Certification Requirements

GS-ENG-04-01: Gas Measuring Apparatus – Atmospheric Pressure Meter Proving Systems Containing Traceable Reference Standards

Version 4.1
April 20, 2011

Patrick (Pat) J. Hardock, P.Eng.
Senior Engineer – Natural Gas Measurement
Engineering and Laboratory Services Directorate
Measurement Canada

Canada

RECORD OF CHANGE

Revision	Date	Description
0.2	2007.04.09	New document (for consultation)
0.3	2007.04.25	Editorial changes with GTWG
0.4	2007-05-03	Added pressure section and reference to GS-ENG-07-03
1.0	2007-05-03	Issued document for use
1.1	2007-05-04	Comments, revisions and suggestions added
1.2	2007-05-18	Comments, revisions and suggestions added
2.0	2007-05-25	Issued document for use
3.0	2007-05-15	Scope change
3.1	2007-10-12	Editorial
3.2	2008-01-23	Title change for consistency with bulletin
4.0	2009-07-14	Removed reference meter type restrictions and expanded scope to diaphragm meters and ASPs Added definitions Modified tile to reflect expanded scope Addition of Appendix B for sonic nozzle provers Addition of Appendix C for Rotary Reference meter provers
4.1	2011-04-20	Updated title page and send for translation

1.0 Scope

The purpose of this certification requirement to document the process of certification of a gas measuring apparatus containing reference meters used for the purpose of establishing the performance of diaphragm, turbine and/or rotary meters at or near atmospheric pressure in accordance to the requirements set out in the *Electricity and Gas Inspection Act, Regulations and related specifications*. This method recognizes the calibration of the reference meters contained in the provers as the source of traceability for the prover.

This document must be read in conjunction with the references listed below.

2.0 References

(a) Electricity and Gas Inspection Act (R.S., 1985, c. E-4)

(b) Electricity and Gas Inspection Regulations (SOR/86-131)

(c) Bulletin GEN-09 (rev. 1*), Delegation of Authorities*, Measurement Canada,

(d) Bulletin G-16, *Recognition of Test Data from Gas Meter Test Facilities*, Measurement Canada, 2007

(e) C-D-01:2006 - Conditions for the Delegation of Authorities for the Calibration and Certification of Standards, Measuring Apparatus and Test Equipment Pursuant to the Electricity and Gas Inspection Act,

(f) S-S-02, *Measurement Uncertainty and Meter Conformity Evaluation Specification,* Measurement Canada, 2007,

(g) GS-ENG-06-01: *Recommendations for the Determination of Measurement Uncertainty, In Meter Inter-comparisons,*

(h) GS-ENG-07-10: *The Selection, Calibration and Application of Working Level Direct Reading Pressure Measuring Instruments,*

(i) GS-ENG-08-03*: Exploration of the traceability chains used in the verification of domestic gas meters,*

(j) GL-CP-002: *Calibration Procedure for the Certification of Reference Meters Used in Low Pressure Transfer Provers Document Number,*

(k) Guide to the Expression of Uncertainty in Measurement (GUM) ISO, 1993,

(l) ISO/IEC 17025:1999(E), General *Requirements for the Competence of Testing and Calibration Laboratories.*

3.0 Authority

This Certification Requirement has been issued under the authority delegated to of the Senior Engineer – Gas Measurement.

4.0 Administration

4.1 Definitions

For the purposes of this document the following definitions apply:

Technical Evaluator (TE): An individual designated by Measurement Canada to perform the evaluation and testing of the Gas Measuring apparatus as prescribed in this document.

Applicant: Owner's representative seeking certification of the Gas Measuring Apparatus.

Designated Authority: Individual delegated by Measurement Canada's in bulletin GEN-09 (rev. 1) *Delegation of Authorities,* with the authority to certify a Gas Measuring Apparatus.

Gas Measuring Apparatus: A device designed and used for the purpose of verification testing of gas meters which is complaint with the requirements referenced in this document.

4.2 Overview

The applicant shall contact the Technical Evaluator and provide the information as prescribed in this document.

Where negotiation or revision of the contents of these requirements is deemed appropriate, the Technical Evaluator or the Designated Authority shall seek and receive conformation from the Senior Gas Measurement Engineer prior to commencing the evaluation.

The Technical Evaluator will perform the evaluation detailed in this document and prepare an evaluation report for submission to the Designated Authority. The content, form and format of this report will be approved prior to the evaluation.

