Measurement Canada **Mesures Canada**

Fair Measure For All *La mesure juste pour tous*

Standards Building Édifice des Normes
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2002-05-17

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

P-G-01-E **Procedures for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, Pursuant to the Requirements of S-G-01**

P-G-01-E Annex: **Worksheets for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers**

Measurement Canada's specifications and procedures for the calibration, certification, and use of sonic nozzle provers have now been completed, and are hereby released as S-G-01: Specifications for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, and P-G-01: Procedures for the Calibration and Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers Pursuant to the Requirements of S-G-01. An accompanying annex to P-G-01, entitled P-G-01 Annex: Worksheets for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, contains worksheets for use with these procedures.

These specifications and procedures apply to all sonic nozzle provers used by accredited meter verifiers for verification, reverification and/or compliance sampling of gas meters.

Additional copies are available from Measurement Canada's Program Development Directorate at the address above. These documents will also be posted on Measurement Canada's web site at http://mc.ic.gc.ca.

For any enquiries, please contact the Program Development Directorate at (613) 952-0657, and ask for the program officer responsible for gas measurement.

Alan E. Johnston
President

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

P-G-01-E **Procedures for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, Pursuant to the Requirements of S-G-01**

P-G-01-E Annex: **Worksheets for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers**

Measurement Canada's specifications and procedures for the calibration, certification, and use of sonic nozzle provers have now been completed, and are hereby released as S-G-01: Specifications for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, and P-G-01: Procedures for the Calibration and Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers Pursuant to the Requirements of S-G-01. An accompanying annex to P-G-01, entitled P-G-01 Annex: Worksheets for the Calibration, Certification, and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers, contains worksheets for use with these procedures.

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Alan E. Johnston
President

S-G-01

Information

2008-05-28

Revisions to the Specifications for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers(S-G-01)

This information bulletin is intended to advise natural gas sector stakeholders that Measurement Canada (MC), has revised MC Specification S-G-01 to remove requirements identified under the Government of Canada burden reduction initiative.

To facilitate a reduction in the frequency for the correlation of transfer meters to the gas measuring apparatus conditions have been added. Organizations that wish to remain on the daily frequency are not required to meet these additional conditions, as they have chosen to exceed the minimum requirement for frequency of the correlation. The maximum error detection requirement has been reduced to only the maximum high and low requirements, therefore calibration of meters to these errors has been reduced to only the two meters. The requirements for evaluation of meters processed since the last correlation have been clarified. The repeatabilty requirement, which was needed when these gas measuring apparatus were first introduced into the industry, to ensure they were stable, has been removed.

The procedures for the calibration, certification and use of these measuring apparatus (P-G-01), have been revised to reflect the revisions to S-G-01. In addition to these revisions MC has also taking this opportunity to correct the formulas, which were identified as being incorrect.

The annex (worksheets) to the procedures have been revised to reflect the revisions and to correct formulas identified as being incorrect.

MC Specification S-G-01 (rev. 1), P-G-01(rev.1) and the Annex are effective immediately. Where the calibration and certification of a gas measuring apparatus has already begun, the organization may choose to continue to have the certification completed under S-G-01 or switch to S-G-01(rev.1) for the remainder of the calibration and certification.

For further information, please contact:

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Gas

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Specifications for the Calibration, Certification and Use Of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers

Canada

S-G-01-E (rev.1): Summary of Amendments to S-G-01-E	
Section	**Description**
All	Reformatted to new formatting requirements.
5.4.2.5	Revised errors in table 1, to reflect range for calibrating transfer meters in subsection 5.4.2.3.
5.5.4.1	Removed low impact requirements identified under the burden reduction initiative. Reworded to remove test points below the maximum errors expected for the intended use of the measuring apparatus.
Previous5.7	Removed low impact requirements identified under the burden reduction initiative. These requirements were necessary until the measuring apparatus certified had proven to be repeatable. No repeatability issues have been reported for the measuring apparatus that have been presented for certification.
6.2	Reworded to permit for weekly correlation, as identified under the burden reduction initiative. Added the conditions that must be met to permit weekly correlation.
6.2.5	Moved a) from 6.2 to avoid confusion. This is a requirement not an option and therefore should not have been under a list of options. Added the requirements that must be addressed to ensure suspect meters are identified and dealt with.

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Specifications for the Calibration, Certification and the Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers

1.0 Scope

This specification outlines the requirements for the certification, recertification, calibration and use of working level gas measuring apparatus consisting of sonic nozzles and any associated readout devices. These measuring apparatus are used for the verification, reverification and/or compliance sampling of gas meters.

This document is supported by procedures set out in P-G-01: Procedures and worksheets for Calibrating and Certifying Gas Measuring Apparatus - Sonic Nozzle Provers Pursuant to the Requirements of S-G-01.

2.0 Authority

This document is issued pursuant to section 5 of the *Electricity and Gas Inspection Act* and Part I of the Regulations established thereto. It has been produced under the authority of the President, Measurement Canada for the purposes of setting out specifications for the calibration, certification and use of gas measuring apparatus.

for Alan E. Johnston
President

Canada

3.0 Definitions

Calibration
Comparison between two instruments, measuring apparatus or standards, one of which is of known accuracy. Performed to detect, correlate, report, or eliminate by adjustment any variation in accuracy of the instrument or measuring apparatus of unknown accuracy.

Certification
A process which ensures that a measuring apparatus has been properly calibrated, properly installed for its intended use, and that an acceptable accuracy correlation exists between it and a reference standard.

Certification Testing
A specialized form of calibration performed according to fixed standards which must be met prior to the issuance of the Measurement Canada proving system certificate.

Direct Counting Gas Measuring Apparatus
A gas measuring apparatus which determines meter error using register revolutions of the meter under test.

High Load Rate
The term used to describe the flow rate corresponding to 145 ± 5.0% of the meter's rated capacity of air at 0.5 inches differential pressure. For example, the high load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 252 cubic feet per hour to 270 cubic feet per hour.

Inferential Gas Measuring Apparatus
A gas measuring apparatus which determines meter error by a method other than direct counting.

Initial Certification
Certification of gas measuring apparatus for the first time.

Local Volumetric Standard
A master bell prover or certified transfer prover located at or near the site of the gas measuring apparatus.

Low Load Rate
The term used to describe the flow rate corresponding to 45 ± 5.0% of the meter's rated capacity of air at 0.5 inches differential pressure. For example, the low load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 72 cubic feet per hour to 90 cubic feet per hour.

Master Bell Prover
The volumetric standard which is traceable to a national volumetric reference standard.

Mean Value $\bar{x}$
The arithmetic mean of the "n" results considered.

Meter Class
A general grouping of meter types having varied manufacturers and model designations but having similar rated capacities of air at 0.5 inches differential pressure. Class Designations (shown in ft^3/hour): 100 class (< 140), 200 class (140 to 200), 300 class (201 to 300), 400 class (301 to 350), 500 class (351 to 450), 600 class (451 to 500), 700 class (501 to 550), 800 class (551 to 650), 900 class (651 to 700), 1000 class (701 to 800). All other meters shall be formed into classes based on 99.0 ft^3 intervals or S.I equivalent.

Meter Classification
A grouping of meters having the same manufacturer, meter class, and units of measure, formed from the listing of meters in the owner's statement of intended use.

Monitor
To observe, record or detect an operation or condition with instruments.

Non-Converting Meter
A meter that does not correct the registered volumes for pressure and/or temperature.

Owner
The owner of the gas measuring apparatus to be calibrated and certified or recertified.

Recertification
Certification of a gas measuring apparatus subsequent to the initial certification.

Relative Error
The absolute error of measurement divided by the true (conventional) value of the measurand. The measurand is a quantity subjected to measurement.

Transfer Meter
A non-converting meter supplied by the owner for the purposes of volume correlations on the gas measuring apparatus.

Volume Correlation
The process by which a specific volume registered by a transfer meter or measured by a gas measuring apparatus is related to or traceable to a local volumetric standard.

Working Level Gas Measuring Apparatus
A gas measuring apparatus intended for use in the verification, reverification and/or compliance test of gas meters.

4.0 Administrative Requirements

4.1 General

These specifications shall apply immediately upon issue to all gas measuring apparatus utilizing sonic nozzle mass flow technology.

4.2 Gas Measuring Apparatus Requirements

4.2.1 Certification will be considered for gas measuring apparatus that:

(a) has been installed in a temperature controlled and monitored environment;

(b) has been installed in accordance with the manufacturer's installation specifications;

(c) has been identified with a legible, readily accessible nameplate showing, as a minimum, a unique identifying number, the serial number, manufacturer, and capacity;

(d) will be used for its designed application and intended purpose; and,

(e) meets the tolerances and other specifications set out in this document.

4.2.2 Gas measuring apparatus may be certified for testing any or all types of approved gas meters at test flow rates within the flow rate capacity of the local volumetric standard and the gas measuring apparatus.

4.2.3 The certificate issued by Measurement Canada shall be valid for the gas measuring apparatus at the location where the calibration was completed for a period of 5 years. Any relocation, equipment, software or component replacements or modifications which affect the performance of the gas measuring apparatus shall require recertification of the gas measuring apparatus. The extent of the recertification shall be determined by Measurement Canada upon receipt of the notice referred to in clause 4.5.2 herewith.

4.3 Statistics

Gas measuring apparatus or accessories thereto intended to perform statistical calculations of average error and standard deviation of a sample of gas meters for the purposes of verification, reverification or compliance sampling shall do so pursuant to the requirements of a Measurement Canada approved statistical sampling plan for the verification and reverification of gas meters.

4.4 Certification Testing

The method of certification testing shall be sufficient to ensure that the gas measuring apparatus will function accurately and reliably over the conditions to which it will be subjected. These conditions may include, but are not limited to, ambient air temperature, meter proving air temperature and humidity, model of meter, condition of meter, test flow rates, and modes of gas measuring apparatus operation. Where it has been determined analytically or empirically that the effect of a particular condition is not significant with respect to the accuracy of a specific type of gas measuring apparatus, the method of certification testing may, with the President's permission, be modified to take this evidence into account. If more than one method of meter proving is to be certified, sections 5.5 herewith must be performed using all meter proving methods requested.

4.5 Roles and Responsibilities

4.5.1 Measurement Canada

4.5.1.1
Measurement Canada shall be responsible for:

(a) Any certification ensuing from the certification testing procedure.

(b) All certification testing procedures and worksheet completion relevant to this specification.

4.5.2 Owner

4.5.2.1
The owner shall be responsible for:

(a) Providing a statement of intended use together with a full set of completed worksheets demonstrating that the gas measuring apparatus is fully compliant with all applicable requirements set out in these specifications prior to certification testing of the gas measuring apparatus by Measurement Canada.

(b) Making all adjustments and calibrations necessary to meet the requirements.

(c) Providing the transfer meters required by these specifications.

(d) Providing the leak test apparatus required to demonstrate the ability of the gas measuring apparatus to detect the specified operational leak.

(e) Using the gas measuring apparatus in the manner for which it was intended and in accordance with any conditions set out in the certificate.

(f) Ensuring that the gas measuring apparatus is maintained in good repair and in the required operational order.

(g) Giving Measurement Canada prior notification of proposed relocation, modification and/or need of repair to the certified gas measuring apparatus. The need for recertification will be determined by Measurement Canada upon receipt of this notification.

(h) Maintaining a log book or file which records the dates and details including the identification of the person or persons performing accuracy checks, adjustments, maintenance, repairs and modifications to the gas measuring apparatus. The log book for each gas measuring apparatus shall be made readily available to Measurement Canada upon request and shall be retained for a period of six years.

(i) Providing a stable temperature environment for the gas measuring apparatus. The prover room ambient air temperature, the meter outlet air and the gas measuring apparatus meter proving air temperature shall be continuously monitored. Records of these temperatures shall be maintained and reviewed prior to calibrating the gas measuring apparatus.

(j) Making available to Measurement Canada operating instruction manuals which provide detailed information pertaining to the installation, maintenance, calibration and use of the gas measuring apparatus.

4.6 Statement of Intended Use of the Gas Measuring Apparatus

4.6.1 Limitations

4.6.1.1
The owner shall provide to Measurement Canada a detailed 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 intended use of the gas measuring apparatus shall:

(a) be within the specifications and limitations of the gas measuring apparatus published by the manufacturer; and,

(b) be such that the gas measuring apparatus is capable of achieving and maintaining the required flow rates.

4.6.2 Statement of Intended Use - Details

4.6.2.1
The statement of intended use of the gas measuring apparatus shall include:

(a) a full description of the gas measuring apparatus to be certified including the manufacturer(s): operating parameters, minimum and maximum test capacities, computer software and hardware revisions, model number(s) and serial number(s).

(b) a description of each class, type or design of meter to be tested on the gas measuring apparatus,

(c) a declaration of the categories of testing for which the gas measuring apparatus is to be utilized as set out in clause 5.5.3 and modes of operation as set out in clause 5.6,

(d) an identification of the minimum and maximum range of test capabilities (ie humidity, pressure, temperature, flowrate) for which certification of the gas measuring apparatus is requested,

(e) a declaration of the method(s) of meter proving, as set out in clauses 5.5.1 and 5.5.2 herewith,

(f) a declaration of the minimum test volumes and/or meter cycles for the purposes of certification and use requirements.

5.0 Metrological Requirements

5.1 Temperature

5.1.1 The prover room ambient air temperature shall be continuously maintained and monitored at ±1.0°C of a temperature chosen by the owner. The chosen temperature may be changed by the owner at any time during the period of the certification but must fall within a range of 22°C ±4°C and meet all the requirements under section 5.0 herewith.

5.1.2 The prover room ambient air temperature, the meter outlet air and the gas measuring apparatus meter proving air temperature shall be within 0.5°C of each other during all testing procedures and during any subsequent verification, reverification or compliance sample testing during the certification period.

5.1.3 Prior to and during certification testing, the prover room ambient air temperature shall not vary by more than ±1.0°C and ± 0.5°C over the previous 24 hour and 4 hour periods, respectively.

5.2 Humidity

5.2.1 The owner shall ensure that the relative humidity of the air passing through the nozzles is within the manufacturer's specification for the measuring apparatus.

5.2.2 The owner may either:

(a) Monitor the relative humidity utilizing the gas measuring apparatus sensors and alarm system and/or shut down the meter proving process if the manufacturer's specification is exceeded or,

(b) Condition the meter proving air prior to delivery to the nozzles to ensure that the manufacturer's specification is not exceeded.

5.2.3 Whichever method is utilized an external relative humidity monitor shall be installed to act as an independent record of the status of the meter proving air. The relative humidity reading shown by the gas measuring apparatus must be within ±10% of the relative humidity recorded by the humidity monitor.

5.3 Mechanical Requirements

The sonic nozzle prover installation and operation shall be verified for compliance with the manufacturer's installation instructions and Measurement Canada specifications.

5.3.1 Operational Leak Test

5.3.1.1
The operational leak test procedure shall be incorporated into the use of the gas measuring apparatus and shall be tested for both leak detection capability and repeatability.

5.3.1.2
Operational leak test procedures shall be capable of detecting a leak of 0.25 cubic foot per hour at 2.0 inches of water column or greater using a leak test duration and applied pressure/vacuum designated by the owner. The operational leak test shall be initiated, three consecutive times to verify the reliability and repeatability of the process.

5.3.1.3
The owner shall provide the leak test apparatus, calibrated to the local volumetric standard or another certified reference standard, for the purpose of the operational leak test.

5.3.2 Flow Rate Tests

5.3.2.1
The flow rate setting mechanism of the gas measuring apparatus shall be tested at both the high and low load verification test points for each meter listed in the statement of intended use.

5.3.2.2
The flow rate mechanism shall be capable of setting flow rates to within the specifications of the high and low load verification test points for each meter listed in the statement of intended use.

5.3.2.3
The flow rate setting mechanism shall be tested on the gas measuring apparatus using:

(a) transfer meters of known accuracy, and/or

(b) production meters of known accuracy,

(c) designated transfer meters representing flow rates between 10% to 150% of rated air capacity,

(d) selected meter(s) may represent both metric and imperial units of measure with identical flow rates.

5.3.2.4
The flow rate test shall be repeated three times at the high load rate and three times at the low load rate to ensure capability and repeatability.

5.3.2.5
Each individual calculated flow rate shall be within ± 5% of the designated low and high load rates for the meter being tested.

5.3.3 Register Verification

If the gas measuring apparatus is equipped with a register ratio verification option, and the apparatus is to be certified in inferential mode, it shall be verified. The register ratio option shall be verified by utilizing both a correct and an incorrect model of register representing a metric and imperial meter designated in the statement of intended use, to ensure that the system is capable of accurately detecting the correct register ratio.

5.4 Meter Classifications and Transfer Meters

5.4.1 Meter Classifications

Meters shown in the statement of intended use shall be grouped according to either meter class or meter classification, depending on the method of counting used by the gas measuring apparatus. A transfer meter is chosen to represent each meter class or meter classification.

5.4.2 Transfer Meters

5.4.2.1
Transfer meters representative of meters in the various meter classes or meter classifications shall be used to determine the percent error of the gas measuring apparatus by comparison to the local volumetric standard.

5.4.2.2
Transfer meters shall be non-converting positive displacement gas meters.

5.4.2.3
Each transfer meter shall be calibrated to possess an error within the range of -2.0% and -3.0% at low and high load rates, and possess a maximum difference between the low load error and the high load error (spread) of 0.3 or less.

5.4.2.4
Transfer meters shall be acclimatized in the area of the gas measuring apparatus for a minimum period of 4 hours.

5.4.2.5
It is the responsibility of the owner to ensure that selected transfer meters are proven repeatable prior to use as transfer meters. The suggested method is as follows:

(a) Potential transfer meters are exercised for a minimum of 5 minutes at a flow rate not exceeding 50% of the rated air capacity.

(b) The meter is to be run six times at both the low and high load rates on the local volumetric standard to determine the meter error.

(c) Meters are considered acceptable for use as a transfer meter provided that the percent error of each of the runs at the specified test flow rate is within ± 0.2 of the $\bar{x}$ of percent errors for all six runs (see Table 1 for example).

TABLE 1 - Determination of Meter Repeatability

Run # 1	Run #2	Run #3	Run #4	Run #5	Run #6	$\bar{x}$ 6 Runs	Acceptable Limits
-2.5	-2.65	-2.47	-2.52	-2.63	-2.48	-2.5	-2.5 ± 0.2

5.4.2.6
The flow rate on the local volumetric standard shall be set to 145 ± 2.0% and 45 ± 2.0% of the badged air flow rate of the transfer meter to be tested. For example, the high load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 257.4 cubic feet per hour to 264.6 cubic feet per hour and the low load rate would be 77.4 cubic feet per hour to 84.6 cubic feet per hour.

5.4.2.7
The flow rate on the gas measuring apparatus shall be set to 145 ± 5.0% and 45 ± 5.0% of the badged air flow rate of the transfer meter to be tested. For example, the high load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 252 cubic feet per hour to 270 cubic feet per hour and the low load rate would be 72 cubic feet per hour to 90 cubic feet per hour.

5.5 Volume Correlation

5.5.1 Direct Counting Gas Measuring Apparatus

In order to test a direct counting gas measuring apparatus for the purpose of initial certification or recertification, a transfer meter shall be chosen from each meter class listed in the statement of intended use to act as representative of the class.

5.5.2 Inferential Gas Measuring Apparatus

In order to test an inferential gas measuring apparatus for the purpose of certification and recertification, a transfer meter representing each meter classification listed in the statement of intended use shall be tested.

