1.3 (with regards to the measurement of natural gas quantity at each Distribution Network Entry Point);
- Paragraph 4.1.4 (with regards to the measurement of the natural gas quality at each Distribution Network Entry Point).

1.4 Legal Effect of these Guidelines

1.4.1 These Guidelines are applicable to the following Licensees:

a. Regasification Licensee;

b. Transportation Licensee; and

c. Distribution Licensee.

1.4.2 Custody Transfer Metering Station shall be designed and constructed after the registration of these Guidelines to comply with requirement stated in these Guidelines.

1.4.3 For existing Custody Transfer Metering Station, the owner of the station shall have the option either to modify it in accordance to these Guidelines or to apply in writing for exemption as per section 14 in the TPA Code to obtain necessary approval from the Commission.

1.5 Modification of these Guidelines

1.5.1 Pursuant to subsections 19(2) and (5) of the Gas Supply Act 1993 [Act 501], the Commission may from time to time change, amend or review these Guidelines. Any changes, amendments or revision of these Guidelines shall be published by the Commission in its website.

1.5.2 Any Licensee who wishes to deviate from these Guidelines shall obtain the necessary approval from the Commission.

1.5.3 There may be other authorities who have jurisdiction over technical and safety issues throughout the gas value chains, for example, the current jurisdiction of the Department of Occupational Safety and Health ("**DOSH**") on technical and safety issues relating to regasification terminals and transmission pipelines in Malaysia pursuant to the Petroleum (Safety Measures) Act 1984 and Factories and Machinery Act 1967. Such matters are not covered under Act 501 and as such the relevant parties are required to independently liaise with these authorities, if necessary. It shall be the sole responsibility of the relevant parties to identify and ascertain such matters.

END OF SECTION

2.0 Underlying Principles for Setting up the Custody Transfer Metering Station

2.1. The function of each Metering Station is to measure gas moving into (entry) and out (exit) from one network to another network and, where necessary and required by the connected network, pressure regulators are installed to regulate the pressure of the gas.

2.2. These Guidelines are established, with regard to the Custody Transfer Metering Station, based on the following underlying principles:

a) Served as Custody Transfer Point(s);

b) Automated and unmanned facilities (*with at least one level of redundancy for critical metering equipment for Regasification Terminals and Transmission Network but optional for Distribution Network*);

c) Accurate and a real-time calculation for the measurement and control system (*optional for Distribution Network on control system*);

d) Operation and maintenance of Measuring Equipment shall be performed with minimal interruption of gas supply to the Connected Party;

e) Smart diagnostic capability for equipment failure detection where applicable (*only for Regasification Terminal and Transmission Network due to criticality to ensure network integrity*);

f) Compliance to regulatory and established standard requirement;

g) Compliance to Health, Safety and Environment (HSE) requirement.

END OF SECTION

3.0 References

3.1 The following international codes and standards include provisions and Guidelines which, through reference in this text, constitute provisions and Guidelines of the Philosophy.

3.2 Latest issue of the references shall be used unless otherwise agreed between Connected Parties. Other recognized standards may be used provided it can be shown that they meet or exceed the standards set forth below.

American Gas Association (AGA) Report No. 3	Orifice Metering of Natural Gas and other related Hydrocarbon Fluids
AGA Report No. 7	Measurement of Fuel Gas by Turbine Meters
AGA Report No. 8	Compressibility Factor of Natural Gas and Other Related Hydrocarbon gases
AGA Report No. 9	Measurement of Gas by Multipath Ultrasonic Meters
AGA Report No. 10	Speed of Sound in Natural Gas and Other Related Hydrocarbon gases
AGA Report No. 11	Measurement of Gas by Coriolis Meter
American National Standards Institute (ANSI) B109.1	Diaphragm Type Gas Displacement Meters, American gas Association
ANSI B109.3	Rotary Type Gas Displacement Meters, American Gas Association
American Petroleum Institute - Manual of Petroleum Measurement	Flow Measurement Using Electronic Metering Systems - Electronic Gas Measurement

Standards (API MPMS) Chapter 21.1	
American Society for Testing and Materials (ASTM) D1945-14	Standard Test Method for Analysis of Natural Gas by Gas Chromatography
British Standard European Norm (BS EN) 1359	Diaphragm gas meter
BS EN 12480	Rotary displacement gas meter
BS EN 12261	Turbine Meter
BS EN 12405	Gas-volume electronic conversion devices
British Standard (BS) 6400	Specification for installation of domestic sized Meters (2nd and 3rd family gases), which specifies siting and fixing of Meters up to 208cu feet/hr rating
International Organization for Standardization (ISO) 12765	Measurement of fluid flow in closed conduits -Methods using transit time ultrasonic flow meters.
ISO 17799	Information Security Standard
ISO 5168	Measurement of fluid flow - Estimation of uncertainty of a flow-rate measurement.
ISO 6974	Natural gas — Determination of composition with defined uncertainty by gas chromatography
ISO 6976	Natural Gas - calculation of calorific value, density, relative density and Wobbe index from gas composition.

ISO 5167	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full. Part 1 & Part 2
Malaysian Standards (MS) 2589	Measurement of fluid in closed conduits- Ultrasonic meters for custody transfer and allocation gas measurement
MS 2608	Measurement of gas flow in closed conduits – Turbine Meter
MS 1870	Gas Meter – Diaphragm Gas Meters
MS 2292	Measurement of Fluid Flow in Closed Conduits – Coriolis Meter

END OF SECTION

4.0 Definitions

4.1 Unless expressly indicated to the contrary or unless the context otherwise requires, terms adopted and used in these Guidelines shall bear the same meaning as they are defined in the Act 501.

Access Arrangements	means the document defined in paragraph 2.1.2 of the Code entitled "Access Arrangement for Regasification Terminals", entitled "Access Arrangement for the Transmission Network", "Access Arrangement for Distribution Networks" issued by each Licensee pursuant to the TPA Code for each facility;
Accreditation Authority	means any authorities that certifies Meters and/or Metering Equipment and/or Measuring Equipment as respective party considers appropriate. Such authorities may include but not limited to SIRIM Berhad and Nasional Metrology Institute of Malaysia (NMIM);
Accuracy Limits	means the accuracy limits for the relevant Measuring Equipment set out under Section 11.8.10 of these Guidelines;
Act	means the Gas Supply Act 1993 (as amended by the Gas Supply (Amendment) Act 2001 and the Gas Supply (Amendment) Act 2016);
Atmospheric Pressure	the pressure exerted by the weight of the atmosphere, which at sea level has a mean value of 101,325 pascals (roughly 14.6959 pounds per square inch);
Bar	means the bar as defined in ISO 80000-4; a Metric unit of atmospheric pressure, but not part of the International System of Units (SI). It is exactly equal to 100000 Pa and is slightly less than the average atmospheric pressure on Earth at sea level. equal to 14.50 pounds per square inch (lb/in2), 1.02 kilograms

	per square centimeter (kg/cm2), 29.53 inches of mercury (in Hg), or 0.9869 atmosphere. In engineering, the term 'bar gauge' (barg) is used to indicate that the pressure is read from a pressure gauge;
British Thermal Unit (btu)	A standard unit of measurement used to denote both the amount of heat energy in fuels and the ability of appliances and air conditioning systems to produce heating or cooling. A BTU is the amount of heat required to increase the temperature of a pint of water (which weighs exactly 16 ounces) by one degree Fahrenheit. Since BTUs are measurements of energy consumption, they can be converted directly to kilowatt-hours (3412 BTUs = 1 kWh) or joules (1 BTU = 1,055.06 joules);
Calorific Value	the quantity of heat produced by its combustion, at constant pressure and under the conditions known as "normal" of temperature and pressure (i.e. to 0°C and under a pressure of 1 013 mbar). The calorific value of natural gas is expressed in MJ/sm3;
CITECH	Means a software development company specializing in the Automation and Control industry who develop SCADA Master System for Transmission Network
Commission	means Suruhanjaya Tenaga (Energy Commission) established under the Energy Commission Act 2001 [Act 610];
Connected Party	means any party whose facilities are physically connected to the licensee's facilities and shall, where applicable, include the relevant licensees and "connected parties" shall be construed accordingly;
Custody Transfer	Fiscal measurement which is used to determine the quantity and financial value of gas transaction (delivery);
Custody Transfer Point(s)	a point (location) where the gas is being measured for sale and changes hands from one party to another;

Custody Transfer Metering Station	a metering station that is defined as a point (location) where the gas is measured and delivered for sale from one party to another;
Distribution Licensee	means the holder of a Distribution Licence issued under Section 11B(1)(a) of the Act;
Distribution Network	means the gas distribution pipelines which typically transport natural gas from a point, where the natural gas is transferred from transmission pipeline, and moving smaller volumes of gas at lower pressures through small-diameter distribution pipe to a great number of individual users such as small industries, commercials, retailers and residential property.
Entry Point	means a point at which gas is received or injected into a Transmission Network or Distribution Network from or on account of a shipping licensee;
Exit Point	means a point at which gas is delivered from regasification terminals or Transmission Network or Distribution Network to Connected Party;
Electronic Flow Measurement (EFM)	means an electronic gas measurement device that is used to measure the flowrate of Gas. It is a field enclosure type of flow computer mounted at flow meter;
Electronic Volume Corrector (EVC)	means an electronic gas measurement device mounted at flow meter that is used to measure the flowrate of Gas;
Flow Measurement Equipment	means an electronic gas measurement device as described in Section 6.7.6 for Regasification Terminal, 6.12.6 for Transmission Network and 6.19.7 for Distribution Network of these Guidelines;
Gas Connection Manual	as describe in Section 2.1.4 of the TPA Code for respective facilities;
Gas Chromatography	as describe in Section 11.7.4 of these Guidelines;

Gas Management System (GMS)	a system of applications which are used to operate gas pipelines and storage facilities and to handle commercial business processes. It is a modular system solution for monitoring and control, analysis and management that combines applications such as forecasting, nominations, operations, simulation, commercial dispatching, data reporting, etc.;
Hourly Manual Metering (HMM)	means Metering Equipment for which: (a) Metering Data is recorded in the Metering Equipment for each hour bar; (b) Data reading is conducted on monthly basis; and (c) Metering Data is available to the Distribution Licensee to be downloaded on monthly basis from the respective Metering Equipment;
Hourly Telemetry Metering (HTM)	means Metering Equipment for which: (a) Metering Data is recorded in the Metering Equipment for each hour bar; and (b) Meter Data is available to the Distribution Licensee at hourly intervals in real time via a SCADA system;
Hydrocarbon Dew Point	The temperature at which higher hydrocarbons condense. Liquid phase is produced in the gas pipeline if the product temperature falls below the hydrocarbon dew point;
Joule or J	means one (1) Joule at 101.325 kPa (abs) and 15°C;
kPa or kPa(abs)	means kilopascals (1000 Pascals) of pressure at absolute condition;
kPag or kPa(gauge)	means kilopascals (1000 Pascals) of gauge pressure. Gauge pressure is zero-referenced against ambient pressure, so it is equal to absolute pressure minus atmospheric pressure.
MAOP or MAWP	Maximum Allowable Operating Pressure (MAOP) or Maximum Allowable Working Pressure (MAWP) refers to the highest amount of pressure under which a piece of equipment can safely be operated;

Measurement and Control System (MCS)	as describe in Section 6.7.5 of these Guidelines;
Measuring Equipment	means a device measuring a physical quantity and quality of gas or liquid and its associated equipment located in the Metering Station(s) owned by respective Licensee(s);
Metering Data	comprises all data collected and transferred from a Metering and Measuring Equipment, where applicable;
Metering Equipment	means any other associated equipment necessary to complete the Metering Station(s) requirement including inlet, outlet and sectional valves, filtration system, regulating system, pressure safety device, etc. as located in the Metering Station(s) owned by respective Licensee(s);
Metering Philosophy	means these harmonized Guidelines for Setting Up Custody Transfer Metering Station at Entry and Exit points issued by Commission on [*20 December 2018*]. Established pursuant to subsections 19(2) and (5) of Act 501 and section 4.1 of Third Party Access (TPA) Code;
Metering Station(s)	a station in a facility designed for the continuous and simultaneous analysis of the quantity and quality of the natural gas being delivered, transported and/or distributed in the pipeline;
MJ	means Mega Joule or 1,000,000 J or Joules;
mmscfd	means million standard cubic feet per day;
m/s	means meter per second;
Pascal	means the international system or SI unit of pressure of that name;
Person	includes any company or association or body of persons, corporate or incorporate;
Pressure Relief Device (PRD)	A device, normally either PSV or PRV, actuated by inlet static pressure designed to open during emergency or

	abnormal conditions to prevent a rise of internal fluid or gas pressure in excess of a specific design value;
Pressure Safety Valve (PSV)	Automatic discharging device actuated by the upstream static pressure upstream of the valve and characterized by rapid full opening or pop action;
Pressure Relief Valve (PRV)	Automatic discharging device actuated by the upstream static pressure upstream of the valve. It will be activated in proportion with the increase of the pressure;
psi	means pound per square inch i.e. a unit of pressure expressed in pounds of force per square inch of area;
Reasonable and Prudent Operator	means a person acting in good faith with the intention of performing its obligations [under these Guidelines] and who, in so doing and in the general conduct of its undertaking, exercises that degree of diligence, prudence and foresight which would reasonably and ordinarily be exercised by a skilled and experienced operator complying with applicable law and engaged in the same type of undertaking and under the same or similar circumstances and conditions;
Reference Meter	the purpose of this meter is to provide an in-situ verification against all the other custody transfer meters at that location. The idea is to route all the gas from a given operational meter periodically through the “reference” meter and make any adjustment based upon the difference;
Regasification Licensee	means the holder of a Regasification Licence issued under Section 11B(1)(c) of the Act;
Regasification Terminal	means an LNG regasification terminal owned by a Regasification Licensee;
Secondary Equipment	on-line equipment that switchovers automatically in the event the primary equipment fails;
Service Station	means a Custody Transfer Meter Station located at Exit Point owned by the Distribution Licensee with Measuring