The Technical Evaluator will make recommendations to the Designated Authority relating to the performance of the measuring apparatus.

Where a review of the report indicates that the measurement apparatus falls within the criteria set out in this document, the Designated Authority will issue a Certificate of Calibration.

4.3 Making Application to Measurement Canada

The administrative processes described in appendix A is directly applicable where the Gas Measuring Apparatus is of a type or design which has been previously certified for use by Measurement Canada's Senior Engineer Gas Measurement. For those measuring apparatus designs and types which have been not been previously certified the following additional requirements apply.

Piping and instrumentation drawings, component specifications and user manuals should be provided by the applicant for review. Methods, recommended by the owner or manufacturer of the Gas Measuring apparatus, for the verification of temperature, pressure and counting instrumentation should be provided. Block diagrams as well as explanations of controlling software should also be included.

This information should be sent to and/or gathered by the Technical Evaluator or Designated Authority. Once he/she is satisfied that the information is complete, it should be forwarded to Measurement Canada's Senior Gas Measurement Engineer for review. Once this package of

information has been reviewed and any modifications to the intended test plan determined, initial testing may commence.

At this time it is also recommended that the applicant provide a reference meter calibration test plan for pre-approval. The calibration test plan should be consistent with the document referenced in section 2(b). The purpose of this pre-review is to avoid any unnecessary duplication in testing or calibration.

The reference meter test plan should be submitted to the Technical Evaluator along with the other required information. The Technical Evaluator will perform a preliminary review of the test plan and then forward it, with recommendations, to the Designated Authority for final review and acceptance.

4.4 Initial Testing and Review

Once the reference meter(s) has been calibrated in accordance with section 5.0 and a certificate of calibration issued by Measurement Canada's Engineering and Laboratory Services Directorate (ELSD), on-site evaluation may commence.

The on-site evaluation will be performed in accordance with the principles contained in the documents referenced in section 2(a) and (b). Once compliance with these requirements is demonstrated, the test data and reports will be sent by the Gas Specialist to the Senior Gas Engineer for review. Upon review and acceptance, a certificate of calibration for the measuring apparatus may then be issued by ELSD.

4.5 Certification Periods

When the reference meter(s) used in the measuring apparatus have been calibrated in accordance with section 5.0, these meter(s) will receive a five year certification period.

5.0 Certification of Measuring Apparatus' Reference Meter(s)

Once the applicant's reference meter test plan has been reviewed and accepted by the Senior Gas Engineer, calibration testing may proceed.

When Measurement Canada is unable to perform the required reference meter calibration testing, laboratories recognized by Measurement Canada in bulletin G-16 shall be used instead. The permissible uncertainty, required number and distribution of test points and manner of handling data, is all described in the document referenced in section 2(b) and is applicable to this type of measuring apparatus.

In general, the following requirements shall apply:

- The calibration of the reference meter should be established at a Measurement Canada recognized test facility or using a certified measuring apparatus.

- The calibration of the reference meter should be established at a sufficient number (usually 15) of test flowrates distributed based on its characteristic operating curve and the intended range of use.

The reference meter's flow calibration test results, along with a request for calibration form, shall be provided to the Senior Gas Engineer for the purpose of review and if appropriate the issuing of a certificate of calibration by ELSD.

6.0 Use of Reference Meter(s) Calibration Data in Measuring Apparatus'

Controller

In order to use the reference meter's certificate of calibration data, issued by Measurement Canada to its fullest potential, a linearization scheme will need to be employed in the measuring apparatus' controller. Where such a scheme is not employed, the measuring apparatus will be restricted to use in the linear portion of the reference meter's performance curve.

Where point-to-point linearization schemes are used, the values may be taken directly from the certificate provided by Measurement Canada and entered into measuring apparatus' controller program. If additional values are needed they can be calculated from the best fit curve equation coefficients included on the calibration certificate.

7.0 Security of Prover Calibration Data

In order to ensure that the integrity of the measuring apparatus is maintained throughout its certification period, the following information shall be included in the certification testing report submitted to the Senior Gas Engineer and will constitute part of the certificate issued for the measuring apparatus:

- All pressure, temperature, and reference meter calibration factors,
- Any additional preset values determined during the initial verification of the apparatus.