5.5.3 Correlation

5.5.3.1
Volume correlation shall be made to the local volumetric standard to determine whether the gas measuring apparatus may be certified for:

(a) verification,

(b) reverification, and/or

(c) compliance sampling.

5.5.3.2
Volume correlations shall be conducted at the low and high load rates of each meter being tested.

5.5.3.3
Volume correlations shall be conducted with the gas measuring apparatus in the non-converting mode.

5.5.3.4
Testing of a gas measuring apparatus using a transfer meter shall be completed on the same day that the transfer meter acceptability and proof errors were established on the local volumetric standard.

5.5.3.5
Each transfer meter shall be proven six times on the gas measuring apparatus at both the low and high load rates of that transfer meter.

5.5.3.6
For each transfer meter, the percent error for all runs shall be within ± 0.2 the $\bar{x}$ of the percent error of that meter as determined on the local volumetric standard at each flow rate.

5.5.3.7
The requirements of sections 5.5.3, 5.5.4, and 5.6 shall be completed for each method of meter proving, as designated by the owner.

5.5.4 Maximum Error Detection

5.5.4.1
Volume correlations to determine the maximum detectable error shall be completed with non-converting transfer meters of any one meter class, type or design set out in the statement of intended use. Transfer meters shall be adjusted by the owner to register the following errors:

(a) for the purposes set out in clause 5.5.3 a) and b) Only;
+2.5 ± 0.5% and -2.5 ± 0.5%

(b) for the purposes set out in clause 5.5.3 c);
+9.0 ± 0.5% and -9.0 ± 0.5%.

5.5.4.2
The transfer meters shall be run six times on the gas measuring apparatus at the high load rates. The $\bar{x}$ of the errors of these six runs shall be used to determine compliance for maximum error detection. The gas measuring apparatus shall be placed in non-converting mode.

5.5.4.3
The percent error of each transfer meter test, as determined on the gas measuring apparatus, shall be within ± 0.2 of the $\bar{x}$ of the percent errors as determined on the local volumetric standard.

5.6 Additional Modes of Operation

5.6.1 Where the owner's statement of intended use includes the operation of the gas measuring apparatus in different modes of operation, each mode of operation shall be tested using one transfer meter.

5.6.2 The transfer meter shall be proven six times on the gas measuring apparatus at the high load rate. The $\bar{x}$ of the percent errors of these six runs shall be used to determine compliance for each additional mode of operation.

5.6.3 The percent error of each transfer meter test, as determined on the gas measuring apparatus, shall be within ± 0.2 of the $\bar{x}$ of the percent errors as determined on the local volumetric standard

5.7 Temperature Converting Mode Correlations

5.7.1 The gas measuring apparatus shall be switched to and tested in the temperature converting mode.

5.7.2 The resulting meter errors are adjusted by calculation to compensate for the correction applied by the gas measuring apparatus.

5.7.3 The $\bar{x}$ of the errors, as determined on the gas measuring apparatus, shall be within ± 0.3 of the $\bar{x}$ of the percent errors of the transfer meter determined on the local volumetric standard.

6.0 Technical Requirements

6.1 Weekly Correlation - Transfer Meter / Local Volumetric Standard

6.1.1 Volume correlation of the transfer meter to the local volumetric standard shall be performed:

(a) each week prior to the use of the gas measuring apparatus.

(b) using a non-converting transfer meter having an error of -2.5 ± 0.5% at a low and high load rates.

(c) using transfer meters which have been acclimatized for a minimum of 4 hours.

d) using transfer meters which have been constantly exercised at a rate equal to, or less than 15% of the badged flow rate.

6.1.2 The transfer meters used for the weekly volume correlation shall be representative of the metric or imperial meter classifications of those meters which are to be verified, reverified or compliance tested that week.

6.1.3 The transfer meter shall be run six times on the local volumetric standard at both the low and high load rates. The flow rate on the local volumetric standard shall be set to 145 ± 2.0 % and 45 ± 2.0 % of the badged air flow rate of the transfer meter to be tested. The $\bar{x}$ of the percent errors of these runs shall be used to determine the average true errors. These values shall be utilized during correlation of the gas measuring apparatus during the next weekly period.

6.1.4 Transfer meter performance shall be tracked to ensure reliability and repeatability. Weekly errors which deviate by greater than ± 0.2 for either the high or low load rate from the previous correlation to the local volumetric standard, shall be investigated and noted in the designated prover log book.

6.2 Daily/Weekly Correlation - Transfer Meter / Gas Measuring Apparatus

To conduct the correlation testing on a weekly basis organizations shall have a system in place to continuously monitor the delta temperature across the meter under test and provide for a notification/indication to operators where the delta T exceeds 0.5 degrees C or 0.9 degrees F. Where the tolerance for delta T has been exceeded, inspection shall be discontinued until the cause has been determined, corrective action developed and implemented.

6.2.1 Volume correlation of the gas measuring apparatus shall be performed:

(a) Once daily/weekly,

(b) using designated non-converting transfer meters from 6.1,

(c) using transfer meters which have been acclimatized for a minimum of 4 hours and,

(d) with the gas measuring apparatus in the;

(i) temperature differential mode if non-converting meters are to be verified or reverified, and/or

(ii) temperature converting mode if temperature converting meters are to be verified or reverified.

6.2.2 For direct counting gas measuring apparatus, the transfer meters used shall be representative of the metric or imperial meter class of those meters which have been or are to be verified or reverified that day/week. For inferential gas measuring apparatus, the transfer meters used shall be representative of the metric or imperial meter classification of those meters which have been or are to be verified or reverified that day/week. Daily/Weekly volume correlations need not be performed if gas meters are not to be verified or reverified during that day/week.

6.2.3 Transfer meters shall be run three times on the gas measuring apparatus at both the low and high load rate. The low and high load rates of the gas measuring apparatus shall be set to within 145 ±5.0 % and 45± 5.0 % of the badged air rate of the transfer meter to be tested. The $\bar{x}$ of the percent errors of these three runs shall be used to determine the average true errors, and which shall be within ±0.2 of the percent error as established against the local volumetric standard within the previous one week period.

6.2.4 Where the ±0.2 allowable error tolerance has been exceeded, the below steps should be followed until the deficiency is resolved:

(a) repeat the correlation process shown in 6.2;

(b) repeat the weekly correlation process, pursuant to clause 6.1;

(c) perform a complete diagnostic analysis/check to ensure the integrity of the gas measuring apparatus.

6.2.5 Where the ±0.2 allowable tolerance is still being exceeded the following actions shall be taken:

(a) the gas measuring apparatus shall be removed from service and a nonconformance initiated.

(b) the inspection records for meters inspected since the last correlations shall be evaluated to determine if any of the meters inspected during this period could be outside the applicable tolerances.

(c) maintain records of the evaluation.

(d) recall meters that are potential outside the tolerance.

(e) reinspect meters identified.

6.3 Operational Leak Detection

6.3.1 An operational leak detection sequence, shall be utilized prior to the final test sequence on all verification, reverification and compliance testing procedures.

6.3.2 The duration of the operational leak test shall be as determined by the owner and specified for the test shown in section 5.3.1 b).

6.4 Temperature

6.4.1 The prover room ambient air temperature shall be continuously maintained and monitored at ±1.0 °C of a temperature chosen by the owner. The chosen temperature may be changed by the owner at any time during the period of the certification but must fall within a range of 22°C ±4 °C and meet the requirement of section 5.1.

6.4.2 The prover room ambient air temperature, the meter outlet air and the gas measuring apparatus meter proving air temperature shall be within 0.5°C of each other during all verification, reverification or compliance sample testing during the certification period.

6.4.3 Prior to and during all verification, reverification or compliance sample testing, the prover room ambient air temperature shall not vary by more than ±1.0°C and ±0.5°C over the previous 24 hour and 4 hour periods, respectively.

6.4.4 Temperature records shall be retained for a period of not less than three years.

6.5 Maintenance

6.5.1 The owner shall perform routine maintenance as specified in the manufacturer's and owner's manual. As a minimum, the maintenance and/or calibration of component and sensors shall be performed annually.

6.5.2 Calibration of pressure, temperature and relative humidity sensors shall be performed and referenced to a traceable standard.

6.5.3 Records of maintenance and calibrations shall be maintained as part of the prover log book as per section 4.5.2 g).

7.0 Revision

The purpose of this revision is to remove requirements identified under the Government of Canada paper burden reduction initiative.

Information

2006-11-03

Specifications for the Verification and Reverification of Diaphragm Meters

Gas Specification S-G-02, "Specifications for the Verification and Reverification of Diaphragm Meters", is being issued by Measurement Canada (MC) for use in the inspection of diaphragm-type gas meters, in order to facilitate the implementation of "Acceptance Sampling" of these meters using MC's new statistical sampling plan specification S-S-04 (and its associated series of specifications numbered S-S-01, S-S-02, and S-S-03).

S-G-02 is applicable to the verification and reverification of diaphragm meters, of all sizes, that are intended for use in trade measurement of natural gas (and/or manufactured hydrocarbon gases such as propane vapour).

These specifications are intended to provide a consolidated list of the requirements and policies currently being applied or enforced by MC for the inspection and verification of diaphragm meters. They combine into one document all of the applicable requirements which were previously located in various old MC documents, and specify the requirements needed to facilitate implementation of MC's new statistical sampling specification S-S-04.

To enable the implementation and use of S-S-04, the diaphragm meter verification specification S-G-02 defines "conforming unit", "nonconforming unit", "marginally conforming unit", and MADT (Measure of Absolute Deviation from Target), and incorporates "compressed specification limits" and "test limits" that account for the measurement uncertainties associated with the measuring apparatus (prover) used for meter testing. In addition, S-G-02 contains lot homogeneity criteria for the formation of meter lots for sampling, "outgoing quality" requirements and requirements for the disposition of non-conforming meters, and administrative requirements for the marking and sealing of verified meters.

MC plans to review and revise this meter specification in 2007/08 to add applicable requirements for approval-of-type and address various outstanding issues of concern relating to the manufacture, calibration, testing, storage, handling, shipping, and installation of diaphragm meters. A joint working group composed of MC staff and gas industry representatives will be formed to study these issues and make recommendations to MC concerning what specification requirements need to be added or amended.

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Specifications

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Specifications for the Verification and Reverification of Diaphragm Meters

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Specifications for the Verification and Reverification of Diaphragm Meters

1.0 Scope

These specifications apply to the verification and reverification of diaphragm type gas meters of all sizes or capacity ratings, with or without attached telemetering devices, which are intended for use in the measurement of natural gas and manufactured hydrocarbon gases such as propane vapour.

2.0 Authority

These specifications are issued under the authority of sections 12 and 18 of the *Electricity and Gas Inspection Regulations*.

3.0 Normative References

3.1 S-S-01, Specifications for the Generation of Pseudo-Random Samples

3.2 S-S-02, Measurement Uncertainty and Meter Conformity Evaluation Specifications

3.3 S-S-03, Prerequisites to the Use of Sampling Inspection

3.4 S-S-04, Sampling Plans for the Inspection of Isolated Lots and Short Series Lots

3.5 Electricity and Gas Inspection Act

3.6 Electricity and Gas Inspection Regulations

4.0 Terminology

Average Ambient Temperature
The arithmetic mean of the temperatures defined in the applicable specifications for the proving system being used, and the proving room.

Defect
A departure of a meter's quality characteristic from its intended level or state, that occurs with a severity sufficient to cause the meter to not satisfy normal usage requirements. (Note: Depending on the nature and severity of the defect, it may cause a nonconformity to occur immediately or at some time in the future.)

Dial Test
A comparative registration test performed on a diaphragm meter for the primary purpose of verifying that the installed index is functional and compatible with its host meter.

Direct-counting Mode
A selectable mode of operation on an automated prover that employs the use of a photo sensor to gate (trigger) the start and stop of a test run, using counted revolutions of the meter's test dial.

Diaphragm Meter
A volume measuring gas meter (positive displacement type) in which the measurement of the gas flow is effected by means of measuring chambers with deformable walls.

Gas Measuring Apparatus
A term used in the Electricity and Gas Inspection Act and Regulations which, for purposes of application to this specification, can be interpreted to mean "prover" and/or "proving system".

High Load (H.L.) Test
A volumetric accuracy test conducted at the specified testpoint having the highest flowrate; sometimes also referred to as the "open cap" test.

Index
A mechanical-type register used on a gas meter for recording metered volume.

Large Diaphragm Meter
A diaphragm meter having a rated air flowrate capacity exceeding 500 standard cubic feet per hour (or metric equivalent), and which is primarily used for metering of commercial/industrial services.

Low Load (L.L.) Test
A volumetric accuracy test conducted at the specified testpoint having the lowest flowrate; sometimes also referred to as the "closed cap" test.

New Meter
A diaphragm meter which has never been used in service.

Nonconformity
A departure of a meter's quality characteristic from its intended level or state, that occurs with a severity sufficient to cause the meter to not satisfy one or more specification requirements.

Non-TC Meter
A diaphragm meter fitted with a "standard tangent", which is not designed to provide a base temperature-converted volume registration.

Relative Error
The absolute error of measurement divided by the conventional true value of the measurand, and traditionally referred to as the "true error". Expressed as a percentage, relative error is calculated as:

$$E_r = \left(\frac{Q_m - Q_s}{Q_s}\right) \times 100\% = \left(\frac{Q_m}{Q_s} - 1\right) \times 100\%$$

where,

E_r is the relative error of the meter under test, expressed in percent
Q_m is the quantity indicated by the meter under test
Q_s is the quantity indicated by the prover or reference standard, expressed in the same units as Q_m.

Remanufactured Diaphragm Meter
A diaphragm meter which has been manufactured using reconditioned castings from a previously used meter and rebuilt entirely with new O.E.M. parts, using the same manufacturing techniques, processes, and quality assurance criteria as are used in the manufacture of new meters; not to be confused with meters that have been rebuilt, repaired, or reconditioned.

Reverification
Any subsequent confirmation of a meter's conformance to legal requirements following its initial verification of conformance to those same requirements, performed upon expiration of the meter's reverification period (i.e. seal period).

Small Diaphragm Meter
A diaphragm meter having a rated air flowrate capacity less than 500 standard cubic feet per hour (or metric equivalent), primarily used for metering of domestic/residential services.

Specification Limit
The maximum permissible error permitted for a meter's performance characteristic.

TC Meter
A temperature-converted diaphragm meter, more commonly referred to as a "temperature-compensated" meter (or TC meter). Diaphragm meters equipped with a TC tangent are designed to produce a volume registration which has been converted to a base temperature of either 15 °C (for cubic meters) or 60 °F (for cubic feet).

Telemetering
The transmission of measurement information with the aid of intermediate means that permits the source meter information to be interpreted at a distance. Note: The term "intermediate means" is broad enough to include wire or wireless techniques for transmitting measurement data from the source meter.

Telemetering Device
A device used in a telemetering system to duplicate the register reading of the source meter, such as an automatic meter reading (AMR) device or a pulse generator/initiator.

Test Dial
The clock-style dial pointer(s) on the face of a meter's index, the circle of which has graduation marks that are not numbered, designed for use in gating meter accuracy tests performed on a prover.

Test Value (e_i)
The result of a measurement after correction for any known systematic or bias errors, at flowrate i.

Test Limit
The limit established when the specification limit is adjusted for the associated measurement uncertainty.

Verification
All of the operations carried out by an inspector or accredited organization to confirm that a meter entirely conforms to legal requirements.

5.0 Symbols and Abbreviated Terms

k multiplier calculated to provide specified coverage for the uncertainty of a measurement
e_i test value
e'_i bias corrected value of e_i (Note: If no bias, then $e_i = e'_i$)
u_{ci} combined standard uncertainty of e_i
L_{SL} lower specification limit
U_{SL} upper specification limit

MADT median absolute deviation from target
U_{MADT} Upper MADT specification limit

TL_L lower test limit
TL_U upper test limit
T target value for calibration (percent relative error)
Q_{max} manufacturer's rated air capacity of the meter (maximum flowrate rating)
Q_{min} manufacturer's rated minimum air capacity of the meter (minimum flowrate rating)

CSL1 compressed specification limits for type 1 marginal conformities (LQ = 3.15%)
CSL2 compressed specification limits for type 1 marginal conformities (LQ = 8.0%)
L_{CSL1} lower compressed specification limit (LQ = 3.15%)
L_{CSL2} lower compressed specification limit (LQ = 8.0%)
U_{CSL1} Upper compressed specification limit (LQ = 3.15%)
U_{CSL2} Upper compressed specification limit (LQ = 8.0%)

6.0 Metrological Requirements

6.1 General

A meter shall meet all of the performance requirements and non-performance requirements specified in this specification and any related Measurement Canada (MC) bulletins, as well as conform fully with its approved pattern (design, features, functions, markings, etc.) described in the applicable Notice of Approval, in order to be verified or reverified.

6.1.1 Any meter that fails to meet a performance or non-performance requirement, or that possesses a defect which could affect its ability to meet specified requirements, shall be classified as nonconforming.

6.1.2 All meter conformity tests shall be performed in accordance with documented procedures that have been evaluated for technical adequacy by the relevant MC technical experts.

6.2 Conditions for Testing

6.2.1 Test Installation

6.2.1.1
The gas measuring apparatus used for final inspection of meters presented for verifications shall have a valid MC certificate of certification. Any conditions of use noted on the certificate shall be met.

6.2.1.2
Where required by the MC specifications and procedures applicable to the type of prover being used, correlation with the local volumetric standard (e.g. master bell prover) shall be established with the use of transfer meters.

6.2.1.3
Other conditions for testing, as prescribed in the MC specifications and procedures applicable to the type of prover being used, shall also be met. Such requirements may include:

(a) mitigation of the effects of pressure pulsations and resonance when using a rotary meter transfer prover

(b) target value and stability of the meter inlet pressure and meter outlet air temperature

(c) location and orientation of sensors for measuring pressures and temperatures

(d) maximum allowable difference between a bell prover's sealant temperature, supply air, and average ambient temperature

(e) maximum allowable rate of air leakage for the proving system

(f) stability of flowrate settings

(g) monitoring the pressure of the flowing gas (air) at the outlet of the meter under test, and applying a pressure conversion factor to the meter error calculation to compensate for the difference in pressure between the meter outlet and the gas measuring apparatus.

6.2.1.4
The temperature representative of the flowing gas (air) temperature to which the meter's temperature converting tangent is responding, shall be measured at a location approved by MC relative to the meter under test, to facilitate the calculation and application of a corresponding base temperature conversion factor/multiplier to the volume registered by the prover.

6.2.2 Ambient Air Temperature of Test Room

6.2.2.1
The ambient air temperature of the test room shall be continuously monitored and maintained within ±1.0 °C (±1.8 °F) of a temperature chosen by the meter verifier, unless otherwise specified in the MC specifications applicable to the type of gas measuring apparatus being used.

6.2.2.2
During meter testing, the temperatures of the test room ambient air and the gas measuring apparatus air supply temperature shall be maintained within 0.5 °C (0.9 °F) of each other, unless otherwise specified in the MC specifications applicable to the type of gas measuring apparatus being used.

6.2.3 Acclimation of Meters in Test Room

6.2.3.1
Meters shall be acclimated inside the test room for a minimum of four (4) hours prior to the commencement of meter performance testing, unless otherwise authorized by Measurement Canada.