	Equipment where a Private Gas Licensee(s) or Retail Licensee(s) purchases Gas from a registered Shipper which also functions to step down pressure;
Shipper	means any person holding a Shipper's Licence issued under Section 11B(1)(c) of the Act for the shipping of Gas;
SIRIM	SIRIM Berhad, formerly known as the Standard and Industrial Research Institute of Malaysia;
Specific Gravity (SG)	Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio between the density (mass per unit volume) of an actual gas and the density of air. Specific gravity for common natural gas: 0.55 to 0.7**.** Specific gravity is unitless and is given by the density of the gas divided by the density of air at 20C and 1bar;
Standby	secondary or backup equipment or data which is normally off-line but available to switchover and run upon when the primary equipment or primary data fails or faulty. A method of redundancy;
Supervisory Control and Data Acquisition (SCADA) systems	A realtime communication system that take measurements and collect data along the pipeline (in a metering or compressor stations and block valves) and transmit them to the centralized control station;
TPA Codes	means the TPA Code (Malaysian Regasification Terminals), the TPA Code (Malaysian Transmission Pipelines) and the TPA Code (Malaysian Distribution Pipelines);
TPA Code (Malaysian Distribution Pipelines)	means the third-party access code for Malaysian Gas Distribution Pipelines dated 16 January 2017 provided for by Section 37B of the Act and issued by the Commission;
TPA Code (Malaysian Transmission Pipelines)	means the third-party access code for Malaysian Gas Transmission Pipelines dated 16 January 2017 provided for by Section 37B of the Act and issued by the Commission;

TPA Code (Malaysian Regasification Terminals)	means the third-party access code for Malaysian Regasification Terminals dated 16 January 2017 provided for by Section 37B of the Act and issued by the Commission;
Transportation Licensee	means the holder of a Transportation Licence issued under Section 11B(1)(b) of the Act;
telemetry	telemetry is an automated communications process by which measurements and other data are collected at remote or inaccessible points and transmitted to receiving equipment for monitoring;
Transmission Network	means the high pressure gas transportation pipelines network which operates across Peninsula Malaysia
Transporter	means the Gas Transportation Licensee, being the owner and/or operator of the Gas Transmission Network;
Validation	means the testing, by tolerance checking, of the validity of a Meter Reading in accordance with these Guidelines.

END OF SECTION

5.0 Ownership of Custody Transfer Metering Station

5.1 Under the TPA Codes, all rights, interests, covenants, and obligations of the Licensee in respect of the measurement and analysis of natural gas received, stored, regasified, processed, transported and/or delivered in the respective facilities fall under the Licensee of the facilities.

5.2 The metering station, connecting the two (2) networks, is the Custody Transfer Metering Station for both networks. The said station shall be the Exit Point for the delivering party from their network and the Entry Point for the other party receiving gas to their network as indicated in Section 4.2 of TPA Codes.

5.3 Notwithstanding the above section 5.1 and without prejudice to the Network Owner's rights under the TPA Codes, the Connected Party may enter into any alternative arrangements between them to determine the ownership of the Metering Station.

5.4 The Connected Party shall discuss in good faith and determine who between them will own, maintain and operate all Measuring Equipment within the Custody Transfer Metering Station(s).

5.5 The Connected Party who owns the Custody Transfer Metering Station, is obligated to (whichever applicable):

a) measure the quantity of gas at each Entry and/or each Exit Point(s);

b) measure the gas quality at each Entry and/or each Exit Point(s) (*optional for Distribution Network(s), with relation to Exit Point(s), as gas quality at all Exit Point(s) within the same network is the same as gas quality entering the network*);

c) ensure all the Measuring Equipment complies with all the applicable laws and regulations as well as these Guidelines;

d) operate and maintain the Measuring Equipment in accordance with the requirement of the relevant Access Arrangement and these Guidelines;

e) provide the other Connected Party who owns, operates and maintains the connected network(s) to the Custody Transfer Metering Station(s), the access to data taken at the Measuring Equipment of the Custody Transfer Metering Station for monitoring, operational coordination, planning and billing purposes; and

f) provide the other Connected Party who owns, operates and maintains the connected network(s) to the Custody Transfer Metering Station(s), with the right to inspect the Custody Transfer Metering Station(s), the operations and maintenance records and require validation and/or calibration records, as the case may be, of the Measuring Equipment owned, operated or maintained by the party.

5.6 For purposes of clarity, the owner of the Custody Transfer Metering Station is not obligated to provide any access to the data to the Private Gas Licensee(s), Retail Licensee(s) and Gas Consumers and any other Licensee(s) where no Gas Connection Manual is entered between the owner of the Custody Transfer Metering Station and the respective parties.

END OF SECTION

6.0 Design Concept of Custody Transfer Metering Station

6.1 In general, all Custody Transfer Metering Stations can be categorized into the Entry Point and the Exit Point.

6.2 Table 1, 2 and 3 below show the classification according to type and flow capacity for Regasification Terminal, Transmission and Distribution network.

Regasification Terminal: (Classification)

Metering Station type	Flow capacity	Remarks
Entry Point	As per LNG Shipment	Measures LNG quality. As for quantity measurement, it is based on tanker volume (tank gauging)
Exit Point	As per Terminal Send-out Capacity	Measures gas prior to entering Transmission Network

Table 1: Metering station classification for Regasification Terminal

Transmission Network: (Classification)

Metering Station type	Flow capacity	Remarks
Entry Point	Flow ≥ 10 mmscfd	Measures gas prior to entering Transmission Network
Exit Point (Large Station)	Flow ≥ 10 mmscfd	Measures gas to a single/multiple Connected Party as well as prior to entering Distribution Network
Exit Point (Small Station)	Flow < 10 mmscfd	Measures gas to a single/multiple Connected Party as well as prior to entering Distribution Network

Table 2: Metering station classification for Transmission Network

Distribution Network: (Classification)

Exit Network Pressure Range	Outlet Pressure setting	Max Flow capacity
Exit Point (A) (1034 ~2483 kPag)	29.4 – 420 kPag	Flow ≥ 100 sm3/hr
Exit Point (B) (241 ~ 400 kPag)	2.94 – 140 kPag	Flow ≤ 800 sm3/hr

Table 3: Metering station classification for Distribution Network

***Note**: Tapping point of pipeline connection to Gas Consumer(s) will be determined based on the closest distance to either Exit Point (A)-Feeder Line or Exit Point (B)-Distribution Line*

Regasification Terminal: (Station Layout)

6.3 For Regasification Terminal, the Custody Transfer Metering Station at Exit Point, mainly consists of Measurement block.

6.4 Filtration and pressure regulating blocks are generally not equipped in Regasification Terminal Metering Station.

6.5 Figure 1 shows a schematic of the measurement block at Regasification Terminal.

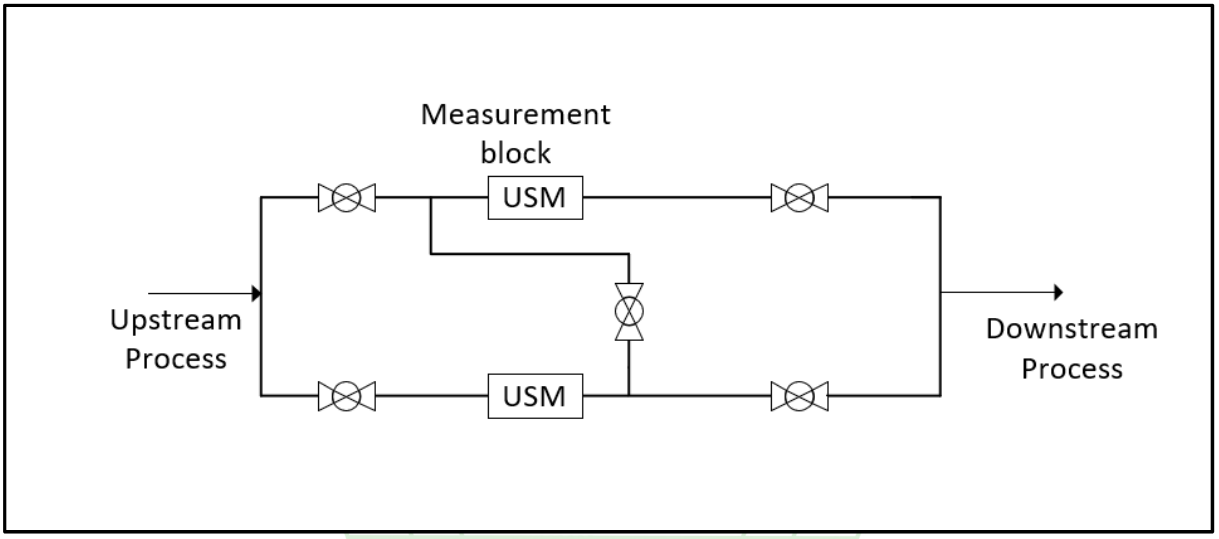


Figure 1: Overall schematic of typical Custody Transfer Metering Station for Regasification Terminal at Exit Point

6.6 Valve indicator status shall be installed at minimum for inlet station, outlet station, proving run and outlet of each meter run.

6.7 **Measurement Block**

6.7.1 The measurement block consists of header, stream meter runs, reference meter run and Flow Measurement Equipment.

6.7.2 Header

a) The inlet header consists of inlet valve upstream of the header and outlet valve at the downstream of the outlet header.

b) The headers are sized to provide equal flow distribution to each of the meter runs to avoid “run hogging”, i.e. more flow being directed to any one run. Maximum velocity for header shall be 15 m/s.

6.7.3 Meter Runs

a) The required redundancy for the meter runs installation is n+1. Multiple meter runs are installed at the stations to ensure that flow rates are kept within the calibrated range of the meter over the full range of expected flows and to improve measurement accuracy. The actual number of meter runs varies depending on the maximum flow scenario through the station.

b) A spare meter run shall be provided so that in the event of a meter failure or meter run component failure (pressure, temperature, profiler, etc.) the failed run can be taken out of service for maintenance and the spare run put into service.

6.7.4 Reference Meter Run

a) A single reference meter run shall be incorporated into the design of the metering station. This is to allow each individual operational meter run to be verified by in-series configuration line-up with a reference meter.

b) The reference meter shall be calibrated at a high-pressure calibration facility which is traceable to primary standard e.g. NMi facility in Netherlands, PIGSAR in Germany or FORCE in Denmark. This shall include other calibration facilities which participated in the harmonization exercise.

6.7.5 Measurement and Control System (MCS)

a) The MCS consists of Programmable Logic Controller (PLC) and Human Machine Interface (HMI) for display and control of a number of functions including monitoring of station auxiliary equipment such as mains and back-up electrical power and the provision of serial communication links to the flow computers and data transmission of alarms, equipment status and billing data to the main Control Room.

6.7.6 Flow Measurement Equipment

a) The required redundancy for flow measurement equipment is n+1. This includes flow meter, Flow Computer (FC), Pressure Transmitter (PT), Temperature Transmitter (TT) and Gas Chromatograph (GC).

b) Each meter run shall be installed with primary and secondary equipment. Each meter run shall have two (2) PT and two (2) TT. These instruments shall be connected to a primary and secondary multi-stream FC.

c) The on-line GC is installed to determine the composition of the gas stream and to calculate the heating value and specific gravity of the gas for use by the FC.

d) The FC utilize inputs from the flow measurement equipment and GC to calculate gas flow rate and accumulated volume and energy delivered to the Connected Party.

Transmission Network: (Station Layout)

6.8 For Transmission network, the Custody Transfer Metering Station, consists of three (3) main blocks:

a) Inlet and filtration block
b) Measurement block
c) Pressure regulation/relief block/automatic shut off device (if required)

6.9 Figure 2 shows a schematic of the inlet and filtration block, the measurement block and the pressure regulation/relief block.

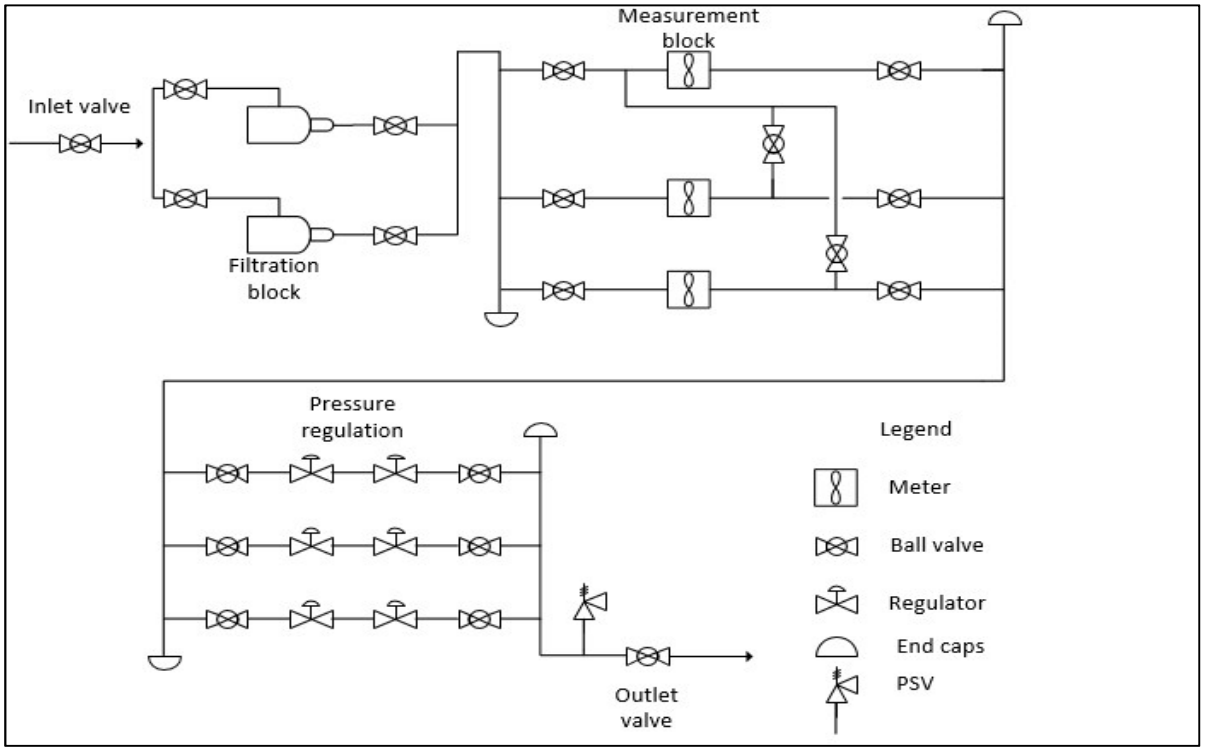


Figure 2: Overall schematic of typical Custody Transfer Metering Station for Transmission Network

6.10 Valve indicator status shall be installed at minimum for inlet station, outlet station, proving run and outlet of each meter run.