Records should be kept on site such that:

- This data will be accessible for audit purposes,
- Any changes to calibration data will be readily detectable under audit.

8.0 Determination of Measurement Uncertainty

The measurement uncertainty of the meter-under-test (MUT) shall be determined in the manner prescribed in ISO Guide to the Expression of Uncertainty in Measurement and Measurement Canada Gas Engineering recommendations. The overall uncertainty of the verification of a meter using the measuring apparatus should be less than 1/3 of the Limit of Error(LOE) for the meter under test at the 95% confidence interval (k=2).

The applicant should provide a complete written Statement of Measurement Uncertainty using the methods prescribed in the ISO Guide to the Expression of Uncertainty in Measurement. Guidance on this determination can be found in the documents referenced in section 2(c) and (d).

The measurement uncertainty should be determined for each class or type of meter, listed in the statement of intended use, in a manner that represents the intended use of the measuring apparatus. A statistical estimate of the MUT's repeatability should also be included.

A detailed copy of the completed analysis should be sent to the Gas Specialist for initial review and forwarding to the Senior Gas Engineer for final review and acceptance.

8.1 Environmental Conditions

Where the measuring apparatus could be subjected to environmental conditions which could influence the behavior of the system or the devices being verified, the influence shall be controlled, monitored or minimized such that:

- The measuring apparatus shall be supplied with clean, dry air (no condensing) from within the proving room or area,

- The maximum contribution of any influence to the uncertainty of the apparatus shall not exceed that in the statement of uncertainty provided by the applicant,
- Provisions for the prevention and detection of such conditions shall be provided, and the appropriate action taken, if such conditions are detected.

8.2 Temperature Considerations

The Statement of Measurement Uncertainty should specify the allowable limits of temperature variation of the measuring apparatus and meter under test, during the testing process, in order to maintain the accuracy requirements of the meter evaluation process.

These shall include:

- for the room containing the measuring apparatus, a temperature set point for the room and the maximum limits,
- for the room containing the measuring apparatus, the maximum rate of change of the ambient temperature prior to, and during the process of certification, testing, and meter verification operations,
- for the room containing the measuring apparatus, the method and frequency of ambient air temperature monitoring and/or recording,
- for the MUT, the time period and method of meter acclimatization required prior to the commencement of testing,
- for the measuring apparatus and the MUT, the limits in the variation between each of the ambient air, MUT flowing air and reference meter flowing air during testing.

8.3 Pressure Considerations

The Statement of Measurement Uncertainty should specify the allowable limits of pressure variation in the reference meter and meter under test, during the testing process, in order to maintain the accuracy requirements of the meter evaluation process.

These shall include:

- for the room containing the measuring device, a temperature set point for the room and the maximum limits,
- for the Measuring Apparatus and the MUT, the limits in the variation between the MUT flowing air and reference meter flowing air pressures.

8.4 Test Protocol Considerations

The method to be used to meter compliance should be considered in the Statement of Measurement Uncertainty. Where a number of tests at each flowrate are conducted, the method for calculating the average error for multiple tests, and the method of comparison to calibration test certificate errors should be considered in the Statement of Measurement Uncertainty. Where the measuring apparatus has the capability of operating in various configurations or uses various methods for communicating with the MUT, each of these methods shall be verified.

9.0 Additional Metrological Guidelines

9.1 Qualification Meters

The applicant should provide the qualification meters needed for completion of certification testing. These meters are will be used to evaluate the overall system performance. Qualification meters selected by the applicant should:

- be Measurement Canada accepted,
- be similar in make, model, and design to those included in the Statement of Intended Use,
- have a rated flowrate capacity sufficient to provide for test flowrates between 10% and 100% of the associated reference meter's rated capacity,
- provide for system qualification of each MUT proving run size, i.e. nominal inside diameter
- provide for qualification of system performance in all intended modes of operation, i.e. ID mounted pulser, single pulse output, dual pulse outputs, etc.
- have its calibration test results fully documented and include an associated statement of uncertainty as per the document referenced in section 2(b).

For the purposes of initial certification testing, qualification meters should be selected to represent each make and model of meter included in the statement of intended use. A single qualification meter may be used to represent a range of meter sizes.