NOTE: The actual time needed for complete acclimation of a meter will vary, depending on the difference in temperature between the ambient air of the test room and the ambient air of the room in which the meter was previously stored. As well, acclimation time may vary for an individual meter, depending on the meter's relative position or degree of exposure to the ambient air flow within the test room.

6.2.4 Relative Humidity

If a sonic nozzle prover is to be used for meter testing, the relative humidity of the test room's ambient air shall be continuously monitored and maintained within the limits specified in the MC specifications applicable to this type of prover.

6.3 Meter Performance Tests

6.3.1 General

6.3.1.1
The requirements for reverification shall be the same as those for verification, with the exception that no bias may be applied to the calibration and test results for reverified meters.

6.3.1.2
Meters may be preconditioned (i.e. exercised) prior to testing, if desired.

6.3.1.3
Meters presented for inspection shall be free of any physical damage, defects in workmanship, or material deficiencies which could affect the meter's performance. Meters shall also be free of dirt, debris, and other foreign substances, both internally and externally.

6.3.1.4
Gating (i.e. starting and stopping) of a meter test run shall be triggered on the upswing of the test dial hand, when using either a non-automated prover or an automated prover operating in "direct-counting mode".

6.3.2 Meter Leak Test

Prior to commencing meter accuracy testing, and with the meter connected to the gas measuring apparatus (prover), a leak test shall be performed to detect any leaks in the meter and the proving system. The leak test shall be performed manually if it is not performed automatically as part of the prover's automated test cycle.

6.3.3 Testpoints

Meters shall be subjected to accuracy testing at the H.L. and L.L. testpoints specified in Table 1. The H.L. test shall be performed first, prior to performing the L.L. test.

Table 1

Testpoint	Flowrate
High load (H.L.)	$(1.45 \pm 0.05)\ Q_{max}$
Low load (L.L.)	$(0.45 \pm 0.05)\ Q_{max}$

6.3.4 Test Duration

6.3.4.1
The test duration, or the total volume measured during a meter accuracy test, shall be sufficient to permit the inspector to resolve the calculated test error to the nearest 0.1%, or better.

6.3.4.2
For tests gated off a meter's test dial, the test volume shall be equal to an integer multiple of the cyclic volume of the meter, or a volume of air that will produce one or more whole revolutions of the meter's tangent or output drive (wriggler or gear).

6.3.5 Index Verification

6.3.5.1
A dial test shall be performed on all meters verified or reverified by the 100% inspection method, as well as those inspected by sampling, performed in accordance with applicable MC specifications. This requirement is also applicable to sample meters inspected under a MC-authorized compliance sampling plan, unless otherwise authorized by MC.

6.3.5.2
The dial test shall be performed with the index mounted on its host meter, unless otherwise authorized by MC.

6.3.5.3
Where a meter index is equipped with two test dials, the dial hand of the directly-driven test dial shall be used for the gating of tests performed in direct-counting mode on a prover.

6.3.5.4
If a meter is to be tested on an inferential-type prover using only the inferential test mode, the dial test may be performed using some other apparatus or method authorized by MC.

6.3.5.5
The test dial of an index shall not exhibit erratic motion during any dial test or meter accuracy test.

6.3.5.6
A visual examination shall be performed to verify that the correct model of index is installed, and that the meter reading dial hands of a clock-type index are properly aligned, or that the numerals of an odometer-type index are properly aligned.

6.3.5.7
If the existing index of a verified meter in service is to be replaced in situ with a retrofit AMR-equipped index, the replacement index shall be installed in accordance with the provisions of the applicable MC bulletin(s).

6.3.6 Temperature Compensation

6.3.6.1
When testing a TC meter, the test volume measured by the prover shall be converted to a volume expressed at the meter's base temperature. If this conversion is not being performed automatically by the prover, the value shall be manually calculated and applied to the "apparent test error" indicated by the prover.

NOTE: A correction for "delta-T" shall not be applied to a prover's indicated test error to compensate for the difference in temperature between the prover air and the TC meter's outlet air, as doing so would produce an incorrect test error result.

6.3.6.2
When testing a non-TC meter, a correction for "delta-T" shall be applied to the indicated test error to compensate for the difference in temperature between the prover air and the non-TC meter's outlet air.

6.3.7 Pulse Generator

6.3.7.1
The temperature-converted volume output of a meter's pulse generator/initiator, if so equipped, is exempt from verification.

6.3.7.2
The non-converted volume output of a meter's pulse generator/initiator, if so equipped, shall be verified unless the pulse output has been permanently disabled. Unless otherwise authorized by MC, testing of a pulse output shall require a minimum of two complete consecutive increments of the test dial which drives the pulse generator. The test volume represented by the output pulses shall match the corresponding volume registered by the host meter's index.

6.3.8 AMR Device

An automatic meter reading (AMR) device is exempt from the need for verification or reverification. This dispensation does not apply to the index on which the AMR device is affixed.

6.3.9 Limits of Error and Conformity Determination

6.3.9.1
The specification limit is ±1.60% and the minimum coverage criterion for the extended result is at least 99% coverage. For the purposes of 100% inspection, the test limit shall be as follows:

The lesser of $TL_u = 1.60 - k\,u_{ci}$ or $TL_u = 1.00\%$
The greater of $TL_L = -1.60 + k\,u_{ci}$ or $TL_L = -1.00\%$

where, $k = 3.0000$ and u_{ci} is determined in accordance to the requirements of MC Specification S-S-02 (reference 3.2).

6.3.9.2
Conformity shall exist if all of the following inequalities are satisfied:

$e_i \leq TL_{u1}$ and $e_i \geq TL_{L1}$ where, $TL_{u1} = (TL_u + T)$ and $TL_{L1} = (TL_L + T)$

median ($|e'_i|$) $\leq TL_{u2}$ where, $TL_{u2} = 0.5\ TL_u$

where, T is the target value established in section 6.3.9.4 and e_i' is the bias corrected value of e_i determined in consideration of section 6.3.9.5.

NOTE: The MADT is calculated from all observations. The calculation method is to first determine the absolute value of each error, e_i', then determine the median of those values.

6.3.9.3
Conformity shall be determined using a one-stage procedure in accordance to the requirements of MC specification S-S-02 (reference 3.2).

6.3.9.4
The target value (T) shall normally be zero, however meter owners may elect to have a bias applied to the H.L. and L.L. calibration of any given make/model of new or remanufactured diaphragm meter, provided that the applied bias value(s) are declared to MC by the meter owner prior to presentation of the meters for inspection. The chosen bias value(s) may be different for the H.L. and L.L. test points, but shall have a value which lies within the interval of -1.0% to 0.0%.

6.3.9.5
If the target value is not zero, then prior to calculating the MADT all errors shall first be transformed to zero using a MC-authorized procedure, in order to take into consideration the applied bias value(s) when determining the acceptability of a meter's calibration error.

6.3.9.6
Measurement results shall be reported in accordance with S-S-02 (reference 3.2).

6.4 Acceptance Sampling Inspection

6.4.1 Devices may have their conformity evaluated by 100% inspection or, where the prerequisites of MC Specification S-S-03 (reference 3.3) have been and continue to be met, by sampling inspection in accordance with the requirements of MC Specification S-S-04 (reference 3.4).

6.4.2 A lot of meters submitted for acceptance sampling shall not contain a mixture of TC and Non-TC meters, nor a mixture of imperial and metric meters. As well, meters in the lot shall meet all of the following additional requirements for lot homogeneity:

(a) Same manufacturer and model, unless otherwise authorized by MC in accordance with clause 6.4.3.

(b) Same measurement technology.

(c) Same units of measure.

(d) Same or similar capacity (within 10% of the rated flow capacity (air) of the other meters in the lot).

(e) Same model or type of telemetering device (if so equipped), unless otherwise authorized by MC in accordance with clause 6.4.3.

(f) Calibrated using the same quality and production processes.

(g) Permissible batch types:

(i) New and/or remanufactured meters; or,

(ii) Previously-verified meters which have all been reconditioned (and/or repaired) and recalibrated within a six-month period.

6.4.3 If an accredited organization wishes to combine, in one lot, various models or vintages of meters, and/or meters equipped with and without a telemetering device, the accredited organization shall submit a request to MC with accompanying documentation in support of their claim that these differing meters can be considered homogeneous for purposes of acceptance sampling.

6.4.4 For the purposes of sampling inspection, a conforming unit is as defined in these specifications, for performance and non-performance characteristics. A lot shall be sentenced based on the specification limit of ±1.60%. The criterion for the extended measurement result is at least 95% coverage. An accredited organization shall have the option to determine conformity using either a one-stage or two-stage procedure in accordance with the requirements of MC Specification S-S-02 (reference 3.2).

6.4.5 The compressed specification limit (CSL) values determined from the device's performance specification limits are defined as follows:

Table 2

Marginal conformity type	Lower CSL	Upper CSL
Type 1 (LQ of 3.15%)	$L_{CSL1} = 0.8350\ (-1.60) + T$	$U_{CSL1} = 0.8350\ (1.60) + T$
Type 1 (LQ of 8.0%)	$L_{CSL2} = 0.6797\ (-1.60) + T$	$U_{CSL2} = 0.6797\ (1.60) + T$
Type 2 (MADT)	-------	$U_{MADT} = 0.5\ (1.60)$

6.4.6 A device is classified as a marginally conforming unit if it has no nonconformity but exhibits performance falling outside the interval defined by the lower and upper CSL values (type 1 marginally conforming) or has an MADT value exceeding one half of the upper specification limit U_{SL} (type 2 marginally conforming), where classification as type 1 takes precedence over classification as type 2.

6.4.7 The conformity, marginal conformity, or nonconformity of the device's performance shall be determined in accordance with the requirements of S-S-02 (reference 3.2) and the following classification criteria based on the device's relative error (e_i), applied in the order presented below:

(a) nonconforming if $e_i + k\,u_{ci} > (U_{SL} + T)$, or $e_i - k\,u_{ci} < (L_{SL} + T)$

(b) marginally conforming type 1 if $e_i + k\,u_{ci} > U_{CSL1}$ or $e_i - k\,u_{ci} < L_{CSL1}$

(c) marginally conforming type 1 if $e_i + k\,u_{ci} > U_{CSL2}$ or $e_i - k\,u_{ci} < L_{CSL2}$ (optional under sampling inspection)

(d) marginally conforming type 2 if the median ($|e_i'|$) > U_{MADT}

(e) conforming otherwise

where, k = 1.6449, u_{ci} is determined in accordance to the requirements of MC Specification S-S-02 (reference 3.2), T is the target value established in section 6.3.9.4, and e_i' is determined in consideration of section 6.3.9.5.

6.4.8 For the purpose of sampling inspection, test results for the following quality characteristics shall be treated as non-performance observations (i.e. pass/fail):

(a) meter leak test

(b) index dial test

(c) pulse output test

6.4.9 Measurement results shall be reported in accordance with S-S-02 (reference 3.2).

6.5 Outgoing Quality Requirements

The outgoing quality standards for meter quality under both 100% inspection and sampling inspection are:

(a) No inspected meters shall be permitted to be placed in service with a result which is not contained within the 100% Inspection test limits specified in subsections 6.3.9.1 and 6.3.9.2.

(b) No meters shall be permitted to be placed in service with one or more nonconformities or defects. (Note: The accredited organization shall be responsible for deciding which types of quality characteristic deficiencies are to be identified as a defect.)

(c) Subject to a) and b) above, sample meters are considered acceptable regardless of the status of the lot.

(d) The outgoing quality requirements shall be met for the product of the associated limiting quality (LQ) value and the lot size, as specified in S-S-03 (reference 3.3) or S-S-04 (reference 3.4) for type 1 and type 2 marginal conformities.

6.6 Sampling Plan for the Inspection of Isolated Lots of Meters in Service

Meters in service may be reverified as a lot by compliance sampling with use of a MC-authorized compliance sampling plan.

7.0 Technical Requirements

Refer to applicable MC specifications for approval-of-type requirements for the design, composition, and construction of diaphragm meters.

8.0 Administrative Requirements

8.1 Markings

8.1.1 In order to qualify for verification and sealing, meters shall bear one or more nameplates or tags which are permanently fastened to the meter body, which bear indelible legible markings of the following items of information:

(a) contractor's assigned meter inspection number (company serial number).

(b) meter manufacturer's serial number.

(c) manufacturer's name or registered trademark.

(d) meter model (model number).

(e) ambient operating temperature range, if narrower than the range of -30 °C to +40 °C

(f) notice of approval (NOA) number (Note: Not applicable to meters approved prior to July, 1987).

(g) maximum allowable operating pressure (MAOP).

(h) manufacturer's rated capacity (air).

(i) base temperature to which the registered volume is being converted (15 °C or 60 °F), with a red-coloured background (Note: Applicable only to temperature-converting diaphragm meters).

(j) arrow to indicate the direction of forward gas flow, or the inlet connection identified with the word "inlet".

(k) direction of rotation of the meter's index drive shaft (applicable only to large diaphragm meters).

(l) capacity per revolution of the meter's index drive shaft marked in the vicinity of the shaft (Note: Applicable only to large diaphragm meters).

NOTE: Meters shall not be marked with a mixture of International System (SI) units of measure and Imperial System units of measure.

8.1.2 Temperature-converting (TC) meters presented for reverification which have a nameplate on which the red-coloured background of the base temperature markings has partially or totally faded, shall not be rejected or classed as a non-conformance, provided that all of the mandatory information markings (as listed in subsection 8.1.1) on the nameplate are still legible.

8.1.3 If any mandatory markings on a meter nameplate have become illegible due to damage, deterioration or fading, the nameplate shall either be replaced or a covered with a self-adhesive label which bears the same information. Such labels may have a cut-out window that exposes the original nameplate's serial number marking, if the serial number is still legible.

8.1.4 The use or application of new pre-printed self-adhesive verification labels is not permitted on meters which are being verified or reverified. Existing old verification labels shall either be removed or painted over, on meters being presented for reverification (excluding compliance sampling meters). A meter presented for compliance sampling which had been previously affixed with a self-adhesive verification label, shall not be considered non-conforming if the faded markings on the label are no longer legible, or if the label has fallen off.

8.1.5 Where a meter incorporates a pulse generator, the following information shall be marked on a nameplate mounted on the host meter:

(a) number of pulses corresponding to a unit of measured quantity or the number of measured units corresponding to one output pulse.

(b) type and amplitude of output signal, or contact rating (e.g. "form C" or "form A").

8.1.6 Where the information content of a meter's pulse output may vary with the meter model on which the pulse generator is installed, a nameplate, tag, sticker, or other suitable means for marking the required information shall be provided by the manufacturer.

8.1.7 Where a pulse generator is a separate entity which can be attached to an approved meter, the following information shall be marked on a nameplate attached to the pulse generator:

(a) number of pulses corresponding to one unit of input to the generator

(b) maximum frequency of input

(c) type and amplitude of output signal, or contact rating (e.g. "form C" or "form A")

8.2 Seals and Sealing

Unless otherwise specified in the applicable Notice of Approval or other applicable MC specifications or policies, as to which components and sealing points require sealing (or the required sealing wire configuration), meters shall be sealed in accordance with the requirements in clauses 8.2.1 to 8.2.7 below.

8.2.1 Meters shall either be sealed using a MC-approved metal roll-up seal and metal sealing wire, and/or encasement seals consisting of a sealing cap and receptacle. The use of plastic mono-filament (or other material) is also permitted as an alternative to the use of metal sealing wire, provided that it has a diameter of at least 0.644 mm and durability characteristics which are at least equivalent to that of metal sealing wire.

8.2.2 At least one of the seals on each sealed component of a meter shall bear a verification marking which shows the year in which the meter was tested and verified, and the unique identity (name, initials, or logo) of the accredited organization which performed the verification or reverification.

8.2.3 On small diaphragm meters, at least one screw shall be sealed on each of the following components: index cover, top cover, and hand-hole cover (or calibration adjustment access hole plug/cover, if so designed). The front and back covers of the meter may be left unsealed.

8.2.4 On large diaphragm meters intended for operation on low pressure and/or Pressure Factor Metering (PFM) installations, at least one screw shall be sealed on each of the following components: index cover, top meter cover, undergear (intermediate gear) assembly cover, and calibration adjustment access hole plug/cover (if so designed). The front and back covers of the meter may be left unsealed.

8.2.5 On large diaphragm meters intended for operation on elevated pressure with use of an ancillary volume conversion device, at least one screw shall be sealed on each of the following components: top meter cover, undergear (intermediate gear) assembly cover, and calibration adjustment access hole plug/cover (if so designed). The front and back covers of the meter may be left unsealed.

8.2.6 If a meter is to be sealed using sealing wire and screws having drilled heads, the sealing wire shall be routed so as not to run in parallel between any two screws, nor with any excess slack, so as to minimize the possibility of those screws being removed (for purposes of tampering) and subsequently reinstalled without breaking the sealing wire.

8.2. If a verified meter is fitted with a pressure tap plug, the plug may be left unsealed or separately sealed so as to permit its removal without affecting the meter's verification seal or sealing wire.

8.3 Disposition of Nonconforming Meters

8.3.1 For small lots inspected by 100% inspection or larger lots inspected but not accepted by sampling, nonconforming meters and excessive marginally conforming meters shall be removed or repaired to ensure the outgoing quality standards of section 6.5 are met.

8.3.2 Individual non-conforming or defective meters may be resubmitted for inspection only after their deficient characteristics have been corrected.

8.3.3 Unacceptable lots may be resubmitted for inspection only after the meter owner or his agent has re-examined all meters and removed or corrected all non-conforming or defective meters. Re-inspection shall include evaluation of all quality characteristics where the non-acceptance is due to performance characteristics, or, for all other types of nonconformities and defects, evaluation of only the characteristic(s) causing lot non-acceptance.

8.4 Reverification Interval

The reverification interval (i.e. "seal period") for diaphragm meters is prescribed in the applicable MC bulletin.

Alan E. Johnston
President
Measurement Canada

Information

2008-10-08

Specifications for the Approval of Type of Gas Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-08 (S-G-03)

This information bulletin is intended to advise natural gas sector stakeholders that Measurement Canada (MC) has now issued Specification S-G-03. This specification has been developed to communicate amendments to MC Specification LMB-EG-08 which have already been implemented by MC but were never formally communicated. S-G-03 also contains amendments required to remove requirements identified under the Government of Canada paper burden reduction initiative. As well, the requirements formerly found in Provisional Specification PS-G-08 have now been moved to S-G-03, and PS-G-08 has been revoked.

This new specification will enable users to find all amendments to LMB-EG-08 in one location, which will reduce the risk of some users not being aware of each of these amendments.

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Specifications

Category: **GAS**	Specification: **S-G-03**	Page: **1 of 21**
Document(s): **Gas Specification LMB-EG-08**	Distribution Date: **2008-10-08**	Effective Date: **2008-10-08**
	Supersedes: **PS-G-08**	

Specifications for Approval of Type of Gas Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-08

1.0 Scope

This specification applies to all gas meters and auxiliary devices submitted for approval pursuant to LMB-EG-08. (Specifications for Approval of Type of Gas Meters and Auxiliary Devices).

2.0 Authority

These specifications are issued under the authority of section 12 of the *Electricity and Gas Inspection Regulations*.

3.0 References

Specifications for Approval of Type of Gas Meters and Auxiliary Devices, LMB-EG-08 (1986).

4.0 Background

Since the beginning of the application of Measurement Canada (MC) specification LMB-EG-08 and prior to the implementation of the Agency's revised publication process in the 1990's, the Agency has implemented changes to some of the requirements of the specifications which have not been published. The purpose of this specification is to consolidate and officially communicate the applicable requirements of LMB-EG-08 that have been changed over the years and that are currently being applied during type approval evaluation.

