

Flow Meter Testing

Calibration & Repair Services

Reynolds Number Proving
(True Service Condition Testing)



*Triple Point –
Where business need, innovative services
and measurement performance meet.*

Reynolds Number Testing

A proven common approach for accurate flow meter calibration.

A unique facility offers a practical solution to Industry need for better flow measurement accuracy.

"...the expected operating Reynolds number range and/or density for a meter needs to be taken into account when designing a calibration program....."

- Quote from AGA Report No. 7 February 2006, section 6.3.2 "Calibration Guidelines"

Facility

The new Terasen Measurement patented facility is the first of its kind; able to test flow meters over a wide range of operating conditions using carbon dioxide (CO₂), matched to true operating conditions.

Customer Benefits

Our customers will benefit from Triple Point with:

- More accurate billing for turbine customers
- Established credibility through third party verification
- Immediate access, year round, to accurate test facilities
- Faster turnaround times
- Technical Expertise

Test Capabilities

Flow Range	1,000 - 230,000 ACFH (30 - 6,500 m ³ /hr)
Pressure Range	2" - 12" turbine meter
(CO ₂ test medium)	0 - 235 psig (0 - 1,620 kPa)
Temperature Range	5°C - 35°C (41°F - 95°F)
Fluid Type	CO ₂ or air
Calibration Capabilities	ANSI 150, 300, 600 and meters sized NPS 2 to NPS 12
Maximum Reynolds No.	9,300,000
Measurement Uncertainty	+/- 0.27%
Reproducibility	+/- 0.2%
Traceability	Traceable to international standards through Nmi (Holland Metrology N.V.)
Meter Runs	Complete meter runs up to 22' (6.7 m) by special arrangement

A Solution to more Accurate Turbine Meters

Studies¹ have shown that turbine meters need to be calibrated under in-service conditions for acceptable accuracy. The best calibration results are obtained by matching the in-service Reynolds numbers and flow rates. Reynolds number is a dimensionless ratio of inertial to viscous forces that takes into account the flow rate and physical properties of a fluid. It is proportional to flow rate and density and inversely proportional to meter diameter and viscosity.

The dependency of turbine meters on Reynolds number can have a severe impact on measurement accuracy. Meter performance changes by up to several per cent at lower Reynolds numbers, gradually improving as Reynolds number increases. Meters in low-pressure, low flow applications operate at the lowest Reynolds conditions and suffer the greatest loss of accuracy unless properly calibrated. A small proportion of turbine meters also exhibit a degree of density sensitivity, also at low pressures and flow rates. Such meters may have slightly (usually less than a few tenths of a per cent) different K-factors at different densities, even at equal Reynolds numbers. Triple Point has been designed to be capable of calibrating meters throughout the types of service conditions which can influence their performance.



Studies¹ – Sources

George, D.L., GRI Topical Report GRI-03-0172, "Metering Research Facility Program: Effects of Line Pressure and Gas Density on Turbine Meter Measurement Accuracy at Conditions from Atmospheric Air to 700 psig in Natural Gas". Gas Research Institute, Des Plaines, Illinois, August 2004.

George, Fraser, Nored and Tang, "Carbon Dioxide as a Test Fluid for Calibration of Turbine Meters", American Gas Association Spring Conference 2004, American Gas Association, Washington, D.C., May 2004.



Cost of Measurement Error

Turbine Meter Operating at 60 psig

Meter Size	Energy Delivered in a 6 year Calibration Cycle*	Cost of Energy Delivered*	Cost of 0.5% Measurement Error
Inches	MMBtu	US\$	US\$
4"	1,470,000	\$ 1,717,000	\$ 52,000
6"	2,454,000	\$ 2,862,000	\$ 86,000
8"	4,908,000	\$ 5,724,000	\$ 172,000
8" HC	7,362,000	\$ 8,586,000	\$ 258,000
12"	11,448,000	\$ 13,356,000	\$ 401,000
12" HC	18,810,000	\$ 21,942,000	\$ 658,000

Turbine Meter Operating at 500 psig

Meter Size	Energy Delivered in a 6 year Calibration Cycle*	Cost of Energy Delivered*	Cost of 0.5% Measurement Error
Inches	MMBtu	US\$	US\$
4"	10,140,000	\$ 11,832,000	\$ 355,000
6"	16,902,000	\$ 19,719,000	\$ 592,000
8"	33,804,000	\$ 39,439,000	\$ 1,183,000
8" HC	50,706,000	\$ 59,158,000	\$ 1,775,000
12"	78,876,000	\$ 92,024,000	\$ 2,761,000
12" HC	129,582,000	\$ 151,182,000	\$ 4,535,000

Figure 1: Cost of Measurement Error

NOTE 1: Energy content of natural gas assumed to be 1.0205 MBtu/cu.ft.
 2: Cost of energy calculated based on \$7.00 USD per MMBtu (including delivery)
 3: Average Flow 30% Qmax

Triple Point Calibration Capabilities

Triple Point can calibrate both normal and extended range meters up to 12 inches diameter to their maximum flow rate in either carbon dioxide or air. Carbon dioxide's density and viscosity properties enable Triple Point to calibrate natural gas meters under Reynolds-matched conditions which replicate natural gas pressures twice those used in carbon dioxide, to a maximum equivalent pressure of 470 psi. The same effect for calibrations in air is very small, owing to the similarity between the ratios of density to viscosity in air and natural gas. See figure 2.