Additional requirements for qualification meters can also be found in Appendix *B: Additional Requirements for Sonic Nozzle and Rotary Meter Based Provers used for the verification of Diaphragm, single path Ultrasonic or Rotary Meters.*

9.2 Check Meters

The applicant is responsible for the provision of check meter(s) required for the routine monitoring of the calibration stability and overall performance of the measuring apparatus: Check meters selected by the applicant should:

- be Measurement Canada verified and accepted,
- have a rated flowrate capacity sufficient to provide for test flowrates of the associated reference meter's rated capacity,
- provide for monitoring of calibration stability and system performance of the measuring apparatus in all intended modes of operation, e.g. ID mounted pulser, single pulse output, dual pulse outputs, etc.,
- be repeatable and have rated accuracy within applicable verification tolerances.

The applicant may designate some or all of the qualification meters used during certification testing as check meters to satisfy the requirements of this section.

10.0 System Qualification Testing

Certification testing of the gas measuring apparatus shall be performed at a location mutually acceptable to all parties involved and must be consistent with the above references such that the following can be performed. All ancillary components and functions which have a metrological impact on the performance accuracy of the measuring apparatus shall be inspected and certified to within the tolerances specified in this document.

10.1 System Leak Detection Test

Certification testing will include an assessment of the measuring apparatus' system leak detection capability.[1] The applicant will be required to provide any equipment needed to introduce the leak rate required for certification testing purposes. Further, the applicant should also provide documented details of the method and associated equipment used to establish the leak rate required for certification testing purposes. The agreed upon leak rate shall be considered in the Statement of Measurement Uncertainty.

The leak rate required for certification purposes shall be verified prior to commencing evaluation testing of the measuring apparatus' system leak detection capability.

10.2 System Flowrate Setting

The measuring apparatus shall have a flowrate setting mechanism capable of setting and maintaining the verification test flowrates applicable to each meter in the applicant's statement of intended use. The flowrate setting mechanism shall be capable of setting and maintaining the flowrates to within +/- 5% of the selected flowrate. The measuring apparatus shall provide for accurate determination of test flowrate using the applicable reference meter's calibrated and certified output.

The measuring apparatus shall make provision for displaying real-time test flowrates based on a sampling frequency sufficient to ensure accurate indications.

The flowrate setting mechanism shall be verified for performance and repeatability.

10.3 System Pressure Measurement

The pressure sensor(s) and associated electronics shall be calibrated and traceable to National Standards. The accuracy of the pressure sensors for each reference meter and each MUT position must be verified as specified, for each proving run configuration.

Test Points and Tolerances	Static Pressure Sensors (gauge and absolute)	Accuracy of registered reading at sufficient number (a minimum of three) of points over intended range of operation. Tolerance = +/- 0.2 in. w.c. or the uncertainty claimed in the Statement of Uncertainty for the Measuring apparatus at the 95% confidence interval.

Test Points and Tolerances	Barometric Pressure Sensors	Accuracy of registered reading. Tolerance = +/- 0.5 in. w.c. or the uncertainty claimed in the Statement of Uncertainty for the Measuring apparatus at the 95% confidence interval.

[1] A system shall be capable of detecting a leak of 0.1% of the lowest expected test flowrate.

Test Points and Tolerances	Differential Pressure Sensors	Accuracy of registered reading at sufficient number (a minimum of three) of points over intended range of operation. Tolerance = +/- 0.2 in. w.c. or the uncertainty claimed in the Statement of Uncertainty for the Measuring apparatus at the 95% confidence interval.

10.4 System Temperature Measurement

The temperature sensor(s) and associated electronics shall be calibrated and traceable to National Standards. The accuracy of the temperature sensors for each reference meter and each MUT position must be verified as specified, for each proving run configuration.

Test Points and Tolerances	Temperature Sensors	Accuracy of registered reading at sufficient number of points (minimum of three) over the controlled temperature range of the test environment. Tolerance = +/- 0.5°F or the uncertainty claimed in the Statement of Measurement Uncertainty for the measuring apparatus at the 95% confidence interval.

10.5 System Metrological Calculations

The measuring apparatus shall provide for temperature and pressure differential corrections to account for differences in flowing pressures and temperatures between the reference meter and the MUT. In addition, the measuring apparatus should be capable of displaying, or providing access to, pressure and temperature differential corrections or correction factors used in the establishment of the MUT error.

Programming of Measuring Apparatus Controller	Verification of pressure and temperature correction calculations using registered values. Verification of temperature conversion calculations using registered value of reference meter temperature and applicable MUT base temperature values. Tolerance: no error permitted
	Verification that the reference meter's certified calibration curve results, including any additional calculated values, are entered correctly into the measuring apparatus software.