5.0 Amendments to Specific Sections of LMB-EG-08

5.1 Amendments to Section 1 - SCOPE of LMB-EG-08

5.1.1 Section 1 has been revised to include the scope of LMB-EG-08. The scope has been updated to identify the current documents being referenced during approvals. Section 1 is hereby amended as follows:

Authority

These specifications are established by the Director (President of Measurement Canada), under the authority of the Electricity and Gas Inspection Act and the Regulations pursuant thereto.

Section 1 - Scope

This document sets out the specifications relating to design, composition, construction and performance to which gas meters and auxiliary devices must conform in order to receive approval pursuant to section 9 of the Electricity and Gas Inspection Act. The criteria also apply to modifications which may be made in future to approved devices.

This document refers to the following and, where such reference is made, it shall be considered to refer to the latest edition and any revisions thereto:

Canadian Standards Association, Natural Gas and Propane Installation Code CAN/CSA-B149
http://www.csa-intl.org/OnlineStore/GetCatalogDrillDown.asp?Parent=522

American Gas Association Report No. 3: Orifice Metering of Natural Gas and Other Related Hydrocarbon Gases (also published as American National Standards Institute Standard ANSI/API 2530, American Petroleum Institute API 14.3, and Gas Processors Association GPA 8185.)

American Gas Association Transmission Measurement Committee Report No. 5: Fuel Gas Energy Metering.

Gas Processors Association Standard 2172, "Calculation of Gross Heating Value, Relative Density, and Compressibility of Natural Gas Mixtures from Compositional Analysis".

American Gas Association Transmission Measurement Committee Report No. 8: Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases (also published as American Petroleum Institute MPMS Chapter 14.2).

Manual For the Determination of Supercompressibility Factors for Natural Gas – Par Research Project NX-19, Extension of Range of Supercompressibility Tables.

United States Department of Defense Military Standard MIL-STD-461E: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
http://www.navair.navy.mil/e3/Documents/mil461e.pdf

5.2 Amendments to Section 2 - Definitions of LMB-EG-08

5.2.1 Section 2 is hereby amended to include the following definitions:

Calorific Power - The number of energy units per unit of volume at a certain temperature and certain pressure. Calorific power is more appropriately known as Energy Density or Heating Value. It is expressed in Btu/ft^3 in the Imperial System of Units (IMP) or in MJ/m^3 in the International System of Units (SI).

Electronic Display - A device or other means used to visually present the value of a measured quantity and other relevant information. It may take the form of an integral part of a meter or a separate display module.

Electronic Register - A specific location in the meter where the value of a measured quantity is recorded.

Integral Transducer or Transmitter - A transducer or transmitter that is installed on or inside the enclosure of a host EVC device (or Flow Computer), or one that is designed to be remotely connected with signal wires for dedicated use with its host EVC device, and is presented to MC for approval together with the host EVC device. It is approved under the host EVC device's Notice of Approval.

Non-integral Transducer or Transmitter - A transducer or transmitter that is not installed on or inside the enclosure of an EVC device (or Flow Computer), and is designed to be connected with signal wires to various different compatible makes and models of EVC devices, and is not presented together with a host EVC device for approval evaluation. It is separately approved under its own Notice of Approval.

5.3 Amendments to Section 3 - General of LMB-EG-08

5.3.1 Section 3-2 has been revised to address the current exemption for rotary meter pressure bodies from this requirement. Section 3-2 is hereby amended as follows:

3-2 Units

3-2.1 Use of Units. No meter or device shall register, or record, or be marked in a mixture of the International system of units and the Imperial system of units.

3-2.1.1 This requirement does not apply to electronic computers capable of performing calculations necessary to convert from the Imperial system of units to the International system of units, or vice versa.

3-2.1.2 This requirement does not apply to rotary meter pressure bodies designed to accept both metric and imperial modules.

3-2.2 Metric Units of Measure

3-2.2.1 Metric units of measure shall be expressed in the SI units of measure listed in the CSA standard Z234.1 Metric Practice Guide.

3-2.2.2 Where a conflict exists between the CSA standard Z234.1 and the Electricity and Gas Inspection Act and Regulations, the legislative requirements shall apply.

3-2.3 Electronic display of units of measure for non-trade purposes

3-3.3.1 The display of units of measure for non-trade purposes, such as monitoring is permitted.

5.3.2 Section 3-3.2 has been revised to remove requirements identified under the reduction initiative as being low impact requirements. Section 3-3.2 is hereby amended as follows:

3-3.2 Case

The case of a meter intended to contain gas shall be so designed and constructed to effectively maintain its accuracy over the entire ranges of its operating parameters

5.3.3 Section 3-4.1 has been revised to remove low impact requirements identified under the reduction initiative. Section 3-3.2 is hereby amended as follows:

3-4.1 Battery Power Supply

3-4.1.1 Devices which operate from a battery, or other power source which must periodically be replaced, shall be fitted with a device/function to indicate replacement is required at least 90 days prior to failure of the battery or power source.

3-4.1.2 Replacement of power source shall not adversely affect the programming, metering information, or subsequent operation of the device.

5.3.4 Section 3-5.5 has been added to address the marking requirements for software or firmware versions installed. Section 3-5 is hereby amended to add the following requirement:

3-5.5 Firmware/Software Versions

The meter firmware and/or software version shall be prominently indicated either on the meter nameplate or be accessible via an electronic display or by remote interrogation software.

5.3.5 Section 3.6.1 (a) has been revised to the ambient temperature range currently being applied. Section 3.6.1 (a) is hereby amended as follows:

(a) Ambient temperature shall be 20° C ± 2° C with a rate of change not greater than 0.5° C per hour.

5.4 Amendments to Section 4 - REGISTERS of LMB-EG-08

5.4.1 Section 4-2.5 has been amended to remove low impact requirements identify under the reduction initiative. Section 4-2.5 is hereby amended as follows:

4-2.5 Registers - Pointer- Type

4-2.5.1 The minimum diameter of clock dial circles shall be 10 mm.

4-2.5.2 Each dial shall be divided into ten equal and clearly numbered divisions. Preferably, the dials shall be distinctly separated from each other.

4-2.5.3 The gearing shall be such that a complete revolution of any pointer shall cause the adjacent pointer on the left to advance one division.

4-2.5.4 Each dial shall be marked to indicate the number of measured units per revolution of the pointer.

4-2.5.5 There shall be no overall multiplier indicated on the register

4-2.5.6 The dial centers shall be located so as to avoid any possibility of ambiguity in reading.

4-2.5.7 Proving Provisions for Pointer - Type Registers

4-2.5.7.1
Proving dials and test dials provided on pointer type registers shall not be in the same geometric line as the reading circles.

4-2.5.7.2
The proving dial and the test dial circles shall have not less than ten equally spaced divisions and arrows shall show the direction of rotation of the pointers.

4-2.5.7.3
The quantity per revolution of the associated pointer shall be clearly marked.

4-2.5.7.4
No numbers shall appear on the divisions.

4-2.5.7.5
Where a register is incorporated in a meter, the measured quantity per revolution of the proving pointer shall be such that at rated capacity of the meter the proving pointer makes at least one revolution every two minutes.

5.4.2 Section 4-2.6.1 has been amended to realign the reference to the requirements for Proving Provisions for Pointer-Type Registers and update the paragraph numbering. Section 4-2.6.1 is hereby amended as follows:

4-2.6.1 Proving Provisions for Drum Type Registers.

4-2.6.1.1
Drum type registers equipped with proving provisions shall have either a proving drum, a proving dial, or a proving dial and a test dial.

4-2.6.1.2
Proving dials and test dials shall conform to the requirements set out in subclause 4-2.5.7.

4-2.6.1.3
Where a proving drum is used, it shall be divided into ten equal numbered divisions.

4-2.6.1.4
The diameter of the proving drum in relation to the size of the cutout in the register face shall be such that for any rotational position of the drum there is at least one numbered division in full view.

4-2.6.1.5
There shall be a reference mark or marks designed in a manner to reduce or eliminate reading errors caused by parallax.

4-2.6.1.6
The volume per revolution of the proving drum shall be marked on the face of the register in the vicinity of the proving drum.

4-2.6.1.7
The proving drum division markings and the size and location of the reference mark shall be such that the position of the drum with respect to the reference mark can be accurately determined.

4-2.6.1.8
Where a register is incorporated in a meter, the measured quantity per revolution of the proving drum shall be such that at rated capacity of the meter the proving drum makes at least one revolution every two minutes.

5.5 Amendments to Section 5 - DIAPHRAGM METERS of LMB-EG-08

5.5.1 Section 5-3 has been revised to remove the red background requirement for temperature correcting meters and diaphragm marking requirements, identified under the reduction initiative for removal. Section 5-3 is hereby amended as follows:

5-3 Markings

5-3.1 Nameplates. In addition to the requirements of subsection 3-5, the following information shall be marked:

(a) Maximum allowable operating pressure.

(b) Manufacturer's rated capacity on air.

5.3.1.1
Nameplates of temperature correcting meters shall show the temperature to which the registered volume is corrected (e.g. 15° C or 60° F). The information shall be permanently and prominently indicated irrespective of background colour.

5-3.2 Diaphragms. The manufacturer of the diaphragm, shall be marked on the diaphragm in such a location that the marking is visible when the diaphragm assembly is in place.

5.6 Amendments to Section 6 - Rotary Meters of LMB-EG-08

5.6.1 Section 6-3.1.1 has been amended to remove the red background requirement identified under the reduction initiative. Section 6-3.1.1 is hereby amended as follows:

6-3.1.1 Temperature Corrected Volume. Nameplates of non-modular integral temperature correcting meters and interchangeable temperature correcting modules shall show the temperature to which the registered volume is corrected (e.g. 15° C or 60° F). The information shall be permanently and prominently indicated irrespective of background colour.

5.6.2 Section 6-3.2 Gear Reduction Ratio has been revised to current practice of allowing the marking of the reduction ratio on the device which contains the gear reduction assembly. Section 6-3.2 is hereby amended as follows:

6-3.2 Gear Reduction Ratio

6-3.2.1 The overall gear reduction ratio(s) from the primary measuring element to the shaft driving the uncorrected register and the output shaft, where provided, shall be clearly and permanently marked.

6-3.2.2 Where the rotary meter pressure body contains the gear reduction assembly the marking shall be on the rotary meter pressure body.

6-3.2.3 Where the TC module contains the gear reduction assembly the marking shall be on the TC module.

5.7 Amendments to Section 7 - Turbine Meters of LMB-EG-08

5.7.1 Section 7-3.3 has been amended to remove the red background requirement identified under the reduction initiative. Section 7-3.3 is hereby amended as follows:

7-3.3 Temperature Corrected Volume. Nameplates of non-modular integral temperature correcting meters and interchangeable temperature correcting modules shall show the temperature to which the registered volume is corrected (e.g. 15° C or 60° F). The information shall be permanently and prominently indicated irrespective of background colour

5.8 Amendments to Section 8 - Orifice Meters of LMB-EG-08

5.8.1 Section 8-2 Mechanical Requirements - has been amended to current requirements that are being applied by the MC approvals Lab. Section 8-2 is hereby amended as follows:

8-2 Mechanical Requirements

8-2.1 General - These specifications adopt the requirements set out in Section 2 of the fourth edition of the AGA Report No. 3, "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids", (hereinafter referred to as the AGA Report No. 3), except as delineated below.

8-2.2 Orifice Plates - Subsection 2.4 of the AGA Report No. 3 shall apply with exception of clause 2.4.2. The recommendation for the limits of the Beta ratio shall be mandatory. The orifice shall be circular in shape.

8-2.3 Meter Tubes - Subsection 2.5 of the AGA Report No. 3 shall apply

8-2.4 Orifice Flanges - In addition to the requirements of subsection 2.5.2 of the AGA Report No. 3, the face of each orifice flange shall be perpendicular to the axis of each tube section.

8-2.5 Gaskets - The design and material used for sealing the orifice plate in a meter shall be such as to ensure that in operation the thrust caused by total force due to the maximum differential pressure shall not displace the orifice plate to the extent that the allowable tolerances for pressure tap hole location specified in subsection 2.5.4 of the AGA Report No. 3 are exceeded under dynamic conditions.

8-2.5.1 The approval applicant shall supply written attestation that this requirement has been met, complete with supporting test data from a recognized authority.

5.8.2 Section 8-4 Performance Test - has been amended to current requirements that are being applied by the MC approvals Lab. Section 8-4 is hereby amended as follows:

8-4 Performance Tests

8-4.1 General - All measurements shall be made at reference ambient temperature as specified in clause 3-6.1(a).

8-4.2 Dimensional Measurements - Measurements shall be made to establish the dimensions of the meter tubes, orifice fittings, pressure tap holes and their locations in relation to the orifice plate faces, orifice plate and surface roughness, and the thermometer well location as set out in Section 2 of the AGA Report No. 3.

The results of all measurements shall not exceed the tolerances set out in Section 2 of the AGA Report No. 3.

8-4.3 Compressibility of Orifice Plate Sealing Material

The approval applicant shall supply written attestation that this requirement has been met, complete with supporting test data from a recognized authority.

8-4.3.1 Displacement of Orifice Plate - Where the construction of the orifice plate sealing material could allow the plate to be displaced to the extent that the tolerance for a Beta ratio of 0.70, as set out in Figure 2-3 of AGA Report No. 3, would be exceeded, tests may be made to determine the actual plate displacement under maximum load as described below.

The displacement of the orifice plate caused by compressibility of the sealing material shall be such that the tolerance for a Beta ratio of 0.70, as set out in Figure 2-3 of AGA Report No. 3, is not exceeded.

8-4.3.2 Test Method using Blank Plate - The orifice plate shall be replaced in the meter run by a solid plate having the same thickness and outside diameter as the orifice plate. The sealing arrangement shall be the same as for the orifice plate. The upstream section of the orifice fitting or tube shall be sealed and the downstream section opened to the atmosphere. Pursuant to the calculations set out in subclause 8-4.3.3, pressure equivalent to the load on the orifice plate caused by 400 inches W.C. differential pressure shall be applied to the sealed section via the upstream pressure tap hole.

Where the sealing material is bonded to the orifice plate, a blank plate complete with identical sealing material bonded to it shall be supplied by the manufacturer.

The displacement of the blank plate caused by the applied load shall be measured.

8-4.3.3 Sample Calculations - The maximum load on an orifice plate corresponds to the maximum differential pressure and the smallest Beta ratio.

Assumptions:

Nominal pipe size:	12 inches
Pipe schedule:	40
Pipe inside diameter (D):	11.938 inches
Smallest Beta ratio:	0.15
Calculated orifice diameter (d') = D x 0.15:	1.7907
Nearest higher acceptable Orifice diameter (d):	1.875 inches
Differential pressure:	400 inches W.C. = 14.44 psi

5.9 Amendments to Section 9 - Mass Flow Meters of LMB-EG-08

Reserved for future revisions to section 9 of LMB-EG-08.

5.10 Amendments to Section 10 - Dispensers for Natural Gas of of LMB-EG-08

Reserved for future revisions to section 10 of LMB-EG-08.

5.11 Amendments to Section 11 - Recorders of LMB-EG-08

5.11.1 Section 11 Recorders has been revoked - Advances in technology has resulted in MC not approving a new recorder in over 30 years. Therefore the reduction initiative identified this entire section as low impact requirements for removal.

5.12 Amendments to Section 12 - Chart Drives and Timing Devices of LMB-EG-08

5.12.1 Section 12 - Chart Drives and Timing Devices has been revoked - This section is no longer applicable as Section 11 has been revoked.

5.13 Amendments to Section 13 - Charts of LMB-EG-08

5.13.1 Section 13 - Charts has been revoked. This section is no longer applicable as Section 11 has been revoked.

5.14 Amendments to Section 14 - Mechanical Correcting Devices of LMB-EG-08

Reserved for future revisions to section 14 of LMB-EG-08.

5.15 Amendments to Section 15 - Electronic Correcting Devices of LMB-EG-08

5.15.1 Section 15-3 - 1 has been amended to current requirements that are being applied by the MC approvals Lab. Section 15-3.1-2 is hereby amended as follows:

15-3.1 Calculations - Calculation of accumulated units of measurement shall be according to appropriate flow equations and other provisions of the Electricity and Gas Inspection Act and Regulations.

Calculations by flow computers intended for use with orifice meters shall be according to the provisions of the latest edition of the AGA Report No. 3, "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids".

Calculations of supercompressibility factor shall be according to the American Gas Association publication, AGA Report No. 8 - "Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases", or the AGA Report No. 3 - "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids" or the Manual For the Determination of Supercompressibility Factors for Natural Gas – Par Research Project NX-19, "Extension of Range of Supercompressibility Tables".

5.15.2 Section 15-4 - has been revised to allow for the required marking to be accessible through locations other than the nameplate and address the instances in 15-4.2 where the requirement would serve no useful purpose. Section 15-4 is hereby amended as follows:

15-4 Markings

15-4.1 Nameplate - In addition to the requirements of subsection 3-5, the following information shall appear on the nameplate or be accessible via the devices electronic display or output to an external device or through provision for printing this information:

(a) Ranges of measurement parameters for which the device is intended.

(b) Values of all non-programmable constants used in calculation.

(c) Type and range of each electrical input and/or output signal.

15-4.2 Terminal Markings - The connection terminals shall be identified by markings on the device or by a table or a schematic diagram permanently affixed to the device.

15-4.2.1
Where a metering device is designed to accept a non-interchangeable cable connector, the connection terminal for that connector is exempt from this marking requirement.

5.15.3 Section 15-5 - has been renamed to "Metrological Requirements" and updated to address current requirements for integral and non-integral transducers or transmitters. Section 15-5.5 is hereby amended as follows:

15-5.0 Metrological (performance) Requirements

15-5.1 Tests at Reference Conditions

15-5.1.1
Flow Computers (devices without sensors(Delta P, P and T))

Tests shall be conducted with the device at the reference conditions set out in clause 3-6.1 of LMB-EG-08.

The following nine sets of tests shall be made on the device with external sensors. This does not preclude testing with other external devices.

The device shall be tested with (see Table 1):

(a) all inputs and programmable constants at their median(1) values.

(b) each input and programmable constant in turn at its maximum and minimum (1) value with the remaining parameters at their median values.

(c) all inputs and programmable constants at maximum values.

(d) all inputs and programmable constants at their minimum(1) values.

Table - 1

Test Number	1	2	3	4	5	6	7	8	9
Flowing Gas Temperature, % of Span	50	100 (max)	0 (min)	50	50	50	50	100 (max)	0 (min)
Flowing Gas Pressure, % of Max P	50	50	50	100 (max)	25 (min)	50	50	100	25 (min)
Differential Pressure, % of Span	50	50	50	50	50	100 (max)	10 (min)	100	10 (min)

NOTE (1):

- In some cases the minimum value of certain inputs or programmable constants may be zero. In this event, the tests above shall be carried out with the value set at 10 percent of the range of the input or programmable constant instead of the minimum value.

- For flowing gas pressure input, the minimum will be considered to be 25% of the maximum pressure. For differential pressure input, the minimum will be considered to be 10% of the differential pressure span.

- 50% shall correspond to the median value of the range or span of the device.

The error of devices which correct for temperature, pressure, or both shall not exceed ±0.2%.