6.11 Inlet and Filtering Block

6.11.1 The inlet and filtration block consists of station upstream valve and inlet filters. Filters redundancy are achieved with n+1 configuration. The efficiency of the filter elements shall be 99.98% for removing particulate > one (1) micron.

6.11.2 Online monitoring via Differential Pressure Transmitter (DPT) shall be installed at each filter vessel. Differential pressure for the filter element of wire mesh clogging shall not exceed 100 kPag (15 psig). Filter vessel shall be designed with quick opening and closing enclosure.

6.12 Measurement Block

6.12.1 The measurement block consists of the inlet and outlet headers, meter runs consists of reference meter run and the Flow Measurement Equipment.

6.12.2 Headers

a) The headers are sized to provide equal flow distribution to each of the meter runs to avoid “run hogging”, i.e. more flow being directed to any one run. Maximum velocity for header shall be 15 m/s.

6.12.3 Meter Runs

a) The required redundancy for the meter runs installation is n+1. Multiple meter runs are installed at the stations to ensure that flow rates are kept within the calibrated range of the meter over the full range of expected flows and to improve measurement accuracy. The actual number of meter runs varies depending on the maximum flow scenario through the station.

b) A spare meter run shall be provided so that in the event of a meter failure or meter run component failure (pressure, temperature, profiler, etc.) the failed run can be taken out of service for maintenance and the spare run put into service.

6.12.4 Reference Meter Run

a) A single reference meter run shall be incorporated into the design of the metering station. This is to allow each individual operational meter run to be verified by in-series configuration line-up with a reference meter.

b) The reference meter shall be calibrated at a high-pressure calibration facility which is traceable to primary standard e.g. NMi facility in Netherlands, PIGSAR in Germany or FORCE in Denmark. This shall include other calibration facilities which participated in the harmonization exercise.

6.12.5 Measurement and Control System (MCS)

a) The MCS consists of Programmable Logic Controller (PLC) and Human Machine Interface (HMI) for display and control of a number of functions including monitoring of station auxiliary equipment such as mains and back-up electrical power and the provision of serial communication links to the flow computers and data transmission of alarms, equipment status and billing data to the main Gas Control Centre.

6.12.6 Flow Measurement Equipment

a) The required redundancy for flow measurement equipment is n+1. This includes flow meter, Flow Computer (FC), Pressure Transmitter (PT) and Temperature Transmitter (TT). For Gas Chromatograph (GC), the redundancy is achieved by data connection via Gas Chromatograph Zoning (GCZ).

b) Each meter run shall be installed with primary and secondary equipment. Each meter run shall have two (2) PT and two (2) TT. These instruments shall be connected to a primary and secondary multi-stream FC.

c) The on-line GC is installed to determine the composition of the gas stream and to calculate the heating value and specific gravity of the gas for use by the FC.

d) The FC utilize inputs from the flow measurement equipment and GC to calculate gas flow rate and accumulated volume and energy delivered to the Connected Party.

6.13 **Pressure Regulation and Relief Block**

6.13.1 The design of Custody Transfer Metering Station shall include pressure regulation and relief block if required by agreement with consumer and/or Connected Party. The required redundancy of pressure regulator run is n+1.

6.13.2 Loading type regulator shall be used. Other types of regulating devices are subjected to approval by the Commission.

6.13.3 Each run shall be equipped with active (Fail Open) and monitor (Fail Close) regulator in series arrangement.

6.13.4 PSV is located downstream of the pressure regulation block to provide overpressure protection for Connected Party piping. Downstream PSV is not required if there is no pressure regulation. Automatic shut off device may be used based on case to case basis.

6.14 Power Supply System

6.14.1 Metering Station(s) shall be powered with 400Vac, three-phase, 4 wire supply from electricity service provider.

6.14.2 In the event of a mains power outage or disruption from electricity service provider, vital loads at metering station shall be powered up by a parallel redundant 2 x 100% Direct Current Uninterruptible Power System (DC UPS). DC UPS shall also be installed with a 2 x 100% parallel redundant battery bank.

6.14.3 Each battery bank installed shall be capable to meet vital loads autonomy (back up) time of 8 hours.

Distribution Network: (Station Layout)

6.15 Typical description of Custody Transfer Metering Station for Distribution Network, consists of;

a) Filtration system

b) Regulating system

c) Metering system

6.16 Figure 3 shows a schematic of the Custody Transfer Metering Station(s) in the Distribution Network.

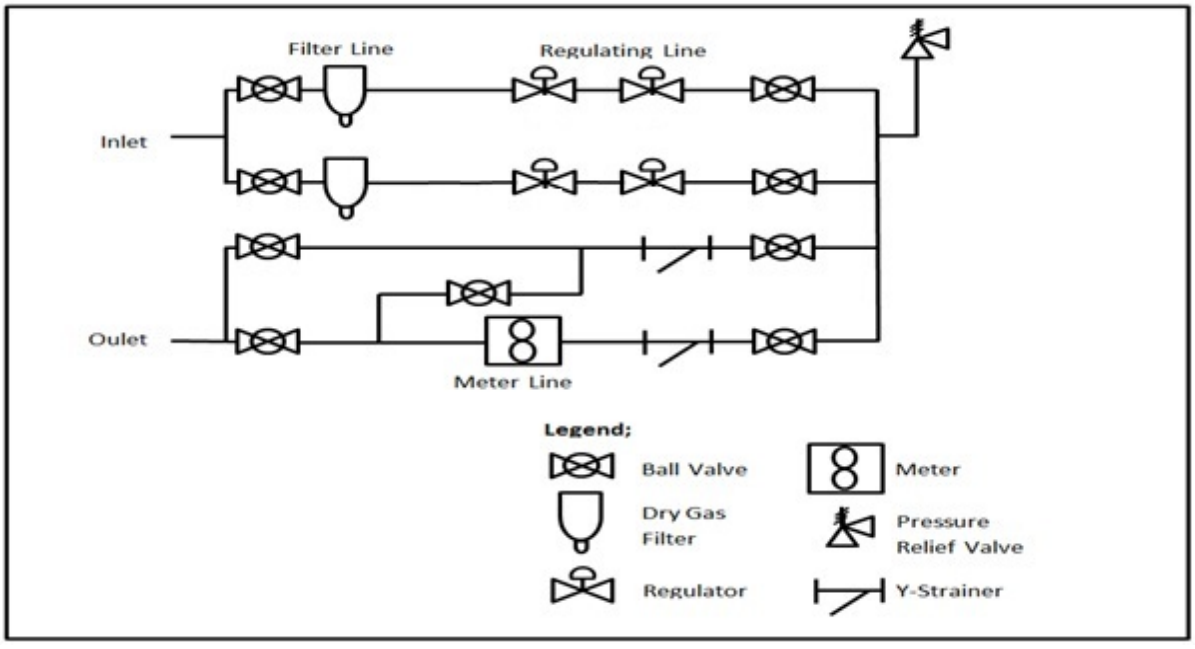


Figure 3: Overall schematic of typical Custody Transfer Metering Station for Distribution Network

6.17 Filtration system

6.17.1 The filtration system is located at the upstream of the station after the first valve. Type of filter installed is based on flow requirement of the station as described below:

a) Dry Gas filter (cartridge type) – installed before regulator line for service station with gas flowrate of 1,000 sm3/hr and above. Filter needs to be able to filter dust particle ≥ 5-micron;

b) Y-strainer – installed before regulator line for service station with gas flowrate of less than 1,000sm3/hr, Y-strainer before regulating line needs to be able to filter dust particle ≥ 5-micron;

c) Installation of Y-strainer before metering line is compulsory for all service station and it shall be able to filter dust particle ≥ 80-micron.

6.17.2 Filtration is designed in dual run concept to protect both the regulating run and the metering run.

6.17.3 To monitor the efficiency of the filter, each filter shall be equipped with Differential Pressure Gauge (DPG). The differential pressure for the filter shall not exceed 50kPag (7psi). Filter shall be equipped with drain valve for maintenance process.

6.17.4 The velocity gas before the filtration system shall be at 20 m/s and after the filtration system shall be at 30 m/s.

6.17.5 For Dry Gas Filter with size 6-inch and above, platform and davit's arm need to be provided for maintenance purpose.

6.18 Regulating System

6.18.1 Regulating system shall be designed to reduce the pressure to the supply pressure requirement of the gas consumers. Regulating line shall be of dual

run for the required redundancy. Each run shall be equipped with Active (Fail Open) and Monitor (Fail Close) regulators in series arrangement.

6.18.2 For service station of 1,000 sm3/hr and above, both runs shall be equipped with loading type regulator (fail open) for active regulator and un-loading type regulator (fail close) for monitor regulator arrange in series. For service station of less than 1,000sm3/hr, both runs shall be equipped with one (1) loading type regulator (fail open) equipped with Over Pressure Shut Off (OPSO) device.

6.18.3 Pressure relief valve (PRV) shall be located downstream of regulating line to provide overpressure protection. PRV is not required if there is no pressure regulation. Downstream of the regulator shall have valves for both runs for maintenance purpose.

6.19 **Metering System**

6.19.1 The metering system shall consist of main meter line, secondary meter line, by-pass line and flow measurement equipment. Metering line shall be designed after the regulating line.

6.19.2 Meter Line

a) Only main meter line will be installed with custody transfer meter equipped with Electronic Flow Measurement device. On the secondary meter line, a spool is installed for ease of meter installation i.e. for check meter or replacement meter in case of main meter dispute or main meter malfunction. At the upstream of the main meter line and secondary meter line, Y-strainer that able to filter dust particle ≥ 80-micron shall be installed.

6.19.3 Type of Meter

a) Turbine meter

Turbine meter will be used for Metering Station which flow coming from Exit (A) i.e. Feeder Line. The turbine meter has to comply with international standards and approved for Custody Transfer purpose. The meter shall be provided with one (1) low flow frequency transmitter and two (2) high frequency transmitters for future installation of electronic gas measurement device when needed.

Accuracy of the meter needs to be;

i. Qmin to 0.2Qmax – ± 2.0%

ii. 0.2 Qmax – Qmax - ± 1.0%

The turndown ratio of the turbine meter is 1:20 or better to ensure application at higher flow range.

b) Positive Displacement Meter

Rotary Meter will be used for Metering Station which flow coming from Exit (B) i.e. Distribution Line. The Rotary Meter has to comply with international standards and approved for Custody Transfer. The meter shall be provided with one (1) low flow frequency transmitter and two (2) high frequency transmitters for future installation of electronic gas measurement device.

Accuracy of the meter needs to be;

i. Qmin to 0.2Qmax – ± 2.0%

ii. 0.2 Qmax – Qmax - ± 1.0%

The turndown ratio of the rotary meter is 1:20 or better to ensure application at higher flow range.

6.19.4 The selection of the meter shall comply with criteria of differential pressure across the meter which is less than 15mbar and meter capacity range shall be between 5% ~ 85%.

6.19.5 Gas meter shall be calibrated before it goes to commissioning. There are two types of calibration tests. First one is low pressure calibration with air. Air at atmospheric pressure is used as test medium. Second one is high pressure calibration with natural gas. Meter that has setting 7 bar and above shall undergo high pressure calibration test. Natural gas at high pressure (7 bar and above) is used as test medium.

6.19.6 The meter shall be calibrated at the factory witnessed by a third party. In case of high pressure meter calibration, it shall be conducted at a high-pressure calibration facility which is traceable to primary standard e.g. NMi facility in Netherlands, PIGSAR in Germany, FORCE in Denmark, Landis+Gyr in Australia, or any other facilities recognized by the Commission.

6.19.7 Flow Measurement Equipment

a) For Metering Station using more than or equal to 200,001mmBtu/year, Electronic Flow Measurement (EFM) will be used and for Metering Station(s) using less than or equal to 200,000mmBtu/year, Electronic Volume Corrector (EVC) will be used.

b) EFM shall receive pulse from meter by using high frequency transmitter.

c) For installation of EFM and EVC, thermowell shall be mounted on the pipe to place the temperature sensor while pressure for the pressure sensor will be tapped at the meter.

Energy (MMBtu/Year)	Category	Description of Metering Equipment
≤ 200,000	Hourly Manual Metering (HMM)	Rotary/Turbine Meter with Electronic Volume Corrector (EVC) equipped with pressure and temperature sensor and hourly reading retrievable
≥ 200,001	Hourly Telemetry Metering (HTM)	Turbine meter with electronic flow measurement (EFM) equipped with pressure and temperature sensor and hourly reading retrievable with telemetry

Table 4: Measuring Equipment requirement for Distribution Network

6.19.8 Power supply is required for the EFM. Normal single phase 240Vac power supply of full armored cable shall be laid in safe zone area (5-10m from the metering station). In the event of power failure, EFM shall have back up battery that can power up the EFM for minimum 10 days.