10.6 System Meter Accuracy Measurement

A comparison of the measuring apparatus to the qualification meters, selected in accordance with section 9.1, is to be performed during the certification testing process. Generally the measuring apparatus' performance should be evaluated at the flowrates indicated for each meter under test in the Statement of Intended Use.

The maximum allowable deviation between a qualification meter's calibration test results and the corresponding results taken from the measuring apparatus is 0.3%.[2]

[2] Note that the system and qualification meters will be used as the MUTs in the establishment of the measurement uncertainty for the measuring apparatus.

Note: If the system measurement uncertainty is not sufficient to allow for such a determination, Measurement Canada Engineering shall be consulted.

11.0 Post-certification Usage Requirements

The method of tracking the measuring apparatus' performance should be based on statistical process control (SPC) procedures established by the applicant. These procedures should form part of the information presented to the Gas Specialist with the initial documentation. The written SPC procedures should detail the SPC method, data handling, control limits and how it is to be updated. A sample spreadsheet for this purpose is available from Measurement Canada.

These SPC procedures should also address the stability of the temperature and pressure measuring devices used in the measuring apparatus.

12.0 Conditions for Continual Certification

A statement shall be placed on each of certificate produced by Measurement Canada indicating compliance with the requirements of this document. This statement will also indicate that the any Post-certification usage requirements or conditions listed in GS-*ENG-04-01* or the related documents must continue to be observed in order for the certificate to remain valid.

13.0 Re-certification Requirements

The certification period for a measuring apparatus is valid for a period up to five years, provided the conditions listed on the Certificate of Calibration are met.

13.1 Annual Re-evaluation

As a condition of certification and on an annual basis, a re-evaluation of the gas measuring apparatus shall be performed, at a time mutually acceptable to all parties involved, and must be consistent with the above references such that the tests listed in the following table are performed.

Section number	Test Description
8.1	Environmental controls - The controls and their records should indicate the system has been capable of maintaining the values used in the Statement of Measurement Uncertainty
10.1	Operational leak test - The system should demonstrate that it is capable of maintaining the values used in the Statement of Measurement Uncertainty
10.3	System Pressure Measurement
10.4	System Temperature Measurement
10.5	System Metrological Calculations
10.6	System Meter Accuracy Measurement[3]

The SPC control charts shall also be reviewed to ascertain if the system is under control and that the Statement of Measurement Uncertainty determined at the time of initial calibration is still valid.

Any problems with the measuring apparatus or the applicant's failure to meet conditions on the certificate of calibration, etc., should be reported to ELSD.

13.2 Subsequent Recertification

Subsequent five-year re-certification of the measuring apparatus and its reference meter(s) will be performed in accordance with the requirements of this document.

A review of the applicant's SPC procedures and data may be used in establishing the scope of the certification testing required.

[3] If a review of the validated the SPC procedure indicates that it has being properly implemented and the system is in control, re-testing of the qualification meters is not required.

Appendix A: Administrative Requirements

A.1 General Requirements

Certification will be considered for gas measuring apparatus that has been installed in accordance with the manufacturer's installation specifications and meets the requirements set out in this document.

Gas measuring apparatus shall only be certified for testing approved gas meters at flowrates that are within the certified range of the reference meter(s).

Where test results indicate that the measuring apparatus does not meet accuracy requirements over the reference meter's certified range, the measuring apparatus may be certified for a lesser range.

Modification to the measuring apparatus, relocation, or component replacements which affect the accuracy of the gas measuring apparatus shall be reported to Measurement Canada, and may require recertification testing of the gas measuring apparatus.

A.2 Requests for Certification

The applicant is responsible for providing a written request to the local Measurement Canada district or regional office for the certification of the measuring apparatus. The request shall include the following information:

- A full description of the gas measuring apparatus to be certified, including the manufacturer(s), model number(s), serial number(s), operating parameters, minimum and maximum test capacities, computer software and hardware versions / revisions, name of the applicant, and for the ancillary equipment, model number(s), serial number(s), and operating parameters,

- A complete description of each reference meter, qualification meter and check meter, including make, model, capacity, serial number and forms of metrological output such as a mechanical instrument drive, single rotor pulse output, or multiple rotor pulse output, etc.,

- Reference meter test plan for calibration testing.