The error of devices which correct for temperature, pressure, and supercompressibility shall not exceed ± 0.3%.

15-5.1.2 Electronic Volume Conversion Devices and/or Flow Computers (devices with sensors)

The following tests apply to devices which incorporate transducers.

NOTE: For flow computers that incorporate transmitters which provide an electrical output in response to temperature or pressure, the requirements of section 16 of LMB-EG-08 shall apply.

15-5.1.2.1 Integral Conversion Devices

(a) the devices shall be attached to the host meter for testing.

(b) the devices shall be tested at 10% and at maximum flow rate of the host meter.

15-5.1.2.2 Temperature Conversion Devices

The following two sets of tests shall be made on the device with integral sensors. The device can be an integral or non-integral device to a host gas meter. This does not preclude additional testing with other included devices.

Tests shall be made with the flowing gas temperature sensing element held at the minimum temperature marked on the nameplate, 25%, 50% and 75% of the range, and at the maximum temperature marked on the nameplate (see Table 2).

Table - 2

Test Number	**Integral or Non-integral Conversion Device**	
	1	**2**
Flowrate % of Max (Integral) **or** % of Max Speed of Rotation or Input Frequency (Non-integral)	10	100
Flowing Gas Temperature, % of Span (Min or Max Temperature marked on the nameplate)	Min	Min
	25	25
	50	50
	75	75
	Max	Max

The difference between the error of the corrected registration and the uncorrected registration shall not exceed ±0.5%.

15-5.1.2.3 Pressure Conversion Devices

The following two sets of tests shall be made on the device with integral sensors. The device can be an integral or non-integral device to a host gas meter.

(a) pressure tests shall be made at 25%, 50%, 75% and 100% of the pressure range, first with increasing pressure and then with decreasing pressure (see Table 3).

The difference between the error of the corrected registration and the uncorrected registration shall not exceed ±0.5%

Table - 3

Test Number	Integral or Non-integral Conversion Device	
	1	2
Flowrate % of Max (Integral) or % of Max Speed of Rotation or Input Frequency (Non-integral)	10	100
Pressure Conversion Devices % of Pressure Range	25	25
	50	50
	75	75
	100	100
	75	75
	50	50
	25	25

15-1.2.4 Pressure and Temperature Conversion Devices

(a) for inputs corresponding to a linear meter the following tests shall be made:

(i) Tests 1 through 4 at a 10% of Max flowrate (Integral) or 10% of Max Speed of Rotation or Input Frequency (Non-integral)

(ii) Tests 1 through 4 at a 10% of Max flowrate (Integral) or 10% of Max Speed of Rotation or Input Frequency (Non-integral)

(b) for inputs corresponding to a differential pressure the following tests shall be made:

(i) Test 1 at a differential pressure of 50%

(ii) Test 2 at a differential pressure of 50%

(iii) Test 3 at a differential pressure of 100%

(iv) Test 3 at a differential pressure of 10%

(v) Test 4 at a differential pressure of 100%

(vi) Test 4 at a differential pressure of 10%

(vii) Test 5

Test No. 1 - Pressure held at 50% of range and the flowing gas temperature sensing element temperatures varied as set out in item 5.1.2.2 above (see table 4).

Table - 4

Test Number - One	**Integral or Non-integral Conversion Device**
Flowing Gas Temperature, % of Span (Min or Max Temperature marked on the nameplate)	Min
	25
	50
	75
	Max
Pressure % of Range	50

Test No. 2 - Flowing gas temperature sensing element held at a temperature corresponding to 50% of span and pressure varied as set out in item 5.1.2.3(a) above (see Table 5).

Table - 5

Test Number - Two	**Integral or Non-integral Conversion Device**
Pressure Conversion Devices % of Pressure Range	25
	50
	75
	100
	75
	50
	25
Flowing Gas Temperature % of Span	50

Test No. 3 - Pressure held at 100% of range and the flowing gas temperature sensing element held at minimum and maximum temperature (see Table 6).

Table - 6

Test Number Three	**Integral or Non-integral Conversion Device**
Flowing Gas Temperature, (Min or Max Temperature marked on the nameplate)	Min
	Max
Pressure % of Range	100

Test No. 4 - Pressure held at 25% of range and the flowing gas temperature sensing element held at minimum and maximum temperature (see table 7).

Table - 7

Test Number Four	**Integral or Non-integral Conversion Device**
Flowing Gas Temperature, (Min or Max Temperature marked on the nameplate)	Min
	Max
Pressure, % of Range	25

Test No. 5 - The line pressure and temperature held at 50% their respective ranges and the differential pressure tests shall be made at 10%, 25%, 50%, 75%, 100% of the differential pressure range, first with increasing differential pressure and then with decreasing differential pressure.

The difference between the error of the corrected registration for any combination of temperature and pressure and the uncorrected registration shall not exceed ±0.8%.

Where, in addition, the device corrects for supercompressibility, the difference between the errors of the two registrations shall not exceed ±1.0%.

15-5.2 Tests at Other Than Reference Conditions

15-5.2.1 Flow Computers (devices without sensors)

Tests shall be conducted at ambient temperatures of -30 °C and +40 °C with all inputs and programmable constants at their median values (see table 8).

The difference between the error established at reference conditions and the error at other than reference conditions shall not exceed ±0.2%.

Table - 8

Test Number	1	2
Ambient Temperature	-30 °C	+40 °C
Flowing Gas Temperature % of Span	50	50
Flowing Gas Pressure, % of Max	50	50
Differential Pressure, % of Span	50	50

15-5.2.2 Electronic Volume Conversion Devices and/or Flow Computers (devices with sensors)

The device, complete with the capillary of the temperature measuring system, where present, but excluding the flowing gas temperature sensing element, shall be tested at ambient temperatures of -30 °C and +40 °C. During testing the other provisions set out in sub-clause 5.1.2.1 shall apply.

15-5.2.2.1 Temperature Conversion Devices

Tests shall be made at -30 °C with the flowing gas temperature sensing element at a temperature corresponding to 25% of the span, and at +40 °C with the flowing gas temperature sensing element at a temperature corresponding to 75% of span (see table 9).

Table - 9

Test Number	Integral or Non-integral Conversion Device	
	1	2
Flowrate % of Max (Integral) **or** % of Max Speed of Rotation or Input Frequency (Non-integral)	10	100
Ambient Temperature	-30 °C	-30 °C
	+40 °C	+40 °C
Flowing Gas Temperature, % of Span (Min or Max Temperature marked on the nameplate)	25	25
	75	75

The difference between the error of the corrected registration and the uncorrected registration shall not exceed ±1.0%.

15-5.2.2.2
Pressure Conversion Devices

Tests shall be made as set out in item (a) in subclause 5.1.2.3 (see table 10).

Table - 10

Test Number	Integral or Non-integral Conversion Device	
	1	2
Flowrate % of Max (Integral) or % of Max Speed of Rotation or Input Frequency (Non-integral)	10	100
Ambient Temperature	-30 °C	-30 °C
	+40 °C	+40 °C
Pressure Conversion Devices % of Pressure Range	25	25
	50	50
	75	75
	100	100
	75	75
	50	50
	25	25

The difference between the error of the corrected registration and the uncorrected registration shall not exceed ±1.0%.

15-5.2.2.3
Temperature and Pressure Conversion Devices

(a) tests shall be made at -30 °C with the combination of parameters set out in Table 11.

Table - 11

Test Number	1	2	3
Flowing Gas Temperature, % of Span	25	25	25
Pressure (P or ΔP) % of Max	25	50	75
Ambient Temperature	-30 °C	-30 °C	-30 °C

(b) at +40 °C, tests shall be made with the combination of parameters set out in Table 12.

Table - 12

Test No.	1	2	3
Flowing Gas Temperature, % of Span	75	75	75
Pressure (P or ΔP) % of Max	25	50	75
Ambient Temperature	+40 °C	+40 °C	+40 °C

The difference between the error of the corrected registration for any combination of temperature and pressure and the uncorrected registration shall not exceed ±1.3%.

Where, in addition, the device corrects for supercompressibility, the difference between the errors of the two registrations shall not exceed ±1.5%.

5.16 Amendments to Section 16 - Temperature and Pressure Transducers of LMB-EG-08

5.16.1 Section 16-1 - has been revised to clarify that this section does not apply to temperature and pressure transducers that are integral to an EVC. Section 16-1 is hereby amended as follows:

16-1 Scope

16-1.1 This section of these specifications applies to stand alone devices which provide an electrical output in response to temperature or pressure.

16-1.2 Devices which provide an electrical output in response to temperature or pressure, that are an integral component of a host device are dealt with in the applicable section of these specifications for the host device.

5.17 Amendments to Section 17 - Densitometers of LMB-EG-08

Reserved for future revisions to section 17 of LMB-EG-08.

5.18 Amendments to Section 18 - Relative Denisty Devices of LMB-EG-08

Reserved for future revisions to section 18 of LMB-EG-08.

5.19 Amendments to Section 19 - Calorimeters of LMB-EG-08

5.19.1 Section 19-1 - has been revised to update the term "calorific power" to read "energy density", to reflect current terminology used in the regulations. Section 19-1 is hereby amended as follows:

19-1 Scope

This section of these specifications applies to devices which measure the energy density of gas by the process of combustion of the gas.

5.19.2 Section 19-2 - has been revised to update the term "calorific power" to read "energy density", to reflect current terminology used in the regulations. Section 19-2.1 is hereby amended as follows:

19-2 Mechanical Requirements

In addition to the requirements of subsection 3-3, the following shall apply.

19-2.1 Charts - Where a device incorporates a recorder showing energy density over time, charts supplied with the recorder shall be of an approved type or shall be subject to the requirements of these specifications.

19-2.2 Chart Drive - A chart drive supplied with a recorder showing energy density over time shall be of an approved type or shall be subject to the requirements of these specifications.

5.19.3 Section 19-3 - has been revised to update the term "calorific power" to read "energy density", to reflect current terminology used in the regulations. Section 19-3 is hereby amended as follows:

19-3 Markings

19-3.1 Nameplate - In addition to the requirements set out in subsection 3-5, the following information shall be marked.

(a) Range of energy density . Where applicable, the units of energy density shall include the pertinent base conditions.

(b) Type and range of auxiliary output signal* (if provided).

NOTE: An auxiliary output signal is one which is intended to supply information to an auxiliary device other than a dedicated recorder intended for use with the calorimeter.

19-3.2 Operating Information - Where the operating parameters can be adjusted by the contractor, a nameplate, tag, sticker, or other suitable means shall be provided by the manufacturer for marking the required information.

5.19.4 Section 19-4 - has been revised to update the term "calorific power" to read "energy density", to reflect current terminology used in the regulations. Section 19-4 is hereby amended as follows:

19-4 Performance Tests

19-4.1 Tests at Reference Conditions - Tests shall be conducted with the device at the mid-point of the ambient operating temperature range stated on the nameplate. A sufficient number of test gas samples shall be used to test the device over the range of energy density.

19-4.2 Tests at Other Than Reference Conditions - The device shall be tested at the extremities of the ambient operating temperature range stated on the nameplate with a test gas having energy density equivalent to the mid-point of the operating range.

19-4.3 Accuracy - For tests at reference conditions and other than reference conditions, the device shall measure energy density with an error not greater than ± 0.1 MJ/m^3 (at standard conditions) or ± 2.7 $Btu_{(60.5)}/ft^3$ (at standard conditions).

5.20 Amendments to Section 20 - Gas Chromatographs of LMB-EG-08

5.20.1 Section 20-1 has been revised to update the term "calorific power" to read "energy density", to reflect current terminology used in the regulations. Section 20-1 is hereby amended as follows:

20-1 Scope

This section of these specifications applies to any device or system which measures the energy density, relative density or the molecular composition of a gas sample by identifying the component concentrations of the gas.

5.20.1 Section 20-3.1 - was been amended under PS-G-08. The requirements identified PS-G-08 have been moved to this document to ensure requirements are restricted to a limited number of locations. This will avoid confusion of requirements and ensure consistent application of the requirements.
Section 20-3.1 is hereby amended as follows:

20-3.1 Nameplate - In addition to the requirements set out in subsection 3-5, the following information shall be marked on the nameplate or be capable of being displayed by the device:

(a) type and range of auxiliary output signal* (if provided).

NOTE: An auxiliary output signal is one which is intended to supply information to an auxiliary device other than a dedicated recorder intended for use with the chromatograph.

(b) The recognized standard used by the device in calculating the energy value from the gas composition.

(c) Where a device provides an indication of energy in the Imperial System of units:

(i) the particular British Thermal Unit displayed (eg. $Btu_{(60.5)}$, $Btu_{(IT)}$, $Btu_{(59)}$);

(ii) the base temperature and pressure used in establishing the energy density.

5.20.2 Section 20-4.1 - was been amended under PS-G-08. The requirements identified PS-G-08 have been moved to this document to ensure requirements are restricted to a limited number of locations. This will avoid confusion of requirements and ensure consistent application of the requirements.
Section 20-4.1 is hereby amended as follows:

20-4.1 Tests at Reference Conditions.

20.-4.1.1 The chromatograph shall be set up and calibrated according to the manufacturer's instructions.

20-4.1.2 Unless the operating range is otherwise specified by the manufacturer, the chromatograph shall be tested using gases of known composition which may contain any or all of the components set out below with concentrations within the stated ranges.

Component	**MOL %**
Oxygen	0.01 to 1
Helium	0.01 to 1
Carbon Dioxide	0.01 to 15
Nitrogen	0.01 to 15
Methane	50 to 100
Ethane	0.01 to 20
Propane	0.01 to 10
IsoButane	0.01 to 5
N-Butane	0.01 to 5
Iso-Pentane	0.01 to 2
N-Pentane	0.01 to 2
Hexanes Plus	0.01 to 2

Where one of the above components is used as a carrier gas in the chromatograph under test, the concentration of that gas in the test sample shall not exceed 0.04 mol %.

20-4.1.3
If different ranges are specified by the manufacturer, the device shall be tested using samples of known concentration within the specified ranges.

20-4.1.4
The true energy density and relative density of the sample gas shall be calculated using the true relative concentrations of all components of the sample gas as established in accordance with the Gas Processors Association standards, Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis, GPA 2172 and Table for Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Industry, GPA 2145.

20-4.1.5
Where a device provides energy density and/or relative density as a direct output, with or without providing relative concentrations of gas constituents, the calorific power error shall not exceed ± 0.1 MJ/m^3, and the relative density error shall not exceed ± 0.5 %.

20-4.1.6
Where a device provides the relative concentrations of the gas constituents, the error shall not exceed ± 0.1 mol % for each constituent provided.

5.21 Amendments to Section 21 - Electrical Pulse Devices of LMB-EG-08

5.21.1 Section 21-1 - has been revised to remove the exclusion of these components in flow computers. These requirements are currently being applied to pulse components available for flow computers. Section 21-1 is hereby amended as follows:

21-1 Scope

21-1.1 This section of these specifications applies to pulse generators and associated pulse transmitting and receiving devices.

5.21.2 Section 21-2 - has been revised to allow for the current practice of exempting Automatic meter reading (AMR) devices from marking requirements for firmware versions, provided that certain conditions are met. Section 21-2.5 is hereby added as follows:

21-2.5 Automatic Meter Reading (AMR) Devices

21-2.5.1
AMR devices shall have the applicable marking of this section marked on the nameplate or displayed where a display of the marking is permitted.

21-2.5.2
AMRs are exempt from the requirement to mark or display the firmware version, where the following conditions have been met:

(i) the firmware is not being used to perform a metrological function;

(ii) the readings are not used in the calculation of a legal unit of measurement;

(iii) other means has been provided for identifying the firmware version

5.22 Amendments to Section 22 - Pressure Regulators of LMB-EG-08

Reserved for future revisions to section 22 of LMB-EG-08.

6.0 Additional Information

For additional information regarding this bulletin, please contact the Senior Program Officer for gas measurement. For more information regarding Measurement Canada and its programs, visit our Web site located at http://mc.ic.gc.ca.

Alan E. Johnston
President
Measurement Canada

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Information

2009-02-16

Specifications for the Approval, Installation, Use, and Verification of Flow Conditioners used in Gas Measurement Systems (S-G-04)

This information bulletin is intended to advise natural gas sector stakeholders that Measurement Canada (MC) has now issued Specification S-G-04. This specification has been developed to communicate, within one single document, generic requirements for the approval, installation and inspection of any approved make or model of flow conditioner used in gas measurement systems.

Historically, provisional specifications had been developed and published for each individual make or model series of flow conditioner. The review of these documents, performed under the Government of Canada's paper burden reduction initiative, resulted in a decision to consolidate the applicable requirements into one common specification in order to eliminate duplication and prevent confusion by providing a uniform set of requirements applicable to all flow conditioners. As such, provisional specifications PS-G-01, PS-G-05, PS-G-10, PS-G-11 and PS-G-12 have now been revoked.

MC is in the process of creating new notices of approval for the models of flow conditioners previously covered under these former provisional specifications. New requirements identified in S-G-04 which were not specified in these former provisional specifications, do not apply to flow conditioners manufactured prior to the issuance of the applicable notices of approval.

For further information, please contact:

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Gas

Specifications

Category: **GAS**	Specification: **S-G-04**	Page: **1 of 5**
Document(s):	Issue Date: **2009-02-16**	Effective Date: **2009-04-01**
	Supersedes: **PS-G-01, PS-G-05, PS-G-10, PS-G-11, PS-G-12**	

Specifications for Approval, Installation, Use and Verification of Flow Conditioners Used in Gas Measurement Systems

1.0 Scope

These specifications apply to flow conditioners used in natural gas custody transfer metering systems.

2.0 Authority

These specifications are issued under the authority of sections 12 and 18 of the *Electricity and Gas Inspection Regulations.*

3.0 Application for Approval

3.1 Design

3.1.1 Along with the application for approval, the applicant shall submit diagrams of the flow conditioner and state the design parameters and manufacturing tolerances of the flow conditioner(s).

3.1.2 The design parameters in 3.1.1 shall include the following as a minimum:

(i) plate diameters (and outer flange where applicable)

(ii) plate thickness

(iii) number of bore holes and their pattern

(iv) dimensions of the bore holes, as a function of the inside pipe diameter of the pipe for which the conditioner is intended to be used

(v) manufacturing tolerances for the plate diameter(s), thickness of the conditioner, bore hole dimensions and bore hole configuration.

3.2 Construction Material

3.2.1 The applicant shall provide a listing of the acceptable materials that the flow conditioner may be constructed of.

3.3 Test Data

3.3.1 Applicants shall submit test data that demonstrates improvement in base line conditions for specific the meter types or classes. The test data shall be from a test facility recognized under bulletin G-16.

3.3.2 The test data supplied shall conform to the latest version of the applicable American Gas Association (AGA) Report for the type or class of meters the conditioner is intended to be used with.

3.3.2.1 Where the applicable AGA Report does not provide test data requirements for approval of flow conditioners, the following test data requirements shall apply:

(a) Appendix 2-C of AGA Report No. 3, Part 2 (Fourth Edition) or;

(b) Test data conforming to the requirements as set out by another industry-recognized authority, subject to the following conditions;

(i) identification of the industry-recognized authority and the requirements document;

(ii) provide the flow conditioner approval requirements document to the MC Senior Gas Engineer, where requested;

(iii) MC Senior Gas Engineer approval of the use of the approvals requirement document for the submission of test data.

3.3.3 Test data shall be supplied for each combination of flow conditioner model and meter type or class for which approval is being sought.