END OF SECTION

7.0 General Requirement for Custody Transfer Metering Station Design

7.1 For Regasification Terminal, Transmission and Distribution Network, below are the general requirements that shall be considered (where applicable) in the Custody Transfer Metering Station design:

a) Common inlet and outlet header with system of valves to facilitate inspection and maintenance.

b) Metering station shall have provision to enable gas flow during major maintenance or upgrading works (e.g. inlet and outlet take-off for bypass connection).

c) Total energy of gas shall be specified in metrics unit i.e. Joules, Mega joules, Giga joules at Standard Reference Conditions.

d) The Standard Reference Conditions shall be defined as pressure of 101.325 kPa (abs) at temperature of 15^{o}C.

e) The flow of gas can be measured by ultrasonic meter (USM), turbine meter, orifice, positive displacement meter or coriolis meter based on operational suitability. Meter shall have Accreditation Authority approval.

f) Custody Transfer Metering Station in transmission network shall be tele-metered. For Distribution network, telemetry requirement is only applicable for station equipped with EFM.

g) An instrument building shall be made available at the metering station (*only applicable for transmission network*).

h) Metering station in Transmission network shall have wind block type fencing or equivalent for protection against intrusion. (*only applicable for transmission network but optional for distribution network*).

i) Protection against 3rd party impact shall be considered during risk assessment study and the recommendation shall provide adequate safeguard to mitigate the event.

j) Metering station shall meet Custody Transfer accuracy with final energy measurement uncertainty calculation to be less than +/-1.0% for Transmission Network (ISO 5168, ISO Guide to the expression of uncertainty in measurement) and volumetric measurement uncertainty of +/-2.0% for Distribution Network.

7.2 Requirement for Exit point(s) Custody Transfer Metering Station(s) in Regasification Terminal:

a) The metering equipment for exit metering station shall adhere to the following requirements:

i. n+1 stream meter runs with one reference meter run (preferably ultrasonic meter);

ii. Primary and secondary data of gas components from on-line gas chromatographs (on-line gas data is provided by on-site units);

iii. One unit of H2S analyzer (monitoring purposes);

iv. One unit of Hydrocarbon dew point analyzer (monitoring purposes);

v. One unit of moisture analyzer (monitoring purposes);

vi. One primary and one secondary units of multi-stream FC;

vii. Two units of pressure transmitters for each meter run;

viii. Two units of temperature transmitters for each meter run.

ix. One (1) Human Machine Interface (HMI) unit.

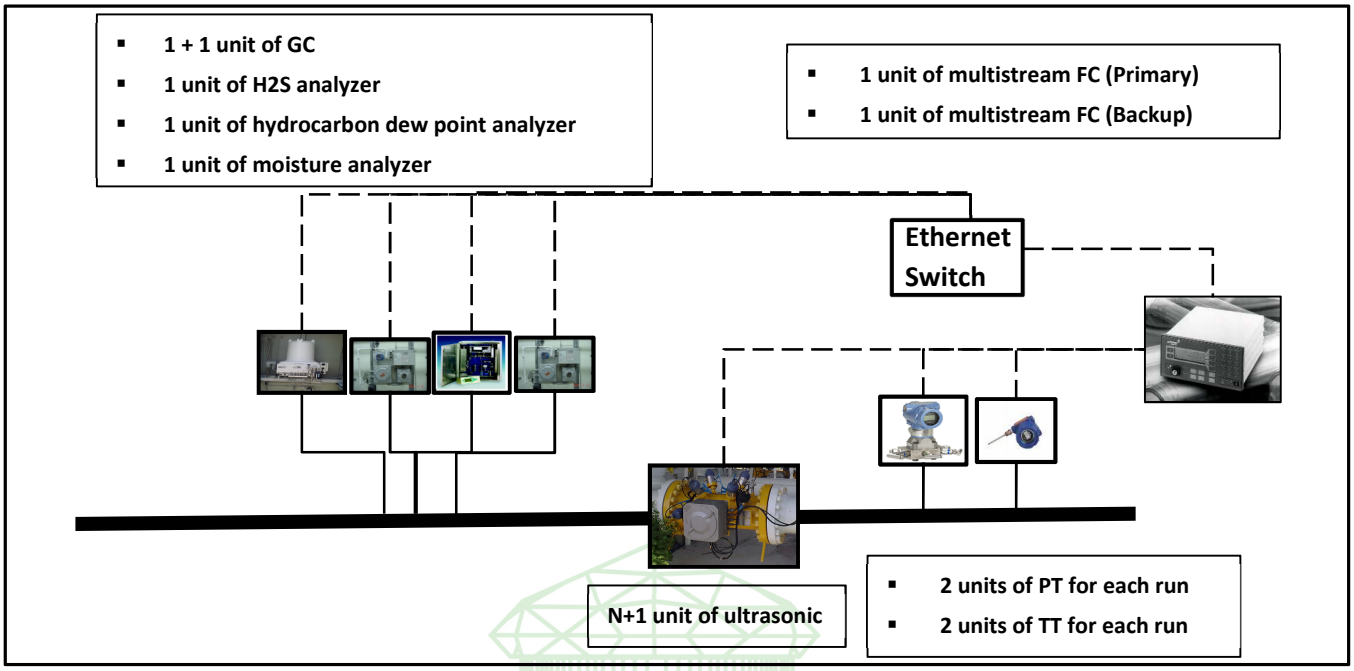


Figure 4: Equipment Requirement for Exit point(s) Custody Transfer Metering Station in Regasification Terminal

7.3 Requirement for Entry and Exit point(s) Custody Transfer Metering Station(s) in Transmission Network:

a) The metering equipment for Entry point(s) shall adhere to the following requirements:

i. n+1 stream meter runs with one reference meter run (preferably ultrasonic meter);

ii. n+1 units of dry gas filters with one spare unit;

iii. Primary and secondary data of gas components from on-line gas chromatographs (on-line gas data is provided either by on-site units or sharing data from another GC units);

iv. One unit of H2S analyzer (monitoring purposes);

v. One unit of Hydrocarbon dew point analyzer (monitoring purposes);

vi. One unit of moisture analyzer (monitoring purposes);

vii. One primary and one secondary units of multi-stream FC;

viii. Two units of pressure transmitters for each meter run;

ix. Two units of temperature transmitters for each meter run;

x. One (1) Human Machine Interface (HMI) unit.

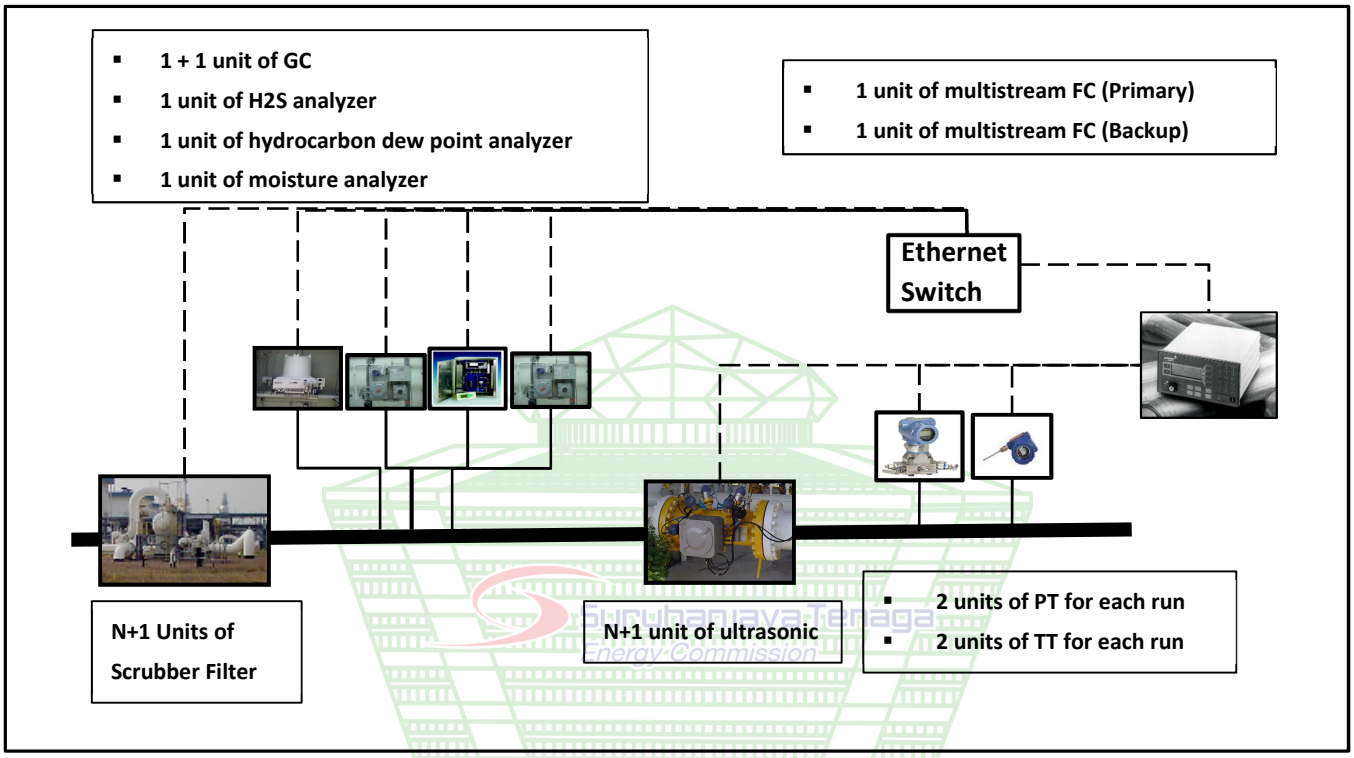


Figure 5: Equipment Requirement for Entry Point(s) (flow ≥ 10 mmscfd) Custody Transfer Metering Station in Transmission Network

b) The metering equipment for large metering station (flow ≥10 mmscfd) shall adhere to the following requirements:

i. n+1 stream meter runs with one reference meter run (preferably ultrasonic meter or turbine meter);

ii. n+1 units of dry gas filters with one spare unit;

iii. n+1 stream regulator runs with one spare run and with one unit of pressure safety valve (if the delivery pressure is regulated);

iv. Primary and secondary data of gas components from on-line gas chromatographs (on-line gas data is provided either by on-site

units or sharing data from GC units from the closest metering station);

v. One primary and one secondary units of multi-stream FC;

vi. Two units of pressure transmitters for each meter run;

vii. Two units of temperature transmitters for each meter run.

viii. One (1) Human Machine Interface (HMI) unit.

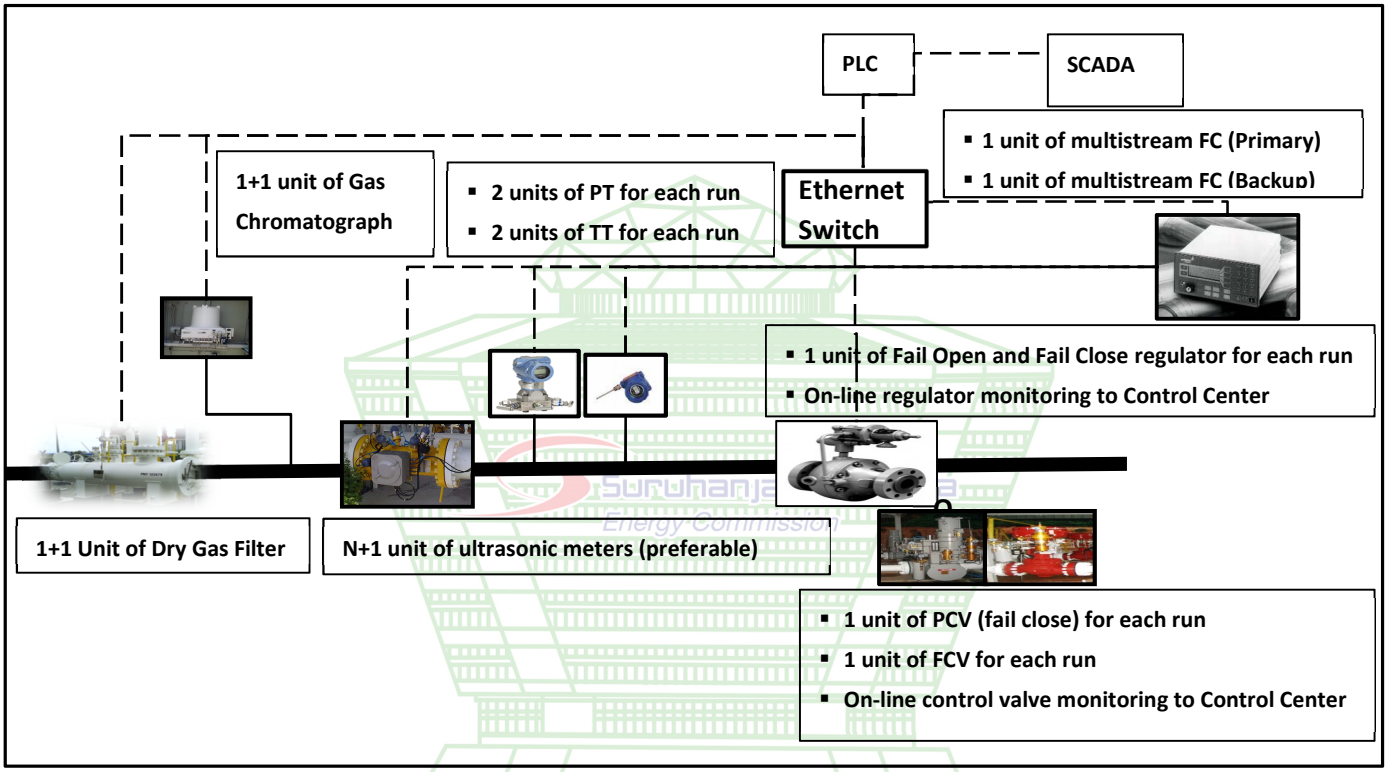


Figure 6: Equipment Requirement for Exit point(s) (flow ≥ 10 mmscfd) Custody Transfer Metering Station(s) in Transmission Network

c) The metering equipment for small metering station (flow < 10 mmscfd) shall adhere to the following requirements:

i. n+1 stream meter runs with one spare/reference meter run (coriolis meter);

ii. n+1 units of dry gas filters with one spare unit;

iii. One primary and one secondary units of multi-stream EFM for each meter run;

iv. n+1 stream regulator runs with one spare run and one unit of pressure safety valve (if the delivery pressure is regulated);

v. One (1) Human Machine Interface (HMI) unit (if necessary).