- Qualification meter test plan for calibration testing

- A statement of intended use as per section A.3,

- The SPC procedure(s) for the monitoring and control of reference meter, and ancillary device performance specific to the design of the gas measuring apparatus,

- An uncertainty statement, for each proving configuration and meter classification, and details of the uncertainty analysis and budget.

- Operating instruction manuals that provide detailed information pertaining to the installation, operation, maintenance, calibration and use of the gas measuring apparatus,

- A full set of completed worksheets showing that the gas measuring apparatus is fully compliant with all applicable requirements set out in these specifications, prior to onsite certification testing of the gas measuring apparatus by Measurement Canada.

- A maintained logbook or file which records the dates and details including the identification of the person or persons performing accuracy checks, adjustments, maintenance, repairs, statistical

process controls and modifications to the gas measuring apparatus. The logbook for each gas measuring apparatus shall be made readily available to Measurement Canada upon request,

- Where the applicant seeks permission to make adjustments to ancillary equipment to maintain acceptable performance, the method, procedure and frequency of these adjustments together with the method of tracking these adjustments.[4]

- A statement or list identifying potential influence factors and the controls implemented, where necessary, to ensure that the uncertainties of the test results remain within defined limits.

- If applicable, copies of any pervious certification documentation for the measuring apparatus specifically or of the design or type.

A.3 Statement of intended Use

The applicant shall provide to Measurement Canada a statement of intended use of the gas measuring apparatus. The documentation provided shall be sufficient to determine the capabilities of the gas measuring apparatus, its intended uses, and all installation requirements. The documentation shall include the items in the following subsections:

- A statement indicating the limitations of each reference meter or the gas apparatus published by the manufacturer and set out in the certificate(s) of calibration,

- A description of the meters to be verified on the gas measuring apparatus, including each make, model or design of meter, and the forms of metrological output such as a register, instrument drive, single rotor pulse output, serial port, multiple rotor pulse output, etc.

- A statement indicating which reference meter is to be used for the verification of each of these meters,

- A description of each meter type or design of meter to be represented by each check meter,

- A declaration of the mode of operation for which the gas measuring apparatus is to be utilized, i.e. T.C., Non-T.C., etc.

- A declaration of the method(s) of determining meter registration, i.e. single pulse output, dual pulse output, mechanical output or any other gating method,

- The test duration and/or test volume selected for each meter listed.

[4] This activity will only be permitted when the reference standard used is certified and traceable to Measurement Canada or the National Research Council of Canada.

Appendix B: Additional Requirements for Sonic Nozzle Based Provers used for the verification of Diaphragm, single path Ultrasonic or Rotary Meters.

B.1 Scope

This Appendix is intended to augment the requirements above when evaluating Working Level Sonic Nozzle Provers based provers which are intended to be used in the verification of Diaphragm, single path Ultrasonic or Rotary Meters.

This document is intended to present an alternative method that used in *S-G-01 Specifications for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers* for the evaluation of sonic nozzles provers. This method recognizes the calibration of the reference meter(s) contained in the prover(s) as the source of traceability for the prover.

B.2 References

1. *AGA Engineering Technical Note: The Theory and Operation of Meter Shop Sonic Nozzle Proving Systems for the Natural Gas Industry, 2003,*

2. *ASME/ANMSI MFC-&M-1987 Measurement of Gas Flow by Means of Critical Flow Venturi Nozzles.*

3. S-G-01, *Specifications for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers.*

4. *GS-ENG-01-04: Additional Guidelines for Including Sonix 6 Domestic Ultrasonic Meters in Existing Sonic Nozzle Prover Certification.*

B.3 Qualification Meters

For the purposes of initial certification testing, qualification meters should be selected for each make and model of meter included in the statement of intended use. The concept of meter classes represented by transfer meters, as specified in S-G-01, should be applied. For the purposes of subsequent re-certification testing, diaphragm qualification meters may be selected based on meter classes where this can be supported by past performance results. The requirements for the performance of diaphragm or ultrasonic type qualification meters should be consistent with the requirements for transfer meters given in section 5.4.2 of S-G-01.

B.4 Measuring Apparatus with Preset Calibration Values Applied

Present specifications for the certification and use of working level bell and sonic nozzle provers provide for the use of preset calibration values to eliminate any perceived bias between the local master bell prover and the measuring apparatus. This same provision also extended to a rotary based measuring apparatus used for testing diaphragm meters.