3.3.4 The test data in 3.3.3 shall be supplied for the Q_{min} and Q_{max} flow rates for each meter type or class for which approval is being sought (i.e. Q_{min} for lowest capacity meter in the meter type or class and Q_{max} for the largest capacity meter in the meter type or class).

3.3.5 The flow range of the flow conditioner, if less than the meter(s) range.

3.3.6 The test medium used to conduct testing (natural gas/air).

3.3.7 The flow conditioner and piping configuration, for each combination in 3.3.3, shall reduce pipeline perpetuations resulting in a measurement system improvement of 1/2 the limit of error of the meter installed.

4.0 Marking Requirements

4.1 The model/type designation and the approval number shall be stamped on the edge of the flow conditioner flange. This marking shall be legible and visible when viewed from the top of the piping when the conditioner is installed.

4.2 The manufacturer's inspection marking (if other than the marking in 4.1) shall also be stamped on the top edge of the flow conditioner to attest to the conformance of the flow conditioner to the manufacturer's design and construction specifications.

4.3 The pipe size and schedule of the upstream pipe that the flow conditioner is intended to be used with, shall be stamped on the downstream face of the plate.

4.4 Where the flow conditioner is not a flange mounted type the required markings shall be stamped on the downstream face of the plate and on a nameplate/tag, to allow for identification the model and it's status with regards manufacturers inspection to design requirements, without disassembling the meter run.

5.0 Configuration Requirements

5.1 The manufacturer shall supply the piping configuration requirements for each type of meter the flow conditioner is intended to be used with.

5.1.1 The piping configuration shall include the distance beween the meter and flow conditioner, the downstream meter tube requirements, and the distance between between the flow conditioner and any elbows or valves upstream of it. The distances shall be stated in the form of the number of pipe diameters.

5.1.2 Any limitations shall be stated, such as the number of elbows or partially opened valves preceeding the flow conditioner.

6.0 Notice of Approval (NOA)

6.1 Upon recommendation from the MC Senior Gas Engineer, the MC approvals laboratory shall generate an NOA for the flow conditioner.

6.2 The NOA shall contain pictorial representations of the flow conditioner model(s) and the piping configurations for each type of meter the flow conditioner is approved for use with.

6.3 Limitations in flow ranges identified in section 3.3.5 shall be communicated in the NOA.

7.0 Installation and Use

7.1 Only approved flow conditioners are permitted in custody transfer metering systems.

7.2 The flow conditioner shall be installed with the model identifier, manufacturer's inspection mark (marking of the model may serve as inspection mark) and NOA number clearly visible, when viewed from the top of the pipe.

7.3 The piping configuration shall conform to the configuration set out in the NOA for the type of meter the conditioner is installed with.

7.4 Where flow range limitations have been identified in the NOA, an evaluation of the installation shall be done to determine if these limitations are exceeded. A record of this evaluation shall be kept and made available to MC upon request.

8.0 Field Verification for Flow Conditioner Installations

8.1 Flow Conditioners Manufactured prior to issuance of this Specification

8.1.1 Flow conditioners manufactured prior to the issuance of this specification and the applicable NOA's are not required to have the additional marking requirements of this specification prior to the field verification.

8.1.2 To facilitate the identification of the approval of the flow conditioner and it's verification to the design requirements, these marking shall be made where it has been determined the device manufacturers inspection or an on site inspection against the design requirements has been completed and the results are found to be acceptable.

8.1.3 The piping configuration shall comply with the approved requirements (NOA) for the type of meter the flow conditioner precedes.

8.1.4 Where flow range limitations have been identified in the NOA the records of the contractor evaluation shall be reviewed and the maximum expected flow range for the metering site shall be recorded on the inspection record.

8.1.5 A field inspection mark shall be applied on the top edge of each section of pipe in the piping configuration, to signify acceptance, where the requirements of sections 8.1.1 to 8.1.4 have been met.

8.1.6 An inspection certificate containing the results of the inspection, including all pertinent information required to identify the contractor, customer and site, shall be issued.

8.2 Flow Conditioners Manufactured after issuance of this Specification

8.2.1 The installed model of flow conditioner shall be an approved model.

8.2.2 Flange type flow conditioners shall bear the NOA number, manufacturer's model and inspection mark (if different), on the edge of the flange. These markings shall be clearly visible, when viewed from the top of the pipe.

8.2.2.1
Where the flow conditioner is not a flange mount type the marking requirements shall be stamped on downstream face of the plate and on a nameplate/tag. Disassembly of the meter run is not required, the nameplate/tag provides for the identication of the flow conditioner and it's status with regards to the manufcaturers design requirements.

8.2.3 The meter type preceding the flow conditioner in the piping configuration shall be a type which has been identified in the NOA.

8.2.4 The piping configuration shall comply with the approval requirements (NOA) for the type of meter the flow conditioner precedes.

8.2.5 Where flow range limitations have been identified in the NOA the records of the contractor evaluation shall be reviewed and the maximum expected flow range for the metering site shall be recorded on the inspection record.

8.2.6 A field inspection mark shall be applied on the top edge of each section of pipe in the piping configuration, to signify acceptance, where the requirements of sections 8.2.1 to 8.2.5 have been met.

8.2.7 An inspection certificate containing the results of the inspection, including all pertinent information required to identify the contractor, customer and site, shall be issued.

Alan E. Johnston
President
Measurement Canada

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Information

2009-12-18

Specifications for In-situ Verification and Reverification of Flow Computers and Transmitters (S-G-05)

This information bulletin is intended to advise natural gas sector stakeholders that Measurement Canada has issued Specification S-G-05: Specifications for In-situ Verification and Reverification of Flow Computers and Transmitters which will become effective April 1, 2010.

These specifications have been developed in consideration of comments received during consultation with stakeholders in June and October 2009, and address the electronic technologies currently being employed in gas flow computers and transmitters. Please note that this document does not include calibration procedures which users will need to develop to ensure gas flow computers and transmitters devices meet the verification and reverification specifications, over the operating range of the device.

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Gas

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Category: **GAS**	Bulletin: **S-G-05**	Page: **1 of 9**
Document(s): **Refer to section 3 below**	Issue Date: **2009-12-18**	Effective Date: **2010-04-01**
	Supersedes:	

Specifications for In-situ Verification and Reverification of Flow Computers and Transmitters

1.0 Scope

This specification applies to High Intervention Trade Transaction level metering sites where a flow computer has been installed.

This specification does not apply to Low Intervention Trade Transaction level metering sites granted conditional permission under Bulletin G-14 for using gas meters in service without verification and sealing.

2.0 Authority

These specifications are issued under the authority of sections 12(2) and 18 of the *Electricity and Gas Inspection Regulations*.

3.0 Normative References

3.1 *Electricity and Gas Inspection Act* (EGIA)

3.2 *Electricity and Gas Inspection Regulations* (EGIR)

3.3 LMB-EG-08, Specifications for Approval of Type of Gas Meters and Auxiliary Devices

3.4 PS-EG-02, Provisional Specifications for the Means and Methods of Sealing Verified Electricity and Gas Meters

3.5 G-14, Policy on Granting Conditional Permission for Using Gas Meters in Service without Verification and Sealing at the Low Intervention Trade Transaction Level of the Natural Gas Market

3.6 PS-G-14, Provisional Specifications and Procedures for the Verification of Correction Devices and Linearization Functions Incorporated in Meters and Flow Computers

4.0 Terminology

Calculator Function
Software coding installed in a flow computer that takes programmable fixed parameters and live inputs, from the connected devices, and calculates the corresponding multipliers and measurement units used in the billing transactions.

Connected Devices
Approved devices connected to a flow computer that measure one or more gas stream parameters such as temperature and pressure, and which provide input signals to the flow computer for use by its calculator function in the determination of the mass, volume and/or energy value used for billing transactions.

Flow Computer
A microprocessor based device that calculates and records volume consumption and/or time-stamped volume flowrates, expressed at line conditions and base conditions. It may optionally also calculate energy consumptions and energy flowrates. Calculations are performed by the calculator function. Examples of inputs include volume-weighted pulses and analogue or digital signals representing differential pressure, static line pressure, flowing gas temperature, gas composition, relative density and energy density (heating value). The device may be used with one or more associated gas meters of various types.

High Intervention Trade Transaction Level
This level of intervention includes all of the current intervention activities that Measurement Canada (MC) employs to regulate the natural gas trade sector. Metering devices in this level of intervention are subject to approval of type, initial verification, and subsequent reverification.

Low Intervention Trade Transaction Level
Trade transactions where the basis of the charge, for the gas supplied, is obtained from a meter falling within the scope of MC Bulletin G-14, for which conditional permission was granted under the subject requirements for use without verification and sealing.

Measuring Apparatus
A device required for inspection of gas meters, which has been certified by tracing its accuracy at one or more points to reference standards kept by the National Research Council of Canada and/or Measurement Canada.

Modular Approach
An inspection methodology whereby a connected device is tested using a measuring apparatus to determine the error of the device. The error in the transfer of the data from the device to the flow computer is considered a component of the device error.

Snapshot
A manually triggered electronic memorization of a flow computer's instantaneously registered values of volume pulse frequency, pressure, temperature, volume and energy flowrates, and other applicable measurement parameters and factors.

System Approach
An inspection methodology whereby the system is tested as a whole (i.e. the flow computer and its connected devices) to determine the overall system error.

Transmitter
Contains a transducer and may be equipped with telemetering capabilities. It converts one or more sensed inputs (such as gas temperature, static pressure, and differential pressure) to an analogue output signal (e.g. 4-20 mA, 1-5V, or resistance measurement) or a digital signal (which uses a particular communications protocol such as Hart, Mod Bus, or Field Bus, etc.).

5.0 General

5.1 This document provides the on-site inspection requirements for the flow computer and transmitters used in the determination of the measurement units used in billing for a particular gas metering installation site.

5.2 Where (re)verification of a connected device is based on the device indicator or measurement of the output, this document also provides the performance requirements to ensure that the data transfer is correct and the total of the device connection errors is maintained within the prescribed limits of error for the connected device.

5.3 Additional requirements specific to a particular connected device may be communicated through the Notice of Approval (NOA).

6.0 Metrological Requirements

6.1 Transmitters (including transducers)

6.1.1 Where a pressure or temperature transmitter or RTD does not hold a valid certificate, it shall be inspected.

6.1.2 The transmitter/RTD markings shall be as stated in the specifications for approval of type, plus any additional requirements identified in the NOA.

Table - 1

Transmitter/RTD Test Points and Tolerances	
Temperature Transmitters and RTDs	
Test Point	**Tolerance**
0 ±1 °C	±2 °C This tolerance is applicable to all output values over the approved operating range
Flowing gas temperature °C*	
≥30 °C	
*Where the flowing gas temperature meets the ≥30 °C criteria, a point approximately midway between zero and the flowing gas temperature shall used for this test point.	
Static Pressure Transmitters	
Test point (% of Line pressure)	**Tolerances (% of line pressure)**
0%	± 1.0% This tolerance is applicable to all output values over the approved operating range
50%	
100%	
Differential Pressure Transmitters	
Test point (% of configured full scale)	**Tolerances (% of configured full scale)**
0%	± 1.0% This tolerance is applicable to all output values over the approved operating range
20%	
40%	
60%	
80%	
100%	

6.1.3 A measuring apparatus shall be installed at the source of the transmitter/RTD to determine the error, at the applicable test points as outlined in Table 1.

6.1.4 The transmitter/RTD error shall be within the tolerances listed in Table 1 for the type of device, at all points within the device's approved operating range.

6.1.5 Transmitters shall be (re)verified using readings from one of the following sources, to determine the transmitter's calibration error relative to the measuring apparatus connected to that source:

a) the uncorrected flow computer reading for the connected transmitter; or

b) uncorrected (e.g. raw flow computer mA reading of the input) reading of the input signal and calculating the applicable reading; or

c) the signal at the output of the transmitter and calculating the applicable reading; or

d) the transmitter's indicator (e.g. display or handheld reader).

6.1.5.1
Where the output signal at the transmitter is used to determine the error it shall be measured with a measuring apparatus.

6.1.5.2
Where the output signal at the transmitter or the transmitter indicator is used to determine the error, the reading (or calculated reading) shall be compared to the uncorrected (non-linearized) flow computer reading (or calculated reading) for the process variable of the transmitter being evaluated, at a minimum of one of the test points for the transmitter. The error at the flow computer input shall not exceed the applicable transmitter tolerance in Table 1, and the difference shall not exceed 20% of the allowable tolerance for the transmitter.

6.1.6 An RTD shall be (re)verified using the flow computer readings for the RTD input to determine the error relative to the measuring apparatus installed at the source, and shall be within the tolerance in Table 1 for temperature transmitter/RTD.

6.2 Flow Computer

6.2.1 Markings

6.2.1.1
The flow computer's markings shall be as stated in MC's specifications for approval of type, plus any additional requirements identified in the NOA.

6.2.2 Software

6.2.2.1
The measurement modules/subroutines of the software used in the flow computer shall be confirmed as having been approved by MC, by means of identifying the software version.

6.2.2.2
All applicable programmable/configurable setup parameters used by the calculator function in the determination of the measurement units, shall be validated.

6.2.3 Flow Computer Inputs (modular approach)

All flow computer inputs that are used in the determination of measurement units shall be evaluated to ensure the flow computer receives the data being sent by the connected devices.

6.2.3.1 Pressure and Temperature Inputs

6.2.3.1.1
Where the transmitters/RTDs are also being (re)verified during the inspection, these inputs are evaluated during the "modular approach" inspection of the transmitter/RTD (see section 6.1).

6.2.3.1.2
Where the pressure and temperature input devices are not being (re)verified during the inspection, the flow computer inputs for these devices shall be evaluated at a minimum of one test point within the range of temperature or pressure anticipated for that metering site. The flow computer's uncorrected non-linearized reading, for the process variable of the transmitter/RTD being evaluated, shall not exceed the applicable tolerance listed in Table 1.

6.2.3.2 Gas Composition Input (modular approach)

6.2.3.2.1
Where the gas composition, heating value and any other quantity used to derive legal billing units, (i.e. mass density, specific gravity) are provided by an approved and verified on-site gas analyzer, these values shall be compared with the flow computer's registered values for the same sample of gas. The values reported by the flow computer shall be the same as those recorded on the gas analyzer report.

6.2.3.3 Meter Input(s) (modular approach)

6.2.3.3.1
Where the data received from the meter is in digital form, the flow computer's reading and the meter's output shall be the same, at the point in time when the flow computer's calculator function performs a calculation to update the readings on the flow computer.

6.2.3.3.2
Where the signal received from a meter is in the form of pulses or an analog signal, the flow computer's readings for pulse count, frequency, or interpreted analog signal, shall be within 0.2% of the source device. The combination of test duration and the resolution of the units used in the calculations shall be sufficient to ensure an error resolution of 0.05% (1 part in 2000).

6.2.4 Flow Computer Calculator Function

This section is not applicable to flow computers that only permit access for the programming of configuration parameters (i.e. the user cannot change the source coding).

6.2.4.1 Verification of Measurement Units used In Billing Transactions

6.2.4.1.1
Where there is access (e.g. initial inspection or seal not intact) to source coding of the measurement software modules/subroutines, the converted volume and/or energy accumulation calculations shall be verified over a combination of test points within the ranges of the connected devices (see 6.2.4.1.2 for methodologies and specific requirements). The calculation may be verified directly through accumulation tests or indirectly through snapshots of the frequency and volume and/or energy flowrates.

6.2.4.1.2
The tests in Table 2 shall be conducted to evaluate the overall converted volume/energy calculator function of the flow computer.

(a) The input values for the tests listed in Table 2 shall be fixed to maintain the necessary stability to evaluate the functioning of the calculator. The flowrate reading(s), for snapshots or test duration, and the units used in the accumulation tests, shall be sufficient to obtain a calculated error resolution of 0.1% (1 part in 1000).

(b) The test data obtained from (a), as indicated by the flow computer for the tests in Table 2, shall be within ± 0.2% of that calculated using an MC approved test program. Where applicable, linearization factors shall be applied to the MC approved test program results in accordance with PS-G-14.

Table - 2

Test No.	Flowrate	Temperature	Flowing Pressure	ΔP (orifice)	Gas Composition
1	Mid range	Mid range	Mid range	Mid range	Mid range*
2	50%	15 ±5 °C	25%	40%	Low HV*
3	50%	0 ±1 °C	100%	60%	High HV*
4	90%	30 ±5 °C	50%	100%	High HV*

* The gas composition values selected are based on the historical or expected range of heating values of the gas being metered at the metering installation site. Where the range of the heating value does not deviate by more than 5% from the historical or expected mean of the heating value, a single gas composition within the range may be used for all tests.

6.2.5 Flow Computer System Error

6.2.5.1
A volume/energy accumulation test, using the system approach, shall be completed at stable flowing conditions (see test 1 of Table 3 for test points). The test duration and resolution of test data shall be sufficient to obtain test results having a resolution of 0.1%.

6.2.5.2
Where the stability of the flowing gas pressure or temperature source does not provide the control necessary for this test, a separate source which is certified (or one that provides for monitoring the source with a measuring apparatus) shall be used to simulate flowing conditions.

6.2.5.3
A volume/energy accumulation test, using the system approach, shall also be completed for tests 2 and 3 of Table 3. These tests may be conducted using the snapshot method.

6.2.5.4
Where it is not possible or practical to obtain the pressure or temperature test points, a separate source which is certified (or one that provides for monitoring the source with a measuring apparatus) shall be used to simulate test conditions.

Table - 3

Test No.	Flowrate	Temperature	Flowing Pressure	ΔP (orifice)	Gas Composition
1	≥ 80%	Flowing Temp. ±5 °C	≥ 80% Flowing Press.	≥ 80%	Flowing Gas HV
2	≥ 50%	≥ 25°C	≥ 50% ≤ 70%	≥ 50%	Low HV
3	≥ 50%	0 ±5 °C	≥70% ≤ 90%	≥ 50%	High HV

6.2.5.5
The overall converted volume and/or energy accumulation or flowrates for snapshot method reported by the flow computer for each test shall be compared to the overall converted volume and/or energy calculated, using an MC approved test program. Where applicable, linearization factors shall be applied to the MC approved test program results, in accordance with the applicable section PS-G-14 for the programmed linearization method.

6.2.5.6 The total overall converted volume and/or energy error of a flow computer and its connected devices, shall not exceed ± 2.0% of the true values determined by the MC approved test program.

6.2.6 Flow Computer Outputs

6.2.6.1
The converted (corrected) volume output of a flow computer's pulse generator/initiator, if so equipped, is exempt from verification.

6.2.6.2
The unconverted (uncorrected) volume output of a flow computer's pulse generator/initiator, if so equipped and approved, shall be verified unless the pulse output has been permanently disabled.

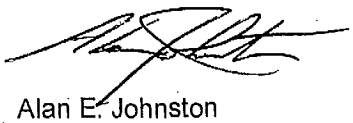
6.2.6.2
The start/stop readings used for the test shall be those with the maximum resolution available in the flow computer. The duration of the test shall be sufficient to increment the flow computer register a minimum of two units, and shall result in a value that is representative of complete pulses. (e.g. a pulse weight of 1.2 units would require a duration sufficient to increment the flow computer register a minimum of five units)

6.2.6.3
The test volume represented by the output pulses shall match the corresponding volume registered by the flow computer.