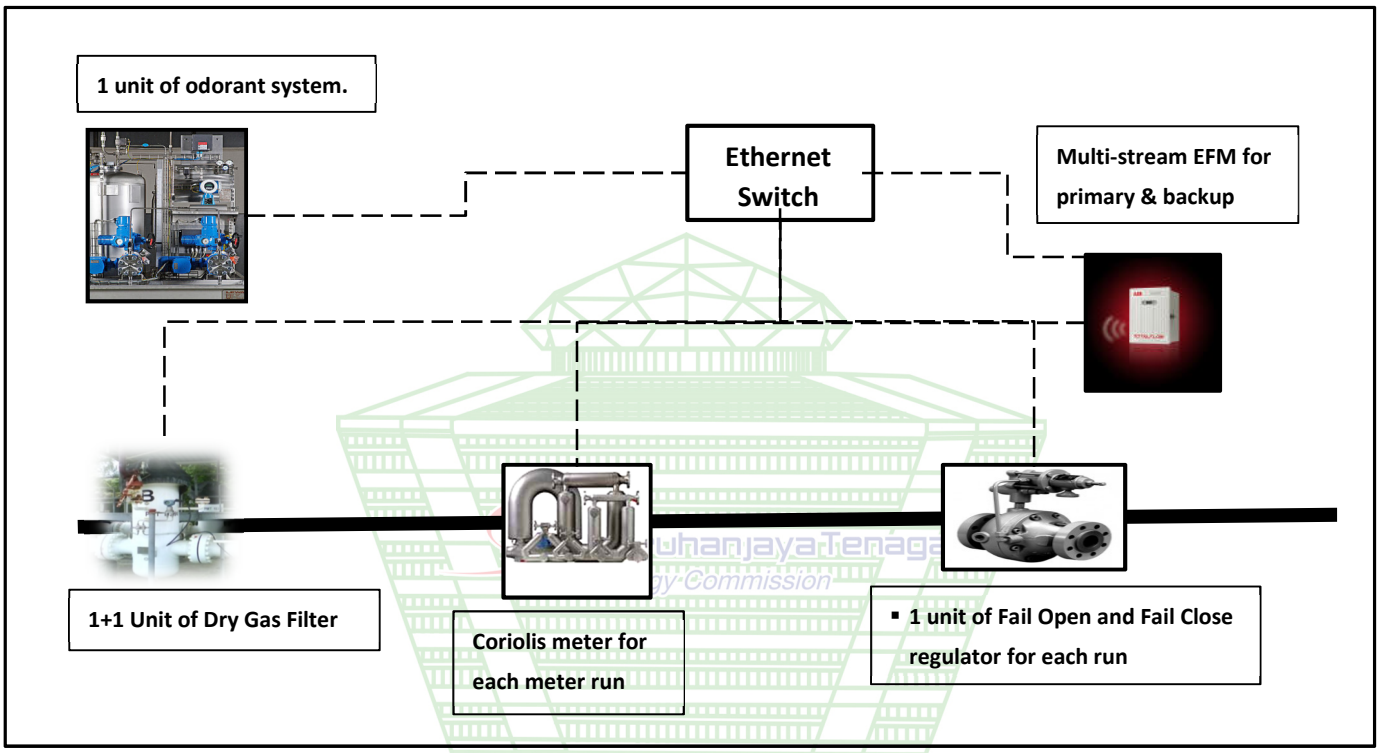


Figure 7: Equipment Requirement for Exit point(s) (flow < 10 mmscfd) Custody Transfer Metering Station(s) in Transmission Network

7.4 Requirement for Exit point(s) Custody Transfer Metering Station(s) for Distribution network:

a) The metering equipment for Distribution Network shall adhere to the following requirements:

i. Dual run system for regulating line (one running and one standby);

ii. Metering line shall have one main meter run and one secondary line for maintenance purposes;

iii. Each run shall have filtration system before regulators and before meter (one running and one standby);

iv. For service station 1000 sm3/h and above, monitor-active regulator configuration shall be used. Loading type regulator to be used as active regulator, un-loading type regulator to be used as monitor regulator and supported by 1 safety equipment which is Pressure Relief Valve (PRV);

v. For service station below 1000 sm3/h, active regulator with OPSO configuration shall be used. Loading type regulator to be used as active regulator and supported by 2 safety equipment which are Over Pressure Shut Off (OPSO) device and Pressure Relief Valve (PRV);

vi. Meter shall be used to measure the gas consumption for billing and operational purposes;

vii. Electronic Flow Measurement (EFM) with telemetry system shall be installed in the metering system for station with flow requirement of 200,001 mmBtu/yr or more;

viii. Electronic Volume Corrector (EVC) shall be used in the metering system for station with flow requirement of 200,000 mmBtu/yr or less.

END OF SECTION

8.0 General Requirement for Equipment Installed in Custody Transfer Metering Station

Regasification Terminal:

8.1 Requirement for Measurement and Control System (MCS)

8.1.1 The Measurement and Control System (MCS) shall be designed in accordance with but not limited to the following:

a) Redundant communication architecture until ethernet switch level;

b) Transmission Control Protocol/Internet Protocol (TCP/IP) Modbus based communication for FC, EFM, GC or analyzers, and PLC;

c) One primary with one standby units of switch interface with metering equipment and SCADA Network;

d) One primary with one secondary unit of multi- stream FC;

e) One unit of Human Machine Interface (HMI);

f) No physical hardwired data connection to customer;

g) Data shall be integrated with following application:

- Regasification Management System (RMS);
- SCADA Master System;
- Alarm Information Management System (AIMS);
- Plant Data Historian.

8.2 Requirement for Spare Capacity

8.2.1 The spare run for meter shall be designed for configuration as per Table 5 below:

Total capacity	Operational run (n)	Spare configuration (n+1)
2 x 100%	1 running	1 running + 1 spare
3 x 50%	2 running	2 running + 1 spare
4 x 33%	3 running	3 running + 1 spare

Table 5: Metering Station spare run configuration

8.2.2 For MCS, the following capacity requirements are as per Table 6 below:

System	Area	Minimum remaining spare capacity
HMI	Hard disk storage	50%
PLC CPU	CPU	20%
FC I/O & I/O rack	Module	20%

Table 6: Metering Station MCS requirement

8.3 Requirement for Reference Meter as Standby Meter

8.9.1 Reference meter shall not be used in normal metering operation.

8.9.2 In case of stream meter failure, the reference meter can be used as a stream meter for a maximum period of twelve (12) month. No further time extension is allowed.

8.4 Requirement for Metering Isolation Valve

8.4.1 All station isolation valve (inlet and outlet), filter isolation valve, meter run isolation valve and regulator isolation valve to be preferably a "top entry" type, full bore ball valves which will permit disassembly and repair of internal components without removing the valve from the piping.

8.4.2 All valves shall have double block and bleed features and specified with grease fittings to allow injection of sealant. Bleed valve shall be installed at the valve body.

8.4.3 An equalizing line (loading line) shall be installed.

8.5 Requirement for Network Protection System

8.5.1 To protect metering data information from external threats, SCADA network communication shall comply ISO 17799: latest version (Information Security Standard).

8.6 Requirement of Fire and Gas Detectors at metering skid

8.6.1 The requirements of detector selection shall consider recommendations in Instrument Protective Function (IPF) study, process safety assessment, Hazard and Operability Study (HAZOP) and Quantitative Risk Assessment (QRA).

Transmission Network:

8.7 Requirement for Measurement and Control System (MCS)

8.7.1 The Measurement and Control System (MCS) shall be designed in accordance with but not limited to the followings:

a) Redundant communication architecture until ethernet switch level;

b) Transmission Control Protocol/Internet Protocol (TCP/IP) Modbus based communication for FC, EFM, GC or analyzers, and PLC;

c) One primary with one standby units of switch interface with metering equipment and SCADA Network;

d) One primary with one secondary unit of multi- stream FC;

e) One unit of Human Machine Interface (HMI). However, this is an optional requirement for small Metering Station;

f) No physical hardwired data connection to third parties;

g) Data shall be integrated with the following applications:

- Gas Management System (GMS);
- SCADA Master System;
- Alarm Information Management System (AIMS);
- Plant Data Historian;
- Auto Billing Correction (ABC) & Gas Chromatograph Zoning (GCZ) Concept.

8.7.2 Figure 8 shows Typical MCS set-up for metering station in Regasification Terminal and Transmission Network.

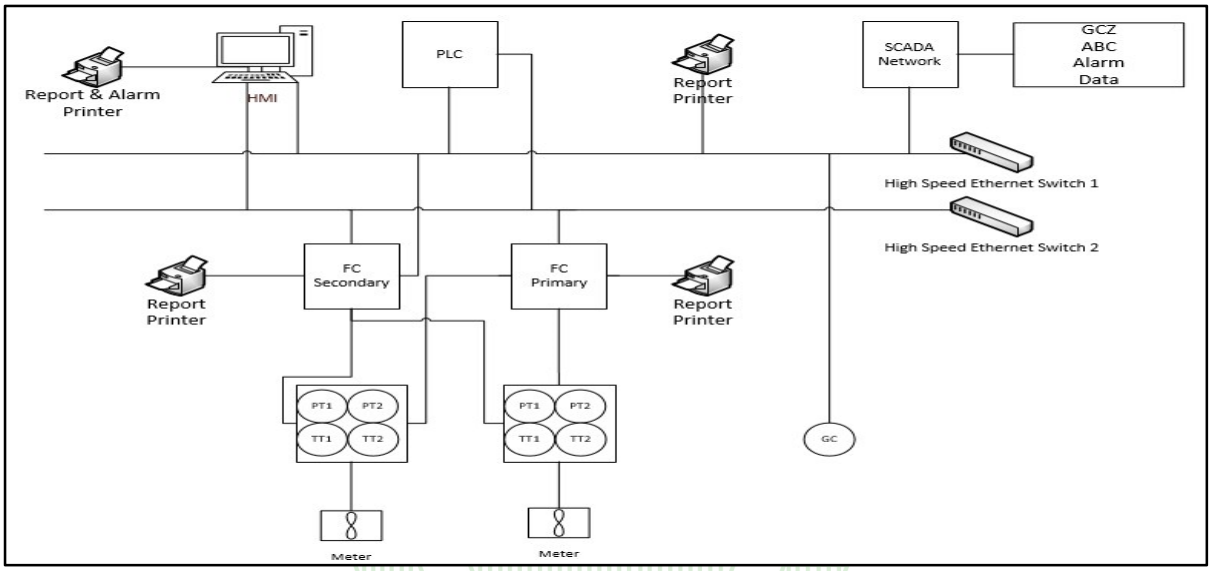


Figure 8: Typical MCS for metering station in transmission network

8.8 Requirement for Spare Capacity

8.8.1 The spare run for filter, meter and regulator systems shall be designed for configuration as per Table 7 below:

Total capacity	Operational run (n)	Spare configuration (n+1)
2 x 100%	1 running	1 running + 1 spare
3 x 50%	2 running	2 running + 1 spare
4 x 33%	3 running	3 running + 1 spare

Table 7: Metering Station spare run configuration

8.8.2 For MCS, the following capacity requirements are as per Table 8 below:

System	Area	Minimum remaining spare capacity
HMI	Hard disk storage	50%
PLC CPU	CPU	20%
FC I/O & I/O rack	Module	20%

Table 8: Metering Station MCS requirement

8.9 Requirement for Reference Meter as Standby Meter

8.9.1 Reference meter shall not be used in normal metering operation.

8.9.2 In case of stream meter failure, the reference meter can be used as a stream meter for a maximum period of twelve (12) month. No further time extension is allowed.

8.10 Requirement for Station Inlet and Outlet Valves

8.10.1 The primary function of station inlet and outlet valve is to isolate the metering facilities from the pipeline and Connected Party piping facilities.

8.10.2 Only station inlet valves shall be actuated and telemetered to SCADA Network to allow remote closing by Control Centre. Remote opening shall not be used for opening of the valve.

8.10.3 Outlet valve shall be equipped with actuator for 12” size or greater.

8.10.4 At minimum, station inlet and outlet valve shall be of Double Isolation and Bleed (DIB) Type 1.

8.10.5 Bypass line shall be provided (1/3 of mainline size) to permit bypassing around the isolation valve for both inlet and outlet valve.

8.10.6 Take-off valves shall be provided before station inlet valve and after station outlet valve for operational flexibility in case requiring maintenance and rectification activities in Metering Station.

8.10.7 Low Pressure Setting (LPS) shall be provided for inlet valve only with option to disable or enable.

8.10.8 Actuator gas tank shall be provided with a hole and plug for PRD installation in future if required.

8.11 Requirement for Metering Isolation Valve

8.11.1 All station isolation valve (inlet and outlet), filter isolation valve, meter run isolation valve and regulator isolation valve to be preferably a "top entry" type, full bore ball valves which will permit disassembly and repair of internal components without removing the valve from the piping.

8.11.2 All valves shall have double block and bleed features and specified with grease fittings to allow injection of sealant. Bleed valve shall be installed at the valve body.

8.11.3 An equalizing line (loading line) shall be installed.

8.12 Requirement for Cathodic Protection systems

8.12.1 Cathodic Protection system shall be installed to protect underground piping from corrosion and the system shall be isolated from aboveground piping.

8.13 Requirement for Lightning and Earthing Protection

8.13.1 A single integrated earthing system for the whole metering station and earthing arrangement shall be of TN-S type.

8.13.2 Safety earth shall be of meshed multipoint earthing.

8.13.3 All metallic structures, equipment, installation shall be bonded together and connected to the plant earth grid.

8.13.4 Instrument earth shall be physically separated from safety earth.

8.13.5 All external and internal lighting protection system shall meet lightning protection level 1.

8.13.6 All above ground piping shall have bonding continuity across its gaskets and the ends of the piping shall be connected to the common earth grid via an earthing boss.

8.14 Requirement for Network Protection System

8.14.1 To protect metering data information from external threats, SCADA network communication shall comply with ISO 17799: latest version (Information Security Standard).

8.15 Requirement for Fire and Gas Detectors Inside Metering Building

8.15.1 Fire and gas detectors inside metering control building (if built up area less than 750 sq. meter) are not required as per Malaysia's Building Code - Uniform Building by Law (UBBL) 1984/2012 and National Fire Protection Association (NFPA) 101 requirement.

8.16 Requirement of Hydrogen and Gas Detectors at battery room

8.16.1 Hydrogen and Gas Detectors is not required if battery capacity in the metering station is less than 20,000 Vah.

8.16.2 Ventilation fan shall be installed for fresh air intakes.

8.17 Requirement of Fire and Gas Detectors at metering skid

8.17.1 The requirements of detector selection shall consider recommendations in Instrument Protective Function (IPF) study, process safety assessment, Hazard and Operability Study (HAZOP) and Quantitative Risk Assessment (QRA).

8.18 Requirement for Design and Setting of Pressure Relief Device (PRD)

8.18.1 The function of Pressure Relief Device (PRD) at metering station are:

a) to protect the equipment from overpressure i.e. filter vessel and actuator tank

b) to protect upstream piping system in fire case scenario and block discharge scenario (gas application) or thermal expansion (liquid application)

c) to protect downstream pressure to customer within delivery pressure range.

8.18.2 The setting of PRD at metering station(s) is as follows:

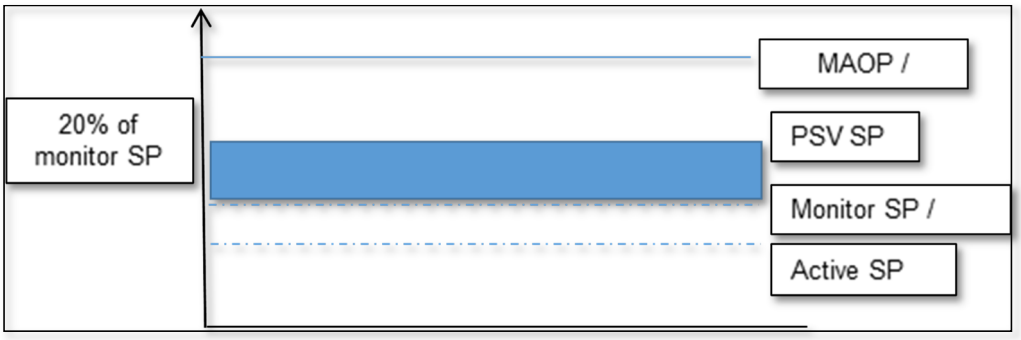


Figure 9: PRD set pressure downstream of regulator.

8.18.3 However, for PRD downstream of regulator, the recommended set pressure is at 20% above the monitor regulator set pressure for PRD to cater for allowance of the monitor regulator lock-up pressure and shall be below MAOP or MAWP of the downstream system.

Distribution Network:

8.19 Requirement for Metering Isolation Valve

8.19.1 All station isolation valves shall be full bore ball valves e.g. inlet and outlet, meter run line and regulator line.

8.19.2 Ball valve at upstream secondary line valve, downstream meter line valve, check line valve shall be trunnion valve with Double Block and Bleed (DBB) type.

8.19.3 For 4-inch and below ball valve, lever operated configuration shall be used. For 6-inch and above, gear operated configuration shall be used.

8.19.4 All trunnion valves shall have Double Block and Bleed (DBB) features and specified with grease fittings to allow injection of sealant. Bleed valve shall be installed at the valve body.

8.19.5 All valves connection shall have raised flanges connection and follow international standards.

8.20 Requirement for Cathodic Protection system

8.20.1 Cathodic Protection system shall be installed to protect underground piping from corrosion and the system shall be isolated from aboveground piping.

8.21 Requirement for Lightning and Earthing Protection

8.21.1 A single integrated earthing system for the whole Metering Station;

8.21.2 All metallic structures and equipment shall be bonded together and connected to the common earth grid;

8.21.3 All above ground piping shall have bonding continuity and shall be connected to the common earth grid via an earthing boss;

8.21.4 Required grounding resistance of each grounding connection shall be less than 5 ohms.

8.22 Requirement for Design and Setting of Pressure Relief Valve (PRV)

8.22.1 The functions of Pressure Relief Valve (PRV) at Metering Station are:

a) to protect upstream piping system in fire case scenario and back pressure (gas application) or thermal expansion; and

b) to protect downstream pressure to customer within delivery pressure range

8.22.2 PRV selected for distribution system shall relieve 10% of the maximum regulator capacity.

8.22.3 The setting of PRV at metering station(s) shall be designed between 20% – 30% of active regulator setting. Downstream PSV is not required if there is no pressure regulation.

END OF SECTION

9.0 General Requirement on Safety and Security of Custody Transfer Metering Station

9.1 Requirement on Safety and Security of Metering Data

9.2.1 Licensee who owns, operates and maintains the Custody Transfer Metering Station(s) shall, in respect of its Metering Equipment, as far as is reasonably practicable:

a) ensure that such metering equipment is secured against unauthorised access, interference, and tampering to the metering equipment;

b) ensure that such metering equipment is located as close to the point of measurement on each network as technically practicable;

c) ensure that metering data held in such metering equipment is protected from unauthorised local or remote electronic access by implementing appropriate security measures;

d) ensure that the security measures it has implemented to prevent any unauthorized local or remote electronic access to the metering data held in the metering equipment are reviewed periodically; and

e) keep secure records of electronic access passwords used to prevent any unauthorized local or remote electronic access to the metering data held in the metering equipment.

9.2 Meter Tampering

9.2.1 If any party finds evidence in relation to any metering equipment, whether or not owned by them, that:

a) there has been tampering with the Metering Equipment; or

b) any person has carried out, engaged in or done anything which will compromise or adversely affect the accuracy of that metering equipment,

then the relevant party shall notify all of the affected parties, as soon as reasonably practicable.

9.2.2 Upon being supplied with information that any of the events in Section 9.2.1 is likely to occur or has occurred, the owner of the Custody Transfer Metering Station shall:

a) notify the Commission as soon as practicable;

b) carry out any relevant investigation or such other investigations as may be directed by the Commission; and

c) furnish the Commission with a written investigation report.

9.2.3 The owner of the Custody Transfer Metering Station shall arrange for tests to be conducted on the affected metering equipment and, if necessary, repair or replace the metering equipment to ensure that the metering equipment is operating within the Accuracy Limits in the event that there has been unauthorised access, interference or tampering with such metering equipment.

9.2.4 Any party who:

a) alters or tampers with any metering equipment at any Custody Transfer Metering Station(s); or

b) carries out, engages in or does anything that will compromise or adversely affect the accuracy of a metering equipment at any Custody Transfer Metering Station(s), shall be liable to and indemnify the affected Connected Party for its reasonable costs of adjustment, repair, replacement and testing of the metering equipment to restore it to operations within the Accuracy Limits.

9.3 Preservation of Metering Data

9.3.1 The owner of the Custody Transfer Metering Station(s) and each relevant party shall ensure that any metering data collected from the relevant metering equipment is not altered, corrupted or lost. With regards to metering data, if such data is lost, altered, or corrupted, the Owner of the Custody Transfer Metering Station(s) shall not be liable to such loss as long as they have taken all reasonable steps and measures to ensure the integrity of such data.

9.4 Confidentiality

9.4.1 The Owner of the Custody Transfer Metering Station(s) and each relevant party shall keep all metering data and passwords confidential, except to the extent that the Owner of the Custody Transfer Metering Station(s) or such party is required to provide such information under these Guidelines, the Code, the Access Arrangement, applicable law or pursuant to the order of any court of competent jurisdiction.

END OF SECTION

10.0 Validation and/or Calibration

10.1 This section is intended to provide Guidelines for the following purposes:

a) measurement and calculation method for volume measurements, volume conversion and gas quality measurements; and

b) validation and calibration procedures for the Metering Equipment.

10.2 The objective is to ensure that all Measuring Equipment and instrumentation used at the metering station is maintained at its level of accuracy and integrity.

10.3 In general, a metering station is designed within acceptable limits for Custody Transfer function. The validation shall determine if a metering station is operating within the operational allowable limits. Equipment specified under the measurement block is subjected to be validated as per procedure outlined in these Guidelines.

10.4 Volume and Energy Measurement

10.4.1 The method of measuring gas passing through a flow meter is as follows:

a) measure the volume of gas; and

b) calculate the energy content of the gas by multiplying the volume with heating value per unit volume.

10.5 Volume at base and standard condition

10.7.1 Since volume of gas varies at different pressure and temperature, it is important to establish a reference condition of pressure and temperature.

10.7.2 Base pressure shall be 101.325 kPa absolute and base temperature shall be 15^{o}C**.**

10.7.3 Volume of natural gas measured at actual pressure and temperature shall be converted into volume of gas at base pressure and temperature using flow computers or electronics flow measurement.

10.6 Volume at normal condition

10.6.1 Gas in normal or real condition behaves differently from gas in standard or ideal condition. The difference is due to attractive and repulsive forces between gas molecules.

10.6.2 To correct for the deviation, a compressibility factor 'z' is introduced into Ideal Gas law which compensates for the effect of dynamic pressure on the kinetic or ideal pressure (AGA Report No 7). The basic Ideal Gas law relationship is per the followings;

$P_f.V_f = z_f.n.R.T_f$ for Flowing condition

and,

$P_b.V_b = z_b.n.R.T_b$ for Base condition

where;

P	=	absolute pressure
V	=	volume
z	=	compressibility factor
n	=	no. of moles of gas
R	=	universal gas constant
T	=	absolute temperature

Since R is a constant for the gas regardless of pressure and temperature, and for the same number of moles of gas n, the two equations can be combined to yield,

$$Vb = Vf \left(\frac{Pf}{Pb}\right)\left(\frac{Tb}{Tf}\right)\left(\frac{Zb}{Zf}\right)$$

10.7 Energy Determination

10.7.1 The amount of Energy delivered can be determined by:

Energy = standard volume x calorific value

10.7.2 The calorific value or heating value of gas is the amount of energy released when a unit volume of the gas is burnt.

10.7.3 The calorific value of gas can be obtained using a gas chromatograph in compliance with ISO 6976.

10.7.4 Gas Chromatography is a process by which the sample of gas is analysed by separating it into its component. From concentration and calorific value of each components, the calorific value and specific gravity of the overall mixture of the gas can be calculated.

10.7.5 The calorific value is taken from the gas chromatograph installed at the metering station. In the case of unavailability of gas chromatograph equipment at the station or unavailability of calorific value due to failure of the equipment, the calorific value for energy calculation shall be obtained from the nearest metering station within the zone.

10.8 Validation Activity

10.8.1 Initial Validation

a) Initial validation shall be carried out on a nominated day after the metering station gas-in to ensure that the metering station has been constructed in accordance with the specifications, codes and standards. The scope and procedures of the initial validation of each equipment as outlined in Section 10.8.7 to 10.8.9 of these Guidelines;

b) The validation shall be carried out by the metering owner or appointed third party with final responsibility shall be under the owner;

c) Metering owner shall notify and invite the relevant shipping licensee, relevant Connected Party and the respective authorities to witness the validation activities. The validation report shall be submitted as per section 10.8.5.

d) For avoidance of doubt, sections 10.8.1(a), (b), (c) are not applicable to the Measuring Equipment and Metering Station located in the Distribution Network. For distribution network, the initial validation shall be based only on manufacturers certification.

10.8.2 Scheduled Validation

a) Subsequent validations shall be carried out on a scheduled basis at the specified intervals as per Section 10.8.6. Scheduled validation is intended to ensure the continued accuracy and integrity of Measuring Equipment. The scope and procedure of the scheduled validation for the respective metering station are as per outlined in Section 10.8.7 to 10.8.9 of these Guidelines;

b) The validation shall be carried out by the metering owner or appointed third party with final responsibility shall be under the owner.

c) The owner of Custody Transfer Metering Station(s) shall notify and invite the relevant shipping licensee, relevant Connected Party and the respective authorities to witness the validation activities. Thereafter, the owner of Custody Transfer Metering Station(s) shall carry out the validation process on such nominated day whether the persons invited to witness the process are present or otherwise. The validation report shall be submitted as per section 10.8.5;

d) For avoidance of doubt, Scheduled Validation for Distribution Network is conducted only for EFM and EVC. There is no Scheduled Validation required for the meters.

10.8.3 Unscheduled Validation

a) While in operation and notwithstanding the intervals as stated for validation, an unscheduled validation will be initiated by the owner whenever the accuracy of a Measuring Equipment is suspected to deviate from the allowable limit or whenever the disputing party disputes the accuracy of an invoice in such circumstances as validation is relevant to the dispute thus requiring immediate revalidation. If the result is found to be within the allowable limits, then the disputing party shall bear all costs related to the unscheduled validation activity;

b) The validation shall be carried out by the owner of Custody Transfer Metering Station(s) or appointed third party with final responsibility shall be under the owner;

c) The owner of Custody Transfer Metering Station(s) shall notify and invite the relevant shipping licensee, relevant Connected Party and the respective authorities to witness the validation activities. Thereafter, the owner of Custody Transfer Metering Station(s) shall carry out the validation process on such nominated day whether the persons invited

to witness the process are present or otherwise. The validation report shall be submitted as per section 10.8.5;

d) For Distribution Network, any dispute on the meter accuracy shall be resolved by sending the meter to third party calibration facilities for validation.

10.8.4 Major Validation

a) After ten (10) years from the initial validation date, and every ten (10) years thereafter a major validation shall be performed. The major validation shall be functionally identical to the initial validation with replacement of new master meter or recalibrated master meter (whichever applicable);

b) The validation shall be carried out by the metering owner or appointed third party with final responsibility shall be under the owner;

c) Metering owner shall notify and invite the relevant shipping licensee, relevant Connected Party and the respective authorities to witness the validation activities. The validation report shall be submitted as per section 10.8.5;

d) For avoidance of doubt, Sections 10.8.4(a), (b), (c) are not applicable to the Measuring Equipment and Metering Station located in the Distribution Network;

e) For Distribution Network, all meters shall be replaced every 10 years in operations in accordance to Section 136 of the Gas Supply Regulation 1997.

10.8.5 Recording of Validation Results

a) The results of all validations shall be recorded and deemed as correct and accurate until the next validation schedule. Original copy of the validation records shall be maintained by the Metering Owner;

b) Validation records for Metering Station on physically connected facilities between Transmission Licensee and Connected Parties shall be forwarded to the Connected Parties within ten (10) working days upon final acceptance of the activity;

c) Validation records for Metering Station on physically connected facilities between Distribution Licensee and the Consumer shall be forwarded to the Consumer as and when requested by the Consumer;

d) In the event where the Shipping Licensee requested for the validation record from the applicable Metering Owner, the applicable Metering Owner shall provide such record to the Shipping Licensee.

10.8.6 Validation Frequency

a) Frequency of validation, depending on metering station classification, are as per the following table:

	Metering Station Type	Frequency	Remarks
1	Entry Metering Station	Initial, Quarterly, & Major	For Metering Station where gas entering transmission pipeline, e.g. Regasification Terminals Exit Point and Gas Processing Plants Metering Station.
2	Exit Metering Station for Power sector	Initial, Quarterly & Major	For all Tenaga Nasional Berhad (TNB), Independent Power Producers (IPPs) and COGEN Metering Station.
3	Exit Metering Station for Non-Power sector and Process plant	Initial, 6-monthly & Major	Include Gas Malaysia Energy Solution (GMES), Petronas NGV (PNGV), Gas District Cooling (GDC), PETCHEM Metering Station and selected process plants using gas for feed or for industrial usage.
4	Exit Metering Station at Exit Point of Distribution network	Yearly	For Pressure Indicator
		Every 3 years	For Electronic Flow Measurement (EFM) and Electronic Volume Corrector (EVC)

TABLE 8: Frequency of Validation Based on Metering Station Type

10.8.7 Validation Procedure

a) A brief description of the objectives and procedures for the validation of each individual item of Measuring Equipment is given below;

b) For Accuracy Limits to be achieved, refer to the detailed tables for the respective Metering Equipment:

i. Section 10.8.11(a) for Regasification Terminal and Transmission Network; and

ii. Section 10.8.11(b) for Distribution Network.

NO	EQUIPMENT	PROCEDURES
1	Meter Run	Introduction: The meter run shall be inspected during the Initial Validation. Objective: To ensure installation is in conformance with relevant standard as per designed. Procedures: When the meter run is ready for installation, inspection and relevant measurement shall be conducted as per standard to determine straight length requirement and installation is in conformance with relevant standard
2	Reference Run Check	Introduction: The operating meter shall be validated against a reference meter through proving exercise to verify that the meter is in good operating condition. During the exercise, operating and reference meters shall be run in series for a certain period of time (e.g. 30 minutes) depending on the convenience of gas flow. Reference Run Check

		shall also be carried-out as Unscheduled Validation if any of the flow meter is suspected to be inaccurate or damaged. Objective: To ensure the meter is in good operating condition and maintain a high degree of measurement accuracy. This is applicable for turbine meter, positive displacement meter, Coriolis meter, Ultrasonic meter where z-configuration is available. Procedures: The valving of the meter run is prepared such that the meter to be checked is flowing in series with the reference run. After the flow and other conditions through the runs are stable, the flow comparison is initiated. All comparison calculations are performed either automatically by the flow computers or manually. Mode of calculation depends on the Metering Station design and the proving period depends on the convenience of gas flow. The percentage of error shall be calculated as below: **Volume (Stream) – Volume (Reference) x 100 = % Error** **Volume (Reference)** ***Note:*** *For Coriolis, the unit Volume need to be replaced with Mass.* If the flow meter is found to be out of the accuracy check limits, action is taken to correct the problem on site if possible. If the problem is meter related and cannot be rectified on-site, the meter is removed from service and sent for repair and re-calibration.

3	Static Pressure Transmitter	<u>Introduction:</u> The static pressure transmitter shall be validated to verify that the transmitter calibration remains stable and accurate. For calibration using dead weight tester, a correction factor for gravity and temperature shall be performed accordingly. <u>Objective:</u> To ensure the static pressure transmitter reading at the FC/EFM is within the agreed accuracy specifications. <u>Procedures:</u> A close loop 5-points calibration to the FC / EFM is performed using a dead weight tester / pressure comparator at the following points (rising): a. 0% of span b. 25% of span c. 50% of span d. 75% of span e. 100% of span ***Note**: The transmitter shall need to be over-ranged to 105% of span.* The above calibration points are repeated in the reverse order (falling) for the second set. The transmitter output reading is displayed and recorded at each individual FC / EFM. "As Found" shall be performed and recorded at all points before any adjustment are made. If "As Found" are not within accuracy limit, calibration shall be made accordingly and recorded as the "As Left" reading. All calibration made (if any) shall be recorded and reported.

Correction Factor for Dead Weight Tester:

a. Gravity Correction Factor

Local gravity differs depending upon geographic locations. The acceleration of local gravity shall be determined as follows:

$G = 9.7803184(1+0.0053024\sin^2\text{Ø} - 0.0000058\sin^2 2\text{Ø}) - 3.086 \times 10^{-6} \times h$

(as per International Gravity Formula 1967)

Where: 9.7803184 = Equatorial gravity at sea level (ms^{-2})

G = Theoretical local gravity (ms^{-2})

Ø = Latitude (decimal format)

h = Height relative to sea level (m)

The local gravity correction factor (F_G) to be applied is calculated as follows:

$$F_G = G / G_{REF}$$

Where: F_G = Local gravity correction factor

G = Local acceleration due to gravity

G_{REF} = Reference acceleration due to gravity (from certificate) Use 9.80665 ms^{-2} for dead weight.

b. Temperature Correction Factor

If the temperature at the site is different for which the dead weight was calibrated, the actual pressure as shown on the dead weight certificate must be corrected to actual pressure at site via the following formula:

$$F_T = 1 + C \times (T-T_{REF})$$

		Where: F_T = Temperature correction factor C = Thermal coefficient (per ^oC) T = Temperature at test site T_{REF} = Reference temperature (from dead weight certificate) Note: For Ametek Dead weight, C = 0.0000167 For Budenberg Dead weight, C = 0.000023 c. <u>Combined Correction Factor</u> Where the local gravity correction factor (F_G) and the temperature correction factor (F_T) have been calculated, the pressure value of the applied deadweight can be corrected as follows: $$P_C = P_A \times F_G \times F_T$$ Where: P_C = Dead weight output corrected for pressure and temperature P_A = Pressure value of dead weight being applied F_G = Local gravity correction factor F_T = Temperature correction factor

4	Temperature Transmitter	<u>Introduction:</u> The temperature transmitter output reading shall be validated as per schedule specified in Section 10.8.11 to verify that the reading remains stable and accurate. <u>Objective:</u> To ensure the temperature transmitter reading at the flow computer/ electronic flow measurement (EFM) is within the agreed accuracy specifications. <u>Procedures:</u> A close loop 3-point calibration to the flow computer is performed using 3 different water-baths and a thermometer at the following points: a. Cold (< 5^0C) b. Ambient (20-35^0C) c. Hot (40^0C - 60^0C) The output reading is displayed and recorded at each individual flow computer/electronic flow measurement. “As Found” shall be performed and recorded at all points before any calibration are made. If “As Found” are not within limit, calibration shall be made accordingly and recorded as the “As Left” reading in the form. All calibration made (if any) shall be recorded and reported.

5	Flow Computer (FC) & Electronic Flow Computer (EFM)	Introduction: The flow computers calculation check shall be performed as per schedule specified in Section 10.8.11. Objectives: a. To ensure the flow rate calculation performed is in accordance with relevant standards (AGA 7, AGA 8, AGA 9, AGA 11, ISO 5167) and the accuracy of the calculation is within the agreed accuracy specifications. b. To ensure the flow accumulation check is within the agreed accuracy specifications. Procedures: Flow is simulated using frequency injector. The relevant figures as per Section 10.8.10 shall be entered into the validation software and result shall be recorded. a) Flow Rate Calculation Check Volume (USM, Turbine Meter, Orifice): Four (4) different sets of input variables under Section 10.8.10 Table 9 for the respective Metering Station shall be entered into the flow computer. The flowrates computed by flow computer are then verified with the results calculated separately using the validation software. Mass: (Coriolis meter only): Three (3) different sets of both pulse input and K-factor as in Section 10.8.10 Table 11 shall be entered. Mass computed by the flow computer shall be verified with the results calculated manually.

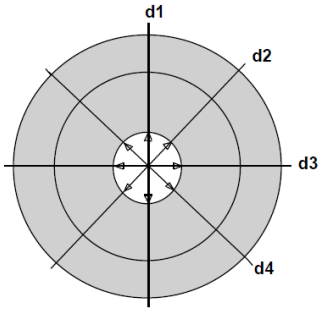
		b) Flow Accumulation Check Volume (USM, Turbine Meter, Orifice): Calibration equipment (frequency injector or portable device) is connected to the process instrumentation already looped to the flow computer to simulate process flowrate with pressure and temperature using online conditions and CV is keypad. Flow is allowed to accumulate for minimum 30 minutes, while volume, energy and mass computed by flow computer/EFM are verified against results calculated separately by validation software. Mass: (Coriolis system only): Frequency injector is connected to the process instrumentation already looped to the flow computer to simulate mass calculation. Mass is allowed to accumulate for minimum 30 minutes, and then the mass computed by flow computer are verified against results calculated separately by manual calculation. The values for process simulation are as per Section 10.8.10 Table 12.
6	Gas Chromatograph (GC)	Introduction: The gas chromatograph (GC) output reading shall be validated as per schedule specified in Section 10.8.11 with standard gas to verify that the readings remain stable, repeatable and accurate within the acceptable limit. Objectives: To ensure that the results from the GC analysis of the calibration gas are within the allowed repeatability limits as per ASTM D1945 and repeatability calculation as per ISO 6976. This include checking the calculated Calorific Value (CV) and Specific Gravity (SG) by the GC.

		Procedures: Standard gas with known composition shall be used as a reference. A total of ten (10) components shall be analyzed and checked for repeatability and accuracy. A minimum of five (5) analysis runs of the standard gas are performed and the results of the gas analysis are checked against the standard gas for their component repeatability. If results are found to be out of tolerance, the GC shall be checked and calibrated.

10.8.8 Validation Procedure (additional requirement) for Orifice Meter

This section is applicable for Metering Station that has been installed with orifice meter configuration. If the process conditions permit, for all validations, any meter run undergoing validation shall be taken offline.

NO	EQUIPMENT	PROCEDURES
1	Orifice Plate Inspection & Changing	Introduction: a. Validation of the orifice plates shall be conducted during the Initial and Scheduled Validations. b. If damage found to the plate, changes of orifice plate shall be made to maintain the differential pressure recording between 20% and 80% in linear scale. Objectives: a. To ensure that the orifice plates are in conformance with ISO 5167-2-2003(E) - Clause 5.1. b. To check for correct installation of plates, possible damage to the plates and plate cleanliness

		Procedures: In the Initial Validation process, all new orifice plates shall be inspected prior to installation and commissioning. The orifice plates shall be re-inspected during Scheduled Validation (6-monthly). The inspection shall include the following: i) General Shape & Orifice Bore Diameter (d) To inspect the general shape, circularity and concentricity of the orifice bore. a. General shape shall be visually inspected. b. The orifice shall be cylindrical. Circularity of the orifice bore shall be verified by measuring the bore diameter at 4 different locations 45 degrees apart as per below diagram, using an internal micrometer or caliper. No individual diameter shall differ by more than 0.05% from the mean diameter.  c. The diameter ratio, B=(d/D), shall always be greater than or equal to 0.10 and less than or equal to 0.75
		ii) Upstream Face A To inspect the flatness and smoothness of the plate. a. Flatness The flatness may be measured with the plate removed from the pipe. Under these circumstances, the plate may be considered

		to be flat when the maximum gap between the plate and a straight edge of length D laid across any diameter of the plate is less than 0,005(D – d)/2, i.e. the slope is less than 0.5 % when the orifice plate is examined prior to insertion into the meter line. The uncertainty requirements for this dimension can be met using feeler gauges. b. Smoothness The upstream face shall have a roughness criterion, Ra < 0.0001d within a circle whose diameter is not less than D and which is concentric with the orifice. iii) <u>Downstream Face B</u> a. The downstream face shall be checked for flatness and shall be checked for flanges and shall be parallel with the upstream face A. b. Inspection for flatness and surface condition can be judged by visual inspection as it is unnecessary to provide the same quality of surface finish as the upstream face. iv) <u>Thickness E and e</u> a. The value of e shall be measured at 4 different locations, 90 degrees apart and shall differ not more than 0.001D among themselves. The thickness of the orifice, e shall be between 0.005D and 0.02D. b. The thickness of the plate E shall be between e and 0.05D. v) <u>Angle of Bevel α</u> a. The angle of bevel α shall be between 45° ± 15°. The angle of bevel shall be measured by using a bevel gauge.

vi) Edges G, H and I

a. The upstream edge G and downstream edges H and I shall have neither wire edged, nor burrs, nor in general any peculiarities visible to the naked eye.

   Upstream edge G will be sharp; the edge radius shall not be greater than 0.0004d.

b. The edge may be checked for nicks by running the thumb nail along the edge to feel for nicks. With visual inspection, the edge is considered sharp if it does not seem to reflect light when viewed by the naked eye.

vii) Diameter of orifice d

The diameter of the orifice plate d, shall be taken as the mean of the measurements of at least four diameters distributed in the axial planes at approximately equal angles to each other.

No diameter shall differ by more than 0.05% from the value of the mean diameter.

Shall then be corrected to d at 20 ^{0}C for the d to be used in the flow computers. (at 20 ^{0}C) = d $_{ambient}$ * (1 + 0.000017* (20 ^{0}C – T $_{ambient}$)).

viii) Scheduled Inspection and During Change of Orifice Plates

a. The orifice plates shall be inspected as per the schedule and during any change of the plates for the condition of the plate and seal.

b. The edge G shall be inspected for nicks or defects.

2	Differential Pressure Transmitter	<u>Introduction:</u> Differential Pressure Transmitter shall be validated as per schedule in order to verify that the transmitter calibration remains stable and accurate. For calibration using dead weight tester, a correction factor for gravity and temperature shall be performed accordingly. Please refer to formula under Pressure Transmitter. <u>Objective:</u> To ensure the differential pressure reading at the flow computer is within the agreed accuracy specifications. <u>Procedure:</u> A close loop 5-points calibration to the flow computer / EFM is performed using a high pressure dead weight tester/pressure comparator at the following points (rising): a. 0% of span b. 25% of span c. 50% of span d. 75% of span e. 100% of span **Note:** The transmitter shall need to be over-range to 105% of span. The above calibration points are repeated in the reverse order (falling) for the second set. The transmitter output reading is displayed and recorded at each individual flow computer / EFM. The transmitter output readings will be displayed and recorded from each dedicated flow computer.

		High pressure zero and as found shall be performed and recorded at all points before any adjustments are made. All adjustments made shall be recorded and reported.

10.8.9 Validation Procedure (additional requirement) for Coriolis Meter

This section is applicable for Metering Station that has been installed with Coriolis Meter configuration.

NO	EQUIPMENT	PROCEDURES
1	Coriolis Mass Meter 3rd Party Calibration	Introduction: The Coriolis mass meter shall be sent to approved third party facility for validation and calibration to verify that the Coriolis mass meter is in good mechanical operating condition and within accuracy check limits. The calibration shall also be carried out as an Unscheduled Validation if the Coriolis mass meter is suspected to be inaccurate or damaged. Objective: To ensure that the Coriolis mass meter is in good mechanical operating condition and that it maintains a high degree of measurement accuracy. Procedures: The Coriolis mass meter shall be remove from service and send for calibration at third party facility. The Coriolis mass meter shall undergo verification in 2 steps. i. In the first step, the accuracy of a mass meter shall be determined using Gravimetric calibration.

		ii. In the second step, the meter is then checked at the field by conducting “zeroing” on the calibrated Coriolis mass meter without performing a dynamic flow test. The frequency of sending Coriolis meter for recalibration depends on Metering Station configuration. For Metering Station that have a reference run configuration (master-operation), only the master meter shall be send for recalibration every 3 years. The operation meter shall be sent if it is out of tolerance during reference run check. For Metering Station without reference run configuration, each operation meter shall be sent for recalibration every 3 years.

10.8.10 Flow rate calculation and flow accumulation calculation checks

The following is the input data to be entered for flow rate calculation and flow accumulation calculation checks.

No	Pressure (kPag/Psig)	Temperature (Deg C/^{0}F)	Frequency (Hz) / Gross Vol (m3/hr)	DPT (orifice only)	Calorific Value (MJ/Sm3)	Remarks
1	5,000/725	60/140	80% Qmax	80%	35-45	Determination of frequency based on meter certificate. Other variables are to be key-pad to one set value and remain the same through the test
2	200/29	0/32	80% Qmax	80%	35-45	
3	5,000/725	0/32	20% Qmax	20%	35-45	
4	200/29	60/140	20% Qmax	20%	35-45	

TABLE 9: Flowrate Calculation Check

No	Loop	Test Equipment	Test set at	Remarks
1	Frequency	Frequency Generator	Set 50% of meter Qmax	Based on meter certificate
2	Gross volume	Validation Software or key-pad	Set 50% of meter Qmax	Based on meter certificate
3	Pressure	High Pressure Deadweight Tester or equivalent	Line Pressure	Set at near operating pressure
4	Temperature	Ambient Water Bath and Thermometer	Ambient Temperature	Easy to maintain at ambient temperature using ambient water bath
5	Differential Pressure (for orifice)	Low Pressure Deadweight Tester or equivalent	Set 50% of DPT meter	Based on DPT meter range
6	C1, C2, C3, i-C4, n-C4, i-C5, n-C5, C6+, N2, CO2, CV, SG	Gas Chromatograph	Online values	Value set from the gas chromatograph

TABLE 10: Flowrate Accumulation Check

Loop	K-factor (pulse/kg)	Calculated Mass (kg)	Remarks
Frequency	Refer meter certificate	Set at 20%, 50% and 80%	Simulate the specified frequency injector and trigger the FC. Record the reading registered by the FC and compare with the calculated reading

TABLE 11: Mass Calculation Check

No	Loop	Test Equipment	Test Set at	Duration	Remarks
1	Frequency	Frequency Injector	Set at 50% of meter Qmax	Min 30 minutes	Set at about 50% of span
2	K-factor	Coriolis Meter	Refer meter certificate	Min 30 minutes	Set at operating value

TABLE 12: Mass Accumulation Check

10.8.11 Equipment Validation Accuracy Limits

a) For Transmission Network, the following is a list of typical equipment and their accuracies which is agreed and allowed during validation exercise.

NO	EQUIPMENT	CALIBRATION RANGE	CALIBRATION ACCURACY	VALIDATION SCHEDULE
1	Meter Run	N/A	N/A	Initial, Major
2	Flow Meter	N/A	Reference Run Check: +/- 1.0% of reading in Sm3 (for Metering Station using meter with high frequency signal) or mass (Coriolis) +/- 2.0% of reading in Sm3 (for Metering Station using turbine meter with low frequency signal)	Initial, Quarterly or 6-monthly (depend on customer type), Major

3	Pressure Transmitter	Typically, 0 – 8,000 kPag 0-1160 psig	+/- 0.1% of calibration range	Initial, Quarterly or 6-monthly (depend on customer type), Major
4	Temperature Transmitter	Typically, 0^0C - 60^0C 32^0F-140^0F	+/- 0.5 ^{0}C of reading	Initial, Quarterly or 6-monthly (depend on customer type), Major
5	Flow Computer	N/A	Flowrate Calculation Check: +/- 0.001% of reading Flow Accumulation Calculation Check: +/- 1.0% of reading Mass Calculation Check: +/- 0.01% of reading Mass Accumulation Check: +/- 1.0% of reading	Initial, Yearly, Major
6	Electronic Flow Measurement (EFM)	Volume: N/A Pressure Sensor: Typically,	Flowrate Calculation Check: +/- 0.01% of reading Flow Accumulation Calculation Check: +/- 1.0% of reading Pressure Sensor:	Initial, Yearly, Major

		0-8000 kPag 0-1160 psig Temperature Sensor: Typically, 0-60^{0}C 32^{0}F-140^{0}F	+/- 0.25% of calibration range Temperature: +/- 0.5^0 C of reading	Initial,6-monthly, Major Initial,6-monthly, Major
7	Gas Chromatograph	N/A	CV: +/- 0.05 MJ/Sm3 of reading +/- 1.0 BTU of reading (at nominal 1000 Btu/Scf) SG: +/- 0.001 of reading For GC repeatability as per ASTM D1945 defined limits.	Initial, Quarterly, Major
8	Orifice Plate Inspection (Various Size)	N/A	N/A	Initial, 6-monthly
9	Differential Pressure (for orifice meter)	Typically, 0-70 kPag 0-60 kPag 0-50 kPag 0-12.5 kPag 0-6 kPag	+/- 0.25% of calibration range	Initial, Quarterly

10	Coriolis Meter	N/A	1. Reference run check (at site): +/- 1% of mass 2. Gravimetric calibration: +/- 0.2% of measured quantity	Initial, Yearly 3-Yearly
11	Electronic Volume Corrector (EVC)	Volume: N/A Pressure Sensor: Typically, 0-8000 kPag 0-1160 psig Temperature Sensor: Typically, 0-60^{0}C 32^{0}F-140^{0}F	Flowrate Calculation Check: +/- 0.01% of reading Flow Accumulation Calculation Check: +/- 1.0% of reading Pressure Sensor: +/- 0.25% of calibration range Temperature: +/- 0.5^0 C of reading	Initial, Yearly, Major Initial, 6-monthly, Major Initial,6-monthly, Major

***Note**: The above accuracies are applicable to field equipment and flow computer or electronic flow computer directly for custody transfer billing calculation.*

b) For Distribution Network, the following is a list of typical equipment and their accuracies which is agreed and allowed during validation exercise.

NO	EQUIPMENT	CALIBRATION RANGE	CALIBRATION ACCURACY	VALIDATION SCHEDULE
1	Pressure Gauge	Typically, 0 - 4000 kPag 0 - 580 psig	+/- 1.0% of full range	Yearly
2	Electronic Flow Measurement (EFM) & Electronic Volume Corrector (EVC)	Volume: N/A Pressure Sensor: Typically, 0-4000 kPag 0-580 psig Temperature Sensor: Typically, 0-60^{0}C 32^{0}F-140^{0}F	Flow Accumulation Calculation Check: EFM: +/- 1.0% of reading EVC: +/- 1.0% of reading Pressure Sensor: EFM: +/- 0.25% of calibration range EVC: +/- 1.0% of calibration range Temperature: EFM: +/- 0.5^0 C of reading EVC: +/- 1.0^0 C of reading	Every 3 Years

10.8.12 List of Test Equipment

The following table is a list of major test equipment used in the validation process (wherever applicable) and the Accreditation Authority or agencies authorized for verification of test equipment accuracy:

NO	EQUIPMENT	AGENCY
1	High Pressure Dead Weight Tester (0 – 10000 kPa)	SIRIM or any SIRIM's appointed testing agencies
2	Low Pressure Dead Weight Tester (0-100 kPa)	SIRIM or any SIRIM's appointed testing agencies
3	Pneumatic Dead Weight Tester	SIRIM or any SIRIM's appointed testing agencies
4	Pressure Comparator with Precision Gauge	SIRIM or any SIRIM's appointed testing agencies
5	Calibration Gas for Gas Chromatograph	Any appointed vendors
6	Precision Decade Resistance	SIRIM or any SIRIM's appointed testing agencies
7	Frequency Counter / Injector	SIRIM or any SIRIM's appointed testing agencies
8	Thermometer (Digital/Mercury in Glass or equivalent)	SIRIM or any SIRIM's appointed testing agencies
9	Measurement Tape & Internal Micrometer	SIRIM or any SIRIM's appointed testing agencies
10	Hardened Straight Edge	SIRIM or any SIRIM's appointed testing agencies
11	Internal Micrometer Set	SIRIM or any SIRIM's appointed testing agencies
12	Bevel Gauge	SIRIM or any SIRIM's appointed testing agencies

13	Precision Feeler Gauge Set	SIRIM or any SIRIM's appointed testing agencies
14	Vernier Caliper	SIRIM or any SIRIM's appointed testing agencies
15	Process Multi-Meter	SIRIM or any SIRIM's appointed testing agencies

END OF SECTION

11.0 Operations, Maintenance and Upgrading of Custody Transfer Metering Station

11.1 The party who owns the Custody Transfer Metering Station(s) is responsible for the operation and maintenance of the Metering and Measuring Equipment reside in the station(s).

11.2 The Custody Transfer Metering Station(s) shall be operated and maintained to the standards of a reasonable and prudent operator in preserving the safety, reliability and integrity of the Measuring Equipment, as well as the continuity of gas supply.

11.3 Owner of the Custody Transfer Metering Station(s) shall:

a) ensure the operation and maintenance activities on its Custody Transfer Metering Station(s) are carried out in a way such that gas supply interruption can be prevented or minimized where reasonably possible; and

b) inform the respective party of the operation and maintenance by providing a prior written notice as soon as reasonably practicable.

11.4 In addition to Section 11.3(b) above, and where an operation and maintenance activity on a Custody Transfer Metering Station(s) necessitates an interruption to gas supply, the owner of the Custody Transfer Metering Station(s) and the respective party shall meet and agree on dates and duration that suit the requirement of both parties, including the possibility of coinciding the said activity within the shutdown window for the respective party's facilities.

11.5 All metering data shall be recorded and maintained by the owner of the Custody Transfer Metering Station(s).

11.6 In view of differences in units of measurement used in operations of each individual facilities, all metering data to be reported shall be in metric units

applying conversion factors published by the International Gas Union (IGU) and shall have at least a minimum of one (1) digit of decimal point.

11.7 In the events of there is a need to upgrading the Measuring Equipment, the party who owns, maintains or operates the metering station must:

a) inform all the affected party within reasonable time frame in advance of the upgrading works; and

b) endeavour to carry out the upgrading work with the objective of causing minimum interruption to the services provided.

END OF SECTION

Dated: 20 December 2018

IR. AZHAR BIN OMAR
Chief Executive Officer
for Energy Commission