Preset calibration values can be established for classes of diaphragm meters or alternatively for each type or model of meter in the statement of intended use. In order to determine which option is acceptable, it is recommended that each type/model of meter be used and the results analyzed to determine if the concept of meter classes can be applied. The determination and application of preset calibration values should be performed by the applicant, based on their documented procedures, prior to certification testing.

Preset calibration values will be recorded in the certification testing report forwarded to the Designated Authority for inclusion in the certificate of calibration of the measuring apparatus. These values should not be modified for the duration of the measuring apparatus' certification period. The maximum allowable difference between each qualification meter's calibration test

results established on the master bell prover and the measuring apparatus is 0.3%.[5]

B.5 Measuring Apparatus without Preset Calibration Values Applied

If the difference between each qualification meter's calibration test results and the measuring apparatus results is within the expected bounds of the individual measuring apparatus' uncertainty, then this difference can be considered as not significant and no preset correction values need to be applied.

This difference should not exceed the root sum squared of the uncertainty (k=2) of the measuring apparatus (±0.3%), the master bell prover (±0.2%) and an allowance for the variation in the qualification meter (±0.3%). Therefore a value of $\{(\pm 0.3\%)^2 + (\pm 0.2\%)^2 + (\pm 0.3\%)^2\}^{1/2} = \pm 0.5\%$ should be considered as a estimate of the maximum permissible value. Please note that this estimate allows for both bias and random errors.

B.6 Multiple Measuring Apparatus In a Single Location

Where the owner has multiple measuring apparatuses all in the same location, it is recommended that the same check meter(s) be used with each of the measuring apparatus. Further, provided that one of the measuring apparatus at the location has been previously certified and presently has a valid certificate of calibration, this apparatus may be used as a "local volumetric standard" for the purpose of diaphragm meter correlation.

B.7 Weekly and Daily Volume Correlation

The applicant may choose to perform the daily and weekly correlation processes similar to that specified in 6.1 and 6.2 of S-G-01. This method is deemed acceptable, provided no changes are made to the measuring apparatus' preset calibration values.

The frequency of the comparison can be reassessed once a statistically significant number of comparisons have been completed. This information can then be used to determine the long-term standard deviation for each particular class of MUT and establish monitoring/correlating frequencies.

Provision should also be made to address the stability of the temperature and pressure measuring devices used in the measuring apparatus.

B.8 Check Metering using Statistical Process Control (SPC) Methods

The applicant may choose to utilize check metering based on statistical process control (SPC) procedures. These procedures should form part of the information presented to the Gas Specialist with the initial documentation. The written SPC procedures should detail the SPC method, data handling, control limits and how it is to be updated. A sample spreadsheet for this purpose is available from Measurement Canada. Final review and acceptance of the applicant's SPC procedures shall be the responsibility of the Senior Gas Engineer.

These SPC procedures should also address the stability of the temperature and pressure measuring devices used in the measuring apparatus.

Diaphragm type check meters should be selected in accordance with section 9.2. The applicant may use check meters of a differing principle of operation (alternative check metering) from those listed in the statement of intended use. The use of alternative check metering requires a period of

[5] Note that the system and qualification meters will be used as the MUTs in the establishment of the measurement uncertainty for the measuring apparatus.

inter-comparison between the trends of results established on the measuring apparatus for the alternative check meter(s) and the diaphragm type check meter(s) results.

Where sufficient data has been collected and presented to demonstrate that the alternative check meter(s) provides the same level of confidence as diaphragm type check meters, the use of diaphragm type check meters may be suspended. Again, the frequency of the comparison can be reassessed once a statistically significant number of comparisons have been completed.

Appendix C: Additional Requirements for Rotary Meter Based Provers used for the verification of Diaphragm, single path Ultrasonic or Rotary Meters.

Requirements for Rotary Meter Based Provers used for the verification of Diaphragm, single path Ultrasonic or Rotary Meters are presently contained in:

GS-ENG-03-06: *Certification of Gas Measuring Apparatuses Containing Rotary Meters Used for the Purpose of Calibrating Diaphragm Meters Version 3.*1.

Note that GS-ENG-03-06 generally mirrors the requirements of this document. It also allows for certification of Rotary Meter Based Provers through prover correlation.