7.0 Seals and Sealing

7.1 Unless otherwise permitted by the President of MC, pursuant to the EGIR, each meter verified for use in trade shall be sealed in accordance with MC Provisional Specification PS-EG-02: *Provisional Specifications for the Means and Methods of Sealing Verified Electricity and Gas Meters.*

7.2 Any additional sealing requirements stipulated in the applicable NOA shall also apply.



Alan E. Johnston
President
Measurement Canada

P-G-01

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Procedures

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Procedures for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers Pursuant to the Requirements of S-G-01

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S-G-01 (rev.1): Summary of Amendments to S-G-01	
Section	**Description**
All	Reformatted to new formatting requirements.
6.3.2.4 (11)	Corrected formula.
6.3.2.4 (12)	Corrected formula.
6.3.2.5	Corrected examples and the formula for TC meters.
6.5.2.4	Reworded to remove test points below the maximum errors expected for the intended use of the measuring apparatus.
6.5.3.1.4 (6)	Added percent correction formula for imperial units.
6.6	Removed as the repeatability testing is no longer a requirement.

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Procedures for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers Pursuant to the Requirements of S-G-01

1.0 Scope

This document is intended to provide support for certification and recertification of gas measuring apparatus - sonic nozzles to the requirements of specifications S-G-01-E. Detailed descriptions and explanations, as well as test procedures related to specific requirements are provided. Worksheets associated with test procedures and requirements are annexed to this document.

1.1 General

The specification S-G-01-E identifies specifications that relate to the certification, calibration, and use of sonic nozzle gas measuring apparatus. The procedures provided in the following sections describe the processes necessary to test and certify a sonic nozzle gas measuring apparatus for compliance to the requirements of S-G-01-E.

The procedures have been formatted so that they follow the structure and format of the Specification. The worksheets associated with each procedure are found attached as an annex to this document. If the combination of the description given in the Specification and the worksheets is sufficient to give the user of the document a clear understanding of the test procedure, the method given in the procedure section will be abbreviated.

2.0 References

2.1 *Electricity and Gas Inspection Act.* 1980-81-82-83, c.87, s.1.

2.2 *Electricity and Gas Inspection Regulations.* SOR/86-131

2.3 Canada Labour Code Part II (Human Resources Development Canada, March 1994).

2.4 Statistical Sampling Plans for the Verification and Reverification of Electricity and Gas Meters (LMB-EG-04, section 3.0 and 4.0, Consumer and Corporate Affairs Canada, Legal Metrology Branch 1986).

2.5 Specifications for the Calibration, Certification and Use of Gas Measuring Apparatus - Sonic Nozzle Provers (S-G-01-E, Measurement Canada, 2001-12-01).

2.6 Worksheets for the Calibration, Certification and Use of Gas Measuring Apparatus - Sonic Nozzle Provers (S-G-01-E, Measurement Canada, 2001-12-01).

3.0 Definitions

Calibration
Comparison between two instruments, measuring apparatus or standards, one of which is of known accuracy. Performed to detect, correlate, report, or eliminate by adjustment any variation in accuracy of the instrument or measuring apparatus of unknown accuracy.

Certification
A process which ensures that a measuring apparatus has been properly calibrated, properly installed for its intended use, and that an acceptable accuracy correlation exists between it and a reference standard.

Certification Testing
A specialized form of calibration performed according to fixed standards which must be met prior to the issuance of the Measurement Canada proving system certificate.

Direct Counting Gas Measuring Apparatus
A gas measuring apparatus which determines meter error using register revolutions of the meter under test.

High Load Rate
The term used to describe the flow rate corresponding to 145 ± 5% of the meter's rated capacity of air at 0.5 inches differential pressure. For example, the high load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 252 cubic feet per hour to 270 cubic feet per hour.

Inferential Gas Measuring Apparatus
A gas measuring apparatus which determines meter error by a method other than direct counting.

Initial Certification
Certification of gas measuring apparatus for the first time.

Local Volumetric Standard
A master bell prover or certified transfer prover located at or near the site of the gas measuring apparatus.

Low Load Rate
The term used to describe the flow rate corresponding to 45 ±5% of the meter's rated capacity of air at 0.5 inches differential pressure. For example, the low load rate of a meter with a rated capacity of 180 cubic feet per hour would be within 72 cubic feet per hour to 90 cubic feet per hour.

Master Bell Prover
The volumetric standard which is traceable to a national volumetric reference standard.

Mean Value ($\bar{x}$)
The arithmetic mean of the "n" results considered.

Meter Class
A general grouping of meter types having varied manufacturers and model designations but having similar rated capacities of air at 0.5 inches differential pressure. Class Designations (shown in ft^3/hour): 100 class (<140), 200 class (140 to 200), 300 class (201 to 300), 400 class (301 to 350), 500 class (351 to 450), 600 class (451 to 500), 700 class (501 to 550), 800 class (551 to 650), 900 class (651 to 700), 1000 class (701 to 800). All other meters shall be formed into classes based on 99.0 ft^3 intervals or S.I. equivalent.

Meter Classification
A grouping of meters having the same manufacturer, meter class, and units of measure, formed from the listing of meters in the owner's statement of intended use.

Monitor
To observe, record or detect an operation or condition with instruments.

Non-converting Meter
A meter that does not correct the registered volumes for pressure and/or temperature.

Owner
The owner of the gas measuring apparatus to be calibrated and certified or recertified.

Recertification
Certification of a gas measuring apparatus subsequent to the initial certification.

Relative Error
The absolute error of measurement divided by the true (conventional) value of the measurand. The measurand is a quantity subjected to measurement.

Transfer Meter
A non-converting meter supplied by the owner for the purposes of volume correlations on the gas measuring apparatus.

Volume Correlation
The process by which a specific volume registered by a transfer meter or measured by a gas measuring apparatus is related to or traceable to a local volumetric standard.

4.0 Safety

4.1 Scope

The purpose of this section is to describe the safety requirements and hazards when performing certification testing and use of gas measuring apparatus - sonic nozzle provers as related to Specification S-G-01-E.

4.2 Requirements

A Measurement Canada inspector shall have sufficient knowledge and experience to test and operate gas measuring apparatus pursuant to the specification. Inspectors will be deemed qualified if they have sufficient knowledge, training and experience with various models and types of gas measuring apparatus - sonic nozzle provers and the metrological theories to perform that duty safely and properly.

A qualified Measurement Canada inspector is required to be aware of the following safety documents:

(1) Canada Labour Code, Part II;

(2) Regulations respecting Occupational Safety and Health made under Part II of the Canada Labour Code;

(3) Safety and Health Committees and representatives' regulations;

(4) Treasury Board Manuals that outline the National Joint Council Agreements as related to Health and Safety. (Personnel Management Manual Vol. 12);

(5) Departmental Policies;

(6) Safety Policies at the site of the gas measuring apparatus inspection, which includes provincial and local occupational safety and health committee policies;

(7) Workplace Hazardous Material Information System (WHIMS); and,

(8) CSA, UL or Special Inspection Certification of electrical inspection.

4.3 Hazards

The Measurement Canada inspector must be aware of the potential hazards associated with live electrical circuits, supply air excess pressure/vacuum and the restrictive work area to which sonic nozzle provers are often located.

4.4 Safe Operating Procedures

The inspector shall wear Omega-rated safety boots and safety glasses while performing inspections of the gas measuring apparatus - sonic nozzle provers.

The inspector shall wear an approved safety helmet as required by the working environment.

The inspector must obey all on-site safety requirements of the owner of the device(s).

5.0 Procedures for Assessing Administrative Requirements

5.1 Roles and Responsibilities

5.1.1 Scope

This section outlines the roles and responsibilities related to the administration and the application of the Specification S-G-01-E.

5.1.2 Measurement Canada: Refer to section 4.5.1of the Specifications

Measurement Canada shall be responsible for:

(1) Making available the specification S-G-01-E, procedures and worksheets, upon request.

(2) Making available the certification request form and accepting the completed request.

(3) Assigning the gas measuring apparatus certification testing to be carried out by the local inspection staff of Measurement Canada.

(4) Ensuring that all required pre-testing has been performed by the owner of the gas measuring apparatus. This should be established by examining all the required worksheets and test results.

(5) Being assured by the owner that the gas measuring apparatus will meet the requirement of the Specifications before commencing certification testing.

(6) Distributing a copy of the completed package (owner's documents, completed worksheets, all printouts of data from gas measuring apparatus, and a summary report) to the applicable Measurement Canada Regional Gas Specialist and to the owner of the gas measuring apparatus. One copy will be retained by the local inspection staff of Measurement Canada.

(7) Reviewing, by the Regional Gas Specialist, the documentation and any recommendations for certification or recertification of the gas measuring apparatus by the inspector. If the Regional Gas Specialist requires clarification of the test data or with the recommendation, consultation with the local inspector, Program Development and/or Engineering/Laboratory Divisions of Measurement Canada will be required.

(8) Providing all documentation and test results satisfy the conditions set out in the Specification S-G-01-E, a certificate of calibration will be generated and issued by the respective Regional Director, Measurement Canada. One copy of the certificate will be forwarded to the owner of the gas measuring apparatus, and to the local Measurement Canada office that performed the certification testing.

(9) Conducting all certification tests and procedures pursuant to the Specification S-G-01-E and this document by a local Measurement Canada inspector designated under the *Electricity and Gas Inspection Act*.

(10) Ensuring that all measuring apparatus and test equipment, used pursuant to specification S-G-01-E and this document for the purposes of determining error, possess a valid certificate of calibration issued by a recognized calibration facility. The local inspector performing the certification testing shall be responsible for ensuring that all measuring apparatus and test equipment possess valid certificates of calibration, if required.

5.1.3 Owner: Refer to section 4.5.2 of the Specifications

The owner shall be responsible for:

(1) Obtaining and forwarding a completed device certification request to the local Measurement Canada office.

(2) Ensuring that the gas measuring apparatus is compliant with all the requirements as stated in section 4.5.2 of the Specification S-G-01-E. All required information must be provided to Measurement Canada.

(3) Ensuring that all setups, pre-testing, calibration, and troubleshooting is performed prior to the request for certification of a gas measuring apparatus.

(4) Providing to Measurement Canada, completed worksheets, providing objective evidence that all requirements of the Specification are met, prior to any certification tests performed by Measurement Canada inspectors.

(5) Ensuring that the scope of certification of any gas measuring apparatus is limited to those meter types identified on the statement intended use. It is the responsibility of the owner of the gas measuring apparatus to inform the local office of Measurement Canada if the apparatus will be required to perform verification tests beyond the scope of its certification. Measurement Canada will determine what, if any, additional certification tests are required to be performed prior to the scope of the gas measuring apparatus certification being expanded. If required, Measurement Canada will perform additional certification tests, prior to the issuance of a revised certificate in accordance with Specification S-G-01-E.

(6) Ensuring that all certificates and certification worksheets are retained for the period of certification of the gas measuring apparatus. Specification S-G-01-E must be readily available whenever the apparatus is being used for verification testing during the course of its certification period.

(7) Maintaining the certified apparatus in good repair and operating order, both electrically and mechanically.

(8) Maintaining a log book for the gas measuring apparatus. Details of all certification, calibration, correlation, maintenance and repairs must be documented in the log book. The log book must be made available to Measurement Canada upon request.

(9) Informing the local office of Measurement Canada, in writing, immediately after any repairs or adjustment are performed. This will include all minor repairs that could affect any settings that were established while preforming the certification tests. Measurement Canada will determine if any additional certification tests are required as a result of the repairs or adjustments. This decision will be made by the local office of Measurement Canada, in consultation with the Regional Gas Specialist and/or Engineering/Laboratory Division, if required.

(10) Informing the local office of Measurement Canada, in writing, prior to any modification or relocation of the gas measuring apparatus. This will include relocation to a different area on the premises or to another premises. This includes any major repairs or replacement of parts. Measurement Canada will evaluate the extent that the modification, the potential affect(s) upon the certification of the gas measuring apparatus and the extent to which additional certification tests must be performed. This decision will be made by the local office of Measurement Canada, in consultation with the Regional Gas Specialist and/or Engineering/Laboratory Division. Measurement Canada may limit the scope of certification of a certified gas measuring apparatus before allowing the owner to proceed with the stated modification.

(11) Providing transfer meters of sufficient stability and repeatability to perform all tests required by this Specification. Any testing required to guarantee this requirement being met shall be performed by the owner.

(12) A complete set of operating instructions for the apparatus to be certified must be made available to the Measurement Canada inspector prior to certification testing. These instructions must be of sufficient detail to allow the inspector to be familiar with the operation of the apparatus.

(13) Providing a suitable leak test apparatus for use to determine the leak test detection capabilities of the gas measuring apparatus. The owner shall provide the necessary calculations referenced to the local volumetric standard or other certified standards to prove the owner supplied leak test apparatus meets the specified requirements.

5.1.4 Statement of intended use:

A statement of intended use must accompany the certification request form listed in the procedures. The documentation requirements are listed in S-G-01-E.

6.0 Procdures for Assessing Metrological Requirements

6.1 General

6.1.1 Scope

To ensure that all metrological requirements described in S-G-01-E are in compliance prior to the commencement of the certification testing.

6.1.2 Worksheet Package

The first step in the certification testing process is to produce a complete set of worksheets for each gas measuring apparatus to be tested.

The worksheet set is reproduced in the annex of these procedures. Following are specific instructions for completing the forms:

(1) Each worksheet is identified with two headers. The top header identifies the document, the revision date and the numbered header for each sheet. This header aids in locating and using the correct sheet for the testing being completed.

(2) The second header is used to customize the worksheet package to the gas measuring apparatus being tested. The second header must be completed for each sheet as testing proceeds. This header allows for the use of multiple pages of the same worksheet as will be required to document the same test for different meter types. For example, the worksheet for flow rate testing contains sufficient area for 1 meter type. If 12 different meter types are to be testing, 11 additional copies of that worksheet must be produced for inclusion in the package.

The completed original and additional sheets are placed in the package and numbered, showing the worksheet page and total number of pages in that section. Using the example above, the pages would show 1 of 12, 2 of 12, and 3 of 12.

6.1.3 Calibration Reference Standards

All reference standards used in the certification of gas measuring apparatus must be certified by an approved laboratory. Included in the worksheet package are sections that require this information.

6.2 Procedures For Assessing Environmental Requirements

6.2.1 Temperature

6.2.1.1 Scope

The purpose of this procedure is to ensure that the ambient temperature surrounding the gas measuring apparatus is within the requirement set out in the specification. The procedure relates to section 5.1 of the Specification.

6.2.1.2 General

This procedure involves measuring the ambient temperature surrounding the gas measuring apparatus.

6.2.1.3 Apparatus

Certified thermometer

6.2.1.4 Procedure

(1) The thermometer and/or sensor shall be place at the same height from the floor as a meter under normal test conditions and within 3 linear feet of the gas measuring apparatus. Care should be taken to insulate the thermometer probe against effects of sudden temperature shifts.

(2) Read and record the ambient and meter proving air temperature once every 30 minutes for a period of 4 hours (Worksheet section 4.1.1).

6.2.1.5 Remarks

(1) The procedure may be repeated during the course of the certification testing if it appears that the temperature is fluctuating to the extent that it may be outside the specified limits.

(2) If more than 1 gas measuring apparatus is requested for certification testing, within the same proving room; the temperature testing procedure must be completed for each gas measuring apparatus for which certification testing has been requested.

(3) The temperature test must be completed once, regardless of the number of meter proving methods requested by the owner.

6.2.2 Humidity

6.2.2.1 Scope

The purpose of this procedure is to ensure that the humidity of the air being used by the gas measuring apparatus is within the requirement set out by the manufacturer. The procedure relates to section 5.2 of the Specification.

6.2.2.2 General

The procedure involves measuring the meter proving supply air humidity of the gas measuring apparatus.

6.2.2.3 Apparatus

None

6.2.2.4 Procedure

Read and record the gas measuring apparatus humidity reading and the independent monitor reading every 30 minutes for a period of 4 hours and record the results.

6.2.2.5 Remarks

(1) The relative humidity reading shown by the gas measuring apparatus must be within ±10% of the relative humidity recorded by the humidity monitor.

(2) This procedure may be repeated during the course of the certification testing if it appears that the humidity is fluctuating to the extent that it may be outside the specified limits.

(3) If more than 1 gas measuring apparatus is requested for certification testing, within the same proving room; the humidity testing procedure must be completed for each gas measuring apparatus for which certification testing has been requested.

(4) The humidity test must be completed once, regardless of the number of meter proving methods requested by the owner.

6.3 Procedures For Assessing Mechanical Requirements

6.3.1 Leak Tests

6.3.1.1 Operational Leak Tests

6.3.1.1.1 Scope

The purpose of this procedure is to ensure that the leak detection mode of the gas measuring apparatus is able to detect leaks accurately and repeatedly. The procedure relates to section 5.3.1 of the Specification.

6.3.1.1.2 General

The procedure involves the introduction of a controlled leak into the system to determine if the gas measuring apparatus can meet the requirement of the Specification.

6.3.1.1.3 Apparatus

Leak test apparatus (supplied by owner) capable of producing a leak of 0.25 cubic feet per hour.

6.3.1.1.4 Procedure

(1) Connect owner supplied apparatus to the local volumetric standard.

(2) Verify that leak is equivalent to 0.25 cubic feet per hour, as referenced to 2.0 inches water column on the local volumetric standard.

(3) Mount apparatus on gas measuring apparatus and operate system.

(4) Determine the leak test time set on the gas measuring apparatus.

(5) Commence the leak test detection system.

(6) Repeat test procedure 3 times.

(7) Record the set leak test time of the gas measuring apparatus on the worksheet.

6.3.1.1.5 Remarks

(1) The length of time taken by the gas measuring apparatus to detect the required leak is set by the owner.

(2) The minimum time required to consistently detect the specified leak rate shall be recorded.

(3) The sonic nozzle controller shall be set for the specified leak test time duration.

(4) The operation leak test must be completed once regardless of the number of meter proving methods requested by the owner.

6.3.2 Flow Rate Tests

6.3.2.1 Scope

This procedure relates to section 5.3.2 of the Specification. The purpose of this procedure is to ensure that the gas measuring apparatus is capable of accurately setting the flow rates of all meters in the statement of intended use.

6.3.2.2 General

This procedure involves checking high and low flow rates using individual meters of each type.

6.3.2.3 Apparatus

Calculator

Stopwatch

Transfer meters or stable temperature compensated meters of known error.

6.3.2.4 Procedure

(1) Mount meter in gas measuring apparatus.

(2) Operate prover to determine error of meter.

(3) Record error. (Worksheets)

(4) Note starting position of dial test hand.

(5) Initiate test sequence, starting stopwatch as initial flow rate begins.

(6) Repeat 3 times.

(7) Record all volumes and associated times.

(8) Initiate test sequence, starting stopwatch as second flow rate begins.

(9) Repeat 3 times.

(10) Record all volumes and associated times.

(11) Calculate flow rates using following formula:

$$\text{measured flowrate} = \frac{\text{test volume}}{\text{time (seconds)}} \times \frac{100}{(100 + \text{error})} \times 3600$$

(12) Compare flow rates determined by testing to the nominal flow rates for the type of meter being tested using the following formula:

$$\text{Percent Variance (PV)} = \frac{\text{Measured Flowrate - Target Flowrate}}{\text{rated air capacity}} \times 100\%$$

(13) Record percent variance. Calculated percent variance must be less than 5.0 %.

(14) Repeat procedure for all meter types listed in statement of intended use.

6.3.2.5 Remarks

The flow rate tests must be completed once regardless of the number of meter proving methods requested by the owner.