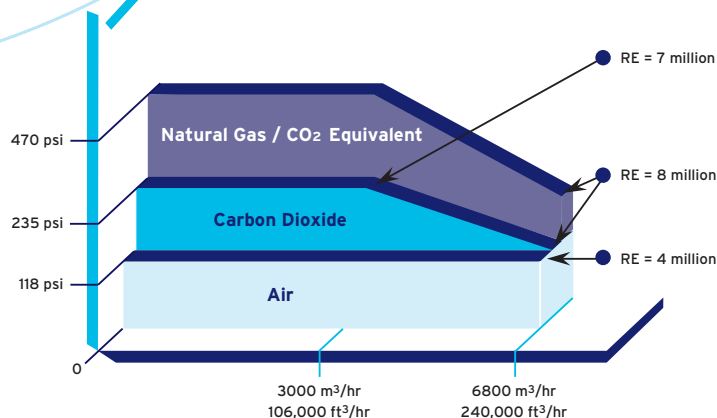


Figure 2: Triple Point Calibration Capabilities

Contact for Terasen Measurement



Toll Free 1-800-667-4338
 Direct 250-490-2613
 Fax 250-490-8714
 Email measurement@terasengas.com
 Website www.terasenmeasurement.com

Flow Meter Testing Service Request



Company Name	Phone	Address		
Contact Name	Fax	City		
Title	E-Mail	Province/Sate	Postal Code/Zip Code	

Meter owner's name and address (if different than above)	Country
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SERVICE / TEST CONDITIONS	
TYPE	PRESSURE OR FLOW RATES
<input type="radio"/> 10 Point (Reynolds Number)	<input type="radio"/> Pressure (Test at maximum pressure) <input type="radio"/> Flow (Test at maximum flow)
<input type="radio"/> 5 Point (Reynolds Number Standard)	<input type="radio"/> Pressure (Test at maximum pressure) <input type="radio"/> Flow (Test at maximum flow)
<input type="radio"/> 2 Point (Atmospheric)	N/A 20% N/A N/A 95%
<input type="radio"/> Other (specify)	

METER SPECIFICATIONS	
Meter Badge Number	Meter make, model & size
Number of meters (for multiple meters/types, please use additional quote form)	Meter serial number
Measurement Canada Registration Number (if applicable)	
Measurement Canada Approval Number (required for custody transfer in Canada)	
Flow range	Meter runs provided with meter <input type="radio"/> No <input type="radio"/> Yes (provide sketch)

FIELD OPERATING CONDITIONS	UNITS		MAX.	MIN.
	<input type="radio"/>	<input type="radio"/>		
Flow	ACFH	m ³ /hr		
Pressure	PSIG	kPa		
Temperature	°F	°C		

TEST REQUIREMENTS / TYPE	GAS COMPOSITION	MOLE %
Type of test required <input type="radio"/> Mechanical <input type="radio"/> Electronic <input type="radio"/> High Frequency <input type="radio"/> Atmospheric <input type="radio"/> High Pressure <input type="radio"/> Both Intest <input type="radio"/> Yes <input type="radio"/> No	Methane (CH ₄)	
	Ethane (C ₂ H ₆)	
	Propane (C ₃ H ₈)	
	Butane (C ₄ H ₁₀)	
	Carbon Dioxide (CO ₂)	
	Nitrogen (N ₂)	
	Other fluid (provide name)	

If natural gas composition is not given, a NG composition at a molecular weight of 16.77 will be used to derive missing properties.

ORDER/REPAIR REQUIREMENTS
Seal Meters <input type="radio"/> Atmospheric <input type="radio"/> High Pressure <input type="radio"/> None
Paint Meters <input type="radio"/> Yes <input type="radio"/> No

Repair Details (please use separate sheet if needed)

Additional Information (please use separate sheet if needed)

Quotations will be returned by email or fax (indicate your preference) <input type="radio"/> Email <input type="radio"/> Fax	Turnaround <input type="radio"/> 4 weeks <input type="radio"/> 5 days (additional cost)	Required Date (Yr/Mth/Day)
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SHIPPING REQUIREMENTS	
Preferred Shipping Company (name/phone number)	Carrier Account Number (if applicable)

To submit your request or if you have any questions, please contact:

Terasen Measurement
 Toll Free 1-800-667-4338 Web www.terasenmeasurement.com
 Direct 250-490-2613 E-Mail measurement@terasengas.com
 Fax 250-490-8714