An example calculation for a standard transfer meter and a stable TC meter of known error follows:

Example using a standard meter:

Transfer meter error = + 0.2 %
Time = 52 seconds
Measured Volume = 1.0 cubic feet
Nominal low load flow = 73 cubic feet per hour
Rated air capacity = 160 cubic feet per hour

Measured flow rate = ((1.0/52) x (100/(100 + .002))) x 3600
= 69.09 cubic feet per hour

$$PV = \frac{(69.09 - 73)}{160} \times 100 = -2.44\ \%$$

Example using a stable TC meter of known error:

Temperature Compensated meter known error = + 0.2 % T.C.

Test Time = 53.0 seconds

Measured Meter Volume = 1.0 cubic feet

Nominal low load flow = 73.0 cubic feet per hour

Air Temperature = 72.0°F
Rated air capacity = 160

Measured flow rate =

$$\left[\frac{1.0 \times \left(\frac{\text{absolute Tmeter}}{\text{absolute Tbase}} \right) \times \left(\frac{100}{100 + \text{error}} \right)}{53.0} \right] \times 3600$$

= 69.35 cubic feet per hour

$$PV = \frac{(69.35 - 73.0)}{160.0} \times 100$$

= - 2.28%

6.3.3 Register Verification

6.3.3.1 Scope

The purpose of this procedure is to ensure that, if so equipped, the gas measuring apparatus is capable of accurately determining if a problems exists with the meter register. The procedure relates to section 5.3.3 of the Specification.

6.3.3.2 General

The procedure involves the use of intentionally mismatched registers to check the ability of the gas measuring apparatus to identify a problem.

6.3.3.3 Apparatus

(1) One metric and/or one imperial transfer meter or meter of known accuracy, as identified within the statement of intended use (as applicable).

(2) Various ratio of registers for the selected metric and imperial meter from the statement of intended (as applicable).

6.3.3.4 Procedure

(1) Choose a meter and install a register which does not match. For example, a metric reading register on a imperial reading meter.

(2) Mount meter in gas measuring apparatus.

(3) Operate prover.

(4) Record success of gas measuring apparatus to identify problem.

6.3.2.5 Remarks

This test is only when the gas measuring apparatus is equipped with this feature.

6.4 Meter Classifications and Transfer Meters

6.4.1 Meter Classifications

6.4.1.1 Scope

The purpose of this procedure is to describe the methodology used in grouping meter types into classes or classifications. The procedure relates to section 5.4.1 of the Specification.

6.4.1.2 General

The procedure requires the grouping of meter types identified on the owner's statement of intended use into classes or classifications as applicable, for use in correlation of a gas measurement apparatus.

6.4.1.3 Apparatus

Calculator

6.4.1.4 Procedure

(1) Meter types identified on the owner's statement of intended use shall be grouped together using the following attributes:

(a) same manufacturer (classificaton only)
(b) same meter class (i.e. 200 class)
(c) same units of measure

(2) The owner shall choose a stable meter from each group that is to be used as the representative transfer meter.

6.4.1.5 Remarks

The owner shall be responsible for ensuring that the transfer meters chosen are of sufficient repeatability for the certification testing procedures.

6.5 Volume Correlations

6.5.1 Correlations

6.5.1.1 Scope

The purpose of this procedure is to describe the procedures concerning the correlation to the local volumetric standard. The procedure relates to section 5.5.3 of the Specification.

6.5.1.2 General

The procedure involves performing volume correlation, comparing the results obtained on the gas measuring apparatus undergoing test to the local volumetric standard.

6.5.1.3 Apparatus

Calculator

Transfer meters

6.5.1.4 Procedure

(1) Using the local volumetric standard, perform 6 tests at both the low load rate and the high load rate.

(2) Determine $\bar{x}$ for each load rate.

(3) Determine the low and high flow rate of the transfer meter, as determined on the local volumetric standard.

(4) Record results.

(5) Using gas measuring apparatus, perform 6 tests at both the low load rate and the high load rate.

(6) Determine gas measuring apparatus flow rate of low and high load rate.

(7) Record results.

(8) The flow rates as determined on the local volumetric standard and the gas measuring apparatus must meet the requirements shown in section 5.5.3 of the Specification.

(9) Results of gas measuring apparatus must be within ± 0.2 % of the results, as determined by the local volumetric standard.

(10) Repeat test procedure for all other transfer meters to be tested.

6.5.1.5 Remarks

Transfer meters must be acclimatized for a minimum of 4 hours in the proving room prior to testing. The complete testing of a transfer meter must be performed on the same day. If time does not allow for both, testing must be delayed until the next day.

6.5.2 Maximum Error Detection

6.5.2.1 Scope

The purpose of this procedure is to describe the procedures concerning the correlation to the local volumetric standard using transfer meters calibrated as specified in Specification clause 5.5.4. The procedure relates to the same section of the Specification.

6.5.2.2 General

The procedure involves performing volume correlation, comparing the results obtained on the gas measuring apparatus undergoing test to the local volumetric standard on transfer meters that are calibrated to have high errors.

6.5.2.3 Apparatus

Transfer meters

Calculator

6.5.2.4 Procedure

(1) The owner may either supply two transfer meters calibrated to the high errors shown in the Specification, or may choose to utilize one meter and recalibrate to meet the required errors.

(2) Using the local volumetric standard, perform 6 tests at the high load rate.

(3) Determine $\bar{x}$ for the high load rate.

(4) Using gas measuring apparatus, perform 6 tests at the high load rate.

(5) Observe gas measuring apparatus flow rate of high load rate.

(6) Record results. (Worksheet section)

(7) The flow rates as determined on the local volumetric standard and the gas measuring apparatus must meet the requirements shown in section 5.5.4 of the Specification.

(8) Results of gas measuring apparatus must be within ± 0.2 % of local volumetric standard.

(9) Repeat test procedure for the other transfer meter to be tested.

6.5.2.5 Remarks

The complete testing of a transfer meter must be performed on the same day. If time does not allow for both, testing must be delayed until the next day.

6.5.3 Additional Modes of Operation

6.5.3.1 Temperature Converting Mode

6.5.3.1.1 Scope

The purpose of this procedure is to describe the procedures utilized in testing other modes of operation. The procedure relates to section 5.6 of the Specification.

6.5.3.1.2 General

The procedure involves testing other modes of operation that the gas measuring apparatus is capable of and the owner wishes to have certified.

6.5.3.1.3 Apparatus

Certified thermometer

6.5.3.1.4 Procedure

(1) Using the local volumetric standard, perform 6 tests at the high load rate.

(2) Record results, calculate $\bar{x}$.

(3) Set gas measuring apparatus on temperature converting mode.

(4) Perform 6 tests at the high load rate and record results.

(5) Record meter outlet temperature for each run.

(6) Calculate correction applied by the gas measuring apparatus to the error reading using the nozzle plenum inlet temperature and the chosen base temperature. Formula for calculation is as follows:

$$PC = \frac{(Tn + 273.15) - (Tb + 273.15) \times 100}{(Tb + 273.15)}$$

or

$$PC = \frac{(Tn + 459.67) - (Tb + 459.67) \times 100}{(Tb + 459.67)}$$

Where Tn is the meter outlet air temperature and Tb is the base temperature to which the gas measuring apparatus is adjusted in the temperature converting mode.

(7) Apply the calculated temperature correction factor (PC) to each meter run performed on the gas measuring apparatus. Record corrected values on worksheets.

(8) Determine $\bar{x}$ for the high load rate.

(9) Record results.

(10) The flow rates as determined on the local volumetric standard and the gas measuring apparatus must meet the requirements shown in section 5.3.2 of the Specification.

$$RXm = PC + TXm$$

(11) Compare results using following formula:

Where Rxm is the indicated $\bar{x}$ for the high load error determined on the gas measuring apparatus and Txm is the true $\bar{x}$ value as determined on the local volumetric standard.

(12) Results of above calculation must be within ± 0.3% of each other.

(13) Record results.

6.5.3.1.5 Remarks

None.

7.0 Procedures for Assessing Technical Requirements

7.1 Use Requirements

7.1.1 Scope

The purpose of this section is to provide a formal method of auditing the user requirements of the Specification. The procedure relates to section 6.0 of the Specification.

7.1.2 General

The procedure is simply the completion of a checklist verifying that the inspector has observed the record of the required procedures.

7.1.3 Apparatus

Gas measuring apparatus log book.

7.1.4 Procedure

Use checklist to verify that all user requirements are being met.

Record findings.

7.1.5 Remarks

None.

Procedures - Worksheets

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Annex to P-G-01 (rev. 1) Worksheets for the Calibration, Certification and Use of Gas Measuring Apparatus - Working Level Sonic Nozzle Provers

1.0 General - Sonic Nozzle Gas Measuring Apparatus - Summary Information

Owner Name and Address:			**Installation Location:**		
Manufacturer:			**District:**		
Model: **Serial No.:** **Owner's No.:**			**Certification Scope:** **Verification** **Reverification** **Compliance**		
Owner has verified compliance to applicable requirements: Yes ____ No ____					
Date of last certification (if applicable):					
Software version (if applicable):					
Operating range (Cu. Ft per hour):					
Meter Registration Method: **Direct Inferential (circle) -** **Magnetic Pulse** **Other -** _____					
Owner worksheets supplied: Yes **No**			**Operating Instructions: Yes** **No**		
Recommended For Certification	**Yes**	**No**	**Accredited**	**Yes**	**No**
Date Tests Completed:					
Tests performed by (Inspector): **Signature:** **Date:**					
Approved by (District Manager): **Signature:** **Date:**					

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Provers #:	Date of Test:	Wksht Pg of

Transfer Meters	
Class:	Class:
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Owner Identifier:	Owner Identifier:
Class:	Class:
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Owner Identifier:	Owner Identifier:
Class:	Class:
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Owner Identifier:	Owner Identifier:
Class:	Class:
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Owner Identifier:	Owner Identifier:

Provers #:	Date of Test:	Wksht Pg of

Temperature Reference Standards	
Standard ID No:	**Standard ID No:**
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Certificate No:	**Certificate No:**
Expiry Date:	**Expiry Date:**

Pressure Reference Standards	
Standard ID No:	**Standard ID No:**
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Certificate No:	**Certificate No:**
Expiry Date:	**Expiry Date:**

Elapsed Time Reference Standards	
Standard ID No:	**Standard ID No:**
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Certificate No:	**Certificate No:**
Expiry Date:	**Expiry Date:**

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Other Reference Standards	
Standard ID No:	**Standard ID No:**
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Certificate No:	**Certificate No:**
Expiry Date:	**Expiry Date:**
Standard ID No:	**Standard ID No:**
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Certificate No:	**Certificate No:**
Expiry Date:	**Expiry Date:**

2.0 Measuring Apparatus Description and Specification

Provers #:	Date of Test:	Wksht Pg of

Description of installation documentation provided, including manuals, drawings and revision dates:

Give brief description of any extraordinary installation requirements for the measuring apparatus as identified from the documentation supplied:

Indicate whether the measuring apparatus has been installed in accordance with all manufacturer's and Measurement Canada's requirement:

3.0 Statement of Intended Use

Provers #:	Date of Test:	Wksht Pg of

Has owner provided a detailed statement of intended use? Yes _____ No_____
If no, explain: _____

Has owner provided completed calibration worksheets? Yes _____ No _____
If no, explain: _____

Transfer meters provided: Yes _____ No _____
If no, explain: _____

Measuring apparatus log book being maintained Yes _____ No _____
If no, explain: _____

Provers #:	**Date of Test:**	**Wksht Pg** ____ **of** ____

Give a detailed summary of the statement of intended use of the measuring apparatus.

_____

_____

_____

_____

_____

_____

A copy of the complete statement of intended use is to be attached.

Is the intended use within the capabilities of the measuring apparatus. Yes____ No ___

If no, explain:_____

4.0 Metrological Requirements

4.1 Environment

4.1.1 Temperature

Brief description of temperature control system for the prover room ambient air temperature and meter proving air:

_____

_____

_____

_____

Temperature Setting of Proving Room: _____

Location of Prover Room Ambient Air Temperature Monitors:

Monitoring Devices	
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Serial No:	**Serial No:**
Operating Range:	**Operating Range:**

Provers #:	**Date of Test:**	**Wksht Pg of**

Location of Meter Proving Air Temperature Monitors: _____

Monitoring Devices	
Description:	**Description:**
Manufacturer:	**Manufacturer:**
Model No:	**Model No:**
Serial No:	**Serial No:**
Operating Range:	**Operating Range:**

Temperature Readings		
Time	**Ambient Air Temperature**	**Meter Proving Air Temperature**

Temperature variance within 24 hours of testing: _____

Temperature variance within 4 hours of testing: _____

Temperature stability acceptable: Yes _____ No _____

Temperature record retention period: _____

4.1.2 Humidity

Provers #:	Date of Test:	Wksht Pg of

How is the relative humidity of the air passing through the nozzles assured?

a) monitor and shut down: _____
b) condition supply air: _____

External Humidity Monitor
Description:
Manufacturer:
Model No:
Serial No:
Operating Range:

Humidity record retention period: _____

Sample frequency: _____

Humidity monitor routinely calibrated: Yes _____ No _____

Humidity Readings		
Time	**External Monitor**	**Gas Measuring Apparatus**

Humidity detection/monitoring system acceptable: Yes _____ No _____

4.2 Mechanical Requirements

4.2.1 Leak Test

4.2.1.1 Operational Leak Test

Provers #:	Date of Test:	Wksht Pg of

Leak Test Mechanism Supplied: _____ Verified: Yes ____ No ____

Calculated leak rate via volumetric standard: _____

Owner's set leak test time: _____

Operational Leak Test	
Leak Test	**Leak Detection Time**
#1	
#2	
#3	

Operational Leak Detection Adequate: Yes ____ No ____

4.2.2 Flow Rate Tests

Provers #:	Date of Test:	Wksht Pg of

Flow Rate Tests - Gas Measuring Apparatus				
Transfer Meter Type:		**Transfer Meter No:**		
High Load Error:		**Low Load Error:**		
High Load Target Range: to		**Low Load Target Range:** to		
Run No.	**Volume Passed**	**Time**	**Measured Flow Rate**	**Acceptable?**
High #1				Yes / No
High #2				Yes / No
High #3				Yes / No
Low #1				Yes / No
Low #2				Yes / No
Low #3				Yes / No

$$\text{measured flowrate} = \frac{\text{test volume}}{\text{time (seconds)}} \times \frac{100}{(100 + \text{error})} \times 3600$$

Meter Models with Identical Badged Flow Rates from Statement of Intended Use	High Load Rate	Low Load Rate

4.2.3 Registry Verification Test

Provers #:	Date of Test:	Wksht Pg of

Is the measuring apparatus equipped with a registry verification function?
Yes ____ No ____

Units of Measure	Correct Detected	Incorrect Detected
Metric	Yes/No	Yes/No
Imperial	Yes/No	Yes/No

The measuring apparatus was able to detect an incorrectly matched registry?
Yes ____ No ____

4.3 Meter Class/Classifications and Transfer Groups

4.3.1 Meter Class/Classifications

Total number of meter classes (Direct):

Total number of meter classifications (Inferential):

4.3.2 Selected Transfer Meters - Class

Meter Class: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Provers #:	Date of Test:	Wksht Pg of

Meter Class: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Meter Class: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Meter Class: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Provers #:	**Date of Test:**	**Wksht Pg** **of**

4.3.3 Selected Transfer Meters - Classifications

Meter Classification: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Meter Classification: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

Meter Classification: _____

Transfer Meter Selected: _____

Meter Models Represented: _____

4.4 Volume Correlations

4.4.1 Correlations

Provers #:	Date of Test:	Wksht Pg of

Transfer Meter Information	
Meter Classification ID:	**Meter No:**
Meter Model No:	**Serial No:**
High Load Rate:	**Low Load Eate:**
As found flow rate - high (LVS):	**As found flow rate - low (LVS):**
As found flow rate - high (GMA):	**As found flow rate - low (GMA):**
Method of Meter Proving:	

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Provers #:	**Date of Test:**	**Wksht Pg** **of**

Volume Correlation				
Load	**Run #**	**Local Volumetric Standard (LVS Error)**		**Measuring Apparatus (GMA Error)**
High	1			
	2			
	3			
	4			
	5			
	6			
$\bar{X}$				
Low	1			
	2			
	3			
	4			
	5			
	6			
$\bar{X}$				

Spread acceptable? Yes _____ No _____	**Error acceptable?** Yes _____ No _____

Flow rate acceptable? Yes _____ No _____

4.4.2 Maximum Error Detection

Provers #:	Date of Test:	Wksht Pg of

Purpose of Certification

Verification _____ Reverification _____ Compliance Sample Testing_____

Target Error: _____

High Positive Meter Model: _____ **Serial Number:**_____

High Negative Meter Model: _____ **Serial Number:** _____

Method of Meter Proving: _____

Maximum Error Detection				
	Run #	Local Volumetric Standard (LVS Error)		Measuring Apparatus (GMA Error)
High Positive	1			
	2			
	3			
	4			
	5			
	6			
$\bar{X}$				
High Negative	1			
	2			
	3			
	4			
	5			
	6			
$\bar{X}$				

Acceptable? Yes _____ No _____

4.4.3 Additional Modes of Operation

4.4.3.1 Temperature Converting Mode

Provers #:	Date of Test:	Wksht Pg of

Meter Model: _____ **Serial Number:** _____

Meter capacity: __ _____ **Registration:** _____

High Load Registered Volume: _____ **Flow rate:** _____

Base Temperature of Converting Mode: _____

Method of Meter Proving: _____

Percent Correction (PC):

$$PC = \frac{(Tn + 273.15) - (Tb + 273.15)}{(Tb + 273.15)} \times 100\% \quad \text{or} \quad \frac{(Tn + 459.67) - (Tb + 459.67)}{(Tb + 459.67)} \times 100\%$$

Temperature Converting Mode					
Load	**Run #**	**Local Volumetric Standard (LVS Error)**	**Gas Measuring Apparatus (GMA Error) (Converting Mode)**		
			Reading	**Temperature**	**Corrected**
High	1				
	2				
	3				
	4				
	5				
	6				
$\bar{X}$		**TXm**	**RXm**		

Expected Error Indication is RXm = PC + Txm
RXm and (PC + TXm) must be within ± 0.3% of each other.

Rxm = Txm = PC = RXm - Txm =

Acceptable? Yes _____ No _____

5.0 Technical Requirements

5.1 Use Requirements

5.1.1 Weekly Correlation - Transfer Meter/ Local Volumetric Standard

Provers #:	Date of Test:	Wksht Pg of

Weekly correlation recorded: Yes _____ No _____

If no, explain: _____

5.1.2 Daily/Weekly Correlation - Transfer Meter/Gas Measuring Apparatus

Correlation is Being Done:	Daily / Weekly

Have the conditions for weekly correlation been met:	Yes / No

Correlation recorded: Yes _____ No _____

If no, explain: _____

5.1.3 Operational Leak Detection

Owner's Leak Detection Time: _____

Leak Detection Time Implemented: Yes _____ No _____

If no, explain: _____

5.1.4 Temperature Records

Temperature Record Retention Time: _____

Provers #:	**Date of Test:**	**Wksht Pg of**

5.1.4 Temperature Records

Temperature Record Retention Time:

5.1.5 Humidity Records

Humidity Record Retention Time:

5.1.6 Maintenance Records

All Required Maintenance Being Performed: