LMB-EG-08
1987

Consumer and
Corporate Affairs Canada

Consommation
et Corporations Canada

Legal Metrology
Branch

Direction de la
métrologie légale

SPECIFICATIONS FOR APPROVAL OF TYPE OF GAS METERS AND AUXILIARY DEVICES

CACC No. 190 15024 E 87-09

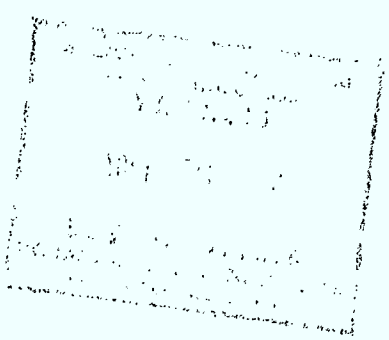
SPECIFICATIONS
FOR APPROVAL OF TYPE OF
GAS METERS AND AUXILIARY DEVICES

LMB-EG-08

July 1987

Issued by

Consumer and Corporate Affairs Canada
Legal Metrology Branch
Holland Avenue
Ottawa, Ontario
K1A 0C9



Le document est aussi disponible en français.

Whereas subsection 12(1) of the Electricity and Gas Inspection Regulations provides that the director appointed under subsection 26(1) of the Electricity and Gas Inspection Act shall establish specifications relating to design, composition, construction and performance to which any meter or any class, type or design of meter shall conform before permission or approval with regard to that meter or such class, type or design of meter may be given pursuant to section 9 of the said Act.

Therefore, the Director of the Legal Metrology Branch of the Department of Consumer and Corporate Affairs is pleased hereby to establish the annexed specifications for the approval of the types of gas meters and auxiliary devices referred to therein.

R.G. Knapp 1987-07-07

Richard G. Knapp
Director, Legal Metrology Branch
Department of Consumer and Corporate Affairs

SPECIFICATIONS FOR APPROVAL OF TYPE OF GAS METERS AND AUXILIARY DEVICES

CONTENTS

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 Gas Association Installation Code for Natural Gas Burning Appliances and Equipment: CGA B149.

American Gas Association Gas Measurement Committee Report No. 3: Orifice Metering of Natural Gas.

American National Standards Institute Standard ANSI/API 2530: Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.

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

American Gas Association Transmission Measurement Committee Report No. 8: Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases.

United States Department of Defense Military Standard MIL-STD-461B: Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.

SECTION 2 - DEFINITIONS

Definitions of terms used in these specifications are included in this section.

Contractor's Badge. A nameplate, tag, sticker or other suitable means permanently affixed to a meter in a conspicuous location. The badge may be used to display the meter's inspection number assigned by the contractor and other informamation relative to the current mode of operation of the meter to which the badge is attached.

Mechanical Register. A pointer-type or drum-type register.

Primary Meter. A meter, such as a positive displacement meter or inferential meter, which produces an output proportional to a quantity of gas passing through the meter.

Priority Pen. The designated "pen", of a multi-pen recording device, which is to track or record a trace with the least possible error.

Programmable Constant. A factor used in a flow computation which is constant for a given set of metering conditions, but which may be reprogrammed for another set of metering conditions.

SECTION 3 - GENERAL

CONTENTS

SECTION 3 - GENERAL

3-1 SCOPE

This section of these specifications applies to all types of gas meters and devices which are submitted for approval of type. These requirements pertain only to the metrological characteristics of measurement devices. They do not pertain to safety and other related considerations.

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. 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.

3-3 MECHANICAL REQUIREMENTS

3-3.1 Design & Construction. The design shall be suitable for the intended purpose and expected service conditions.

The construction shall be mechanically and electrically sound, and the materials, finish, etc., shall be such as to provide assurance of long life and sustained accuracy.

Meters intended for operation in non-temperature controlled locations shall be designed to retain their metrological characteristics in any ambient temperature within the span from -30°C to +40°C. Where the manufacturer's specifications impose a narrower ambient temperature span than above, such restriction shall be set out on any Notice of Approval which may be issued.

Provisions incorporated in meters for sensing flowing gas temperature, and the performance of temperature correction and/or supercompressibility correction shall meet the applicable performance requirements over a minimum temperature range of 40°C.

3-3.2 Case. The case of a meter intended to contain gas shall be so designed and constructed as to operate without leakage or deformation over the expected range of operating pressures, flowing gas temperatures and environmental conditions.

The case of a meter intended for outdoor use shall be water-proof, dust-proof and dimensionally stable under the range

of environmental conditions expected during the service life of the device.

3-3.3 Sealing. Every meter and any interchangeable measuring component thereof shall be constructed so that access to the working parts, adjustments and programming may be effectively prevented by such sealing arrangements as may be approved by the Director.

Electrically operated devices shall have provision for sealing fuses, circuit breakers and signal connections.

3-3.4 Registers for Automatic Correction. In all situations in which automatic correction of metered volume takes place, the overall measurement system shall provide for at least the registration of the uncorrected and the corrected volume. Internally temperature correcting diaphragm meters are exempt from this requirement.

3-3.5 Output Shaft. The capacity per revolution of an output shaft which may be provided on a meter shall be such that at rated capacity of the meter the output shaft makes at least one revolution every two minutes.

3-4 ELECTRICAL REQUIREMENTS

3-4.1 Battery Power Supply. Devices which operate from a battery, or other power source which must periodically be replaced, shall be capable of indicating need for replacement at least 90 days before power failure when the device is operating at an ambient temperature of 0°C. Replacement of the power source shall not adversely affect the programming, metering information, or subsequent operation of the device.

3-5 MARKINGS

3-5.1 Nameplates. Meters shall have the following information clearly and indelibly marked in such a way as to be easily readable:

(a) Manufacturer's name or registered trademark.
(b) Model or type designation.
(c) Serial number.
(d) Ambient temperature range, where less than -30°C to +40°C.
(e) Departmental approval number.

In addition, devices requiring an external electrical power supply for operation shall have the following information marked:

(f) Nominal input voltage and frequency.
(g) Nominal power consumption or input current.

Additional marking requirements applicable to various types of meters and devices are set forth in subsequent sections specific thereto.

3-5.2 Contractor's Badge. Space shall be provided for attachment of a contractor's badge.

3-5.3 Direction of Gas Flow. Meters carrying gas shall be marked showing the direction of gas flow or shall have the inlet connection identified.

3-5.4 Output Shaft. Where a meter is equipped with an external output shaft, its direction of rotation shall be marked in the vicinity of the shaft together with the capacity per revolution of the shaft.

3-6 PERFORMANCE TESTS

3-6.1 Reference Conditions for Tests. Except where stated otherwise in these specifications, the following reference test conditions shall apply:

(a) Ambient temperature shall be 23 ± 2°C with a rate of change not greater than 0.5°C per hour.
(b) Where a flowing medium is used for testing, its reference temperature shall be within ± 0.5°C of the ambient reference temperature, unless temperature corrections are made.
(c) Humidity content of the test medium shall be such that no condensation occurs during testing.
(d) Atmospheric pressure used in calculations shall be that prevailing at the time of testing.
(e) Relative humidity of the ambient air shall be that prevailing at the time of testing, except that where devices are sensitive to humidity, the relative humidity shall be 50 ± 5%.
(f) Meters and devices may be tested in any orientation and installation configuration recommended by the manufacturer.

(g) Density of dry air at standard temperature and standard pressure shall be taken as:
(i) 1.225 kg/m^3, or
(ii) 0.07654 lb/ft^3.

(h) Where a device is powered from the mains, the voltage shall be within $\pm$ 1.0% of rated, and the frequency shall be within $\pm$ 0.2% of rated.

3-6.2 Tests of Rangeability. Where a device incorporates features which allow the user to set the range or operating parameters of the devices, it shall be tested over a range of such features sufficient to establish that the applicable requirements of these specifications are met throughout the range for which approval is sought. All adjustments and recalibrations shall be performed according to the manufacturer's instructions.

3-6.3 Tests at Other Than Reference Conditions.

3-6.3.1 Tests at Low and High Ambient Temperatures. Meters and devices shall be tested at ambient temperatures over the range from -30°C to +40°C, except that those intended for use in a temperature controlled environment shall be tested over the range of ambient temperatures specified by the manufacturer.

Before commencing tests to determine the effect of temperature variation, the meter shall be subjected to each test temperature for such length of time as is necessary to establish thermal stability.

The following sections of these specifications set out the individual tolerances for meters over the ambient temperature range of -30°C to +40°C. Where a manufacturer specifies a narrower temperature range, the tolerances set out shall be prorated according to the manufacturer's specified range.

3-6.3.2 Supply Voltage Variation Tests. Meters and devices requiring power supply from the mains shall be tested, at reference ambient temperature, with a supply voltage equal to 90% and 110% of the nominal voltage. Where a range of input voltages is specified by the manufacturer, the mediam shall be taken as the nominal voltage.

The device shall not exhibit any malfunction or degradation of performance.

3-6.3.3 External Magnetic Field Tests. Devices shall be subject to tests in any orientation within a 60 Hz alternating mag-

netic field equivalent to that produced by a circular coil, one metre in diameter, having 400 ampere turns. The tests shall be made at reference ambient temperature.

The device shall not exhibit any malfunction or degradation of performance.

3-6.3.4 EMI Susceptibility Tests. Devices shall remain within tolerance at reference conditions when tested as follows:

(a) Conducted Susceptibility. Devices powered from the mains shall be tested with test spikes, each having the waveform shown in Fig. 1, superimposed on the power supply voltage. Pulse repetition rate shall be 10 spikes per second and the duration of the test shall be 10 minutes. Further details relating to this test may be found in MIL-STD-461B, dated April 1980.

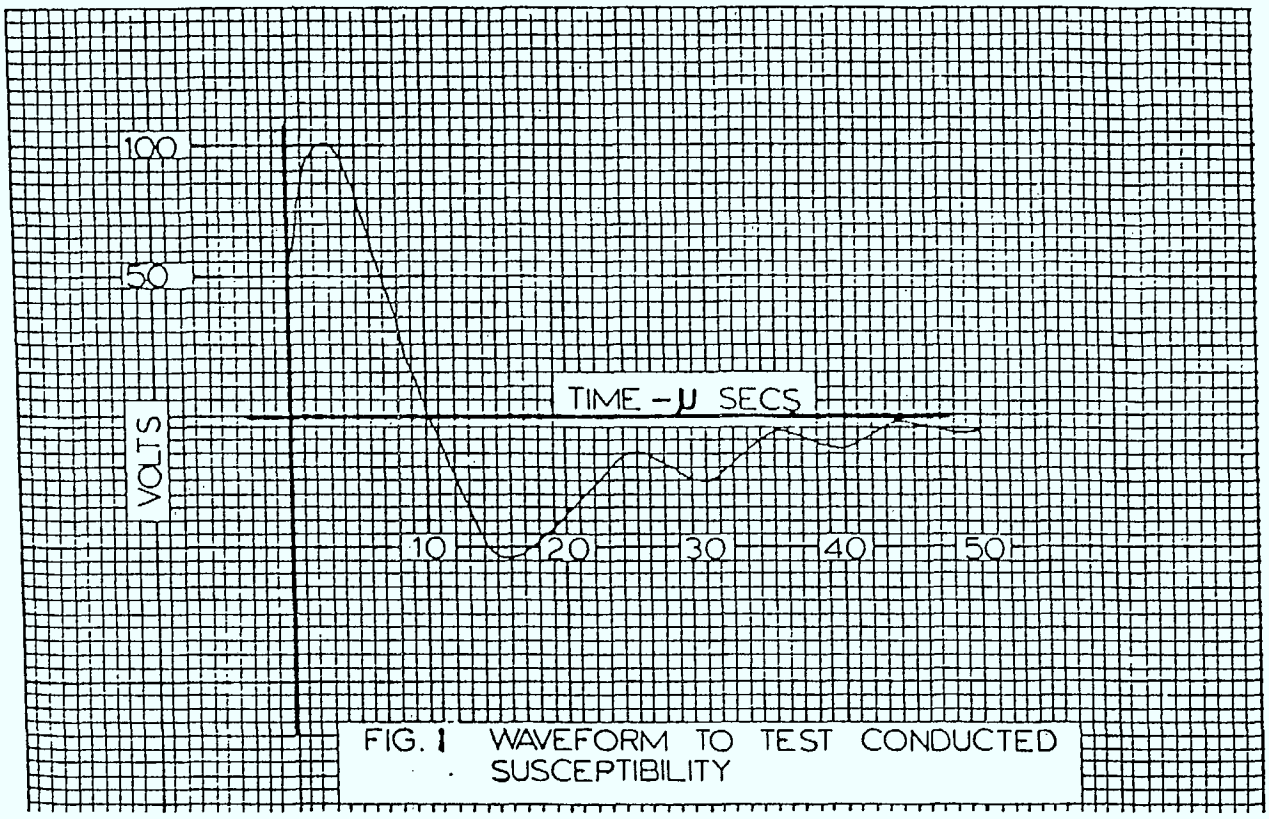


FIG. 1 WAVEFORM TO TEST CONDUCTED SUSCEPTIBILITY

(b) Radiated Susceptibility. Devices shall be scanned at a distance of 2 metres with 4 watt hand-held transceivers operating at 27 and 460 MHz.

SECTION 4 - REGISTERS

CONTENTS

SECTION 4 - REGISTERS

4-1 SCOPE

This section of these specifications applies to registers for use on gas meters.

4-2 MECHANICAL REQUIREMENTS

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

4-2.1 Register Resettability. Means provided for the registration of cumulative volume, mass, or energy units shall be non-resettable under normal operating conditions once the device is sealed. Registers for dispensers for natural gas are exempt from this requirement.

4-2.2 Capacity. A cumulative, non-resettable register, whether corrected or uncorrected, shall be so designed that the registration will not repeat when the host meter operates continuously at its rated or maximum capacity for a period of 90 days, unless stated otherwise in the subsequent sections of these specifications.

4-2.3 Legibility. The register face and markings thereon shall be of contrasting colours to provide for ease of reading. All markings shall be indelible and shall not be adversely affected by environmental conditions. The size of letters and numerals shall be such that they are clearly legible.

4-2.4 Outdoor Register Covers. Registers intended for direct exposure to outdoor environment shall be protected by a strong cover designed to prevent entry of water, snow or other foreign matter. Transparent register covers shall be designed so as to prevent fogging.

4-2.5 Registers: Pointer-Type. The minimum diameter of clock dial reading circles shall be 15 mm.

Each reading circle shall be divided into ten equal parts with division marks numbered from "0" to "9". The "0" division mark shall be located at the twelve o'clock position.

The register gearing shall provide for adjacent pointers to rotate in opposite relative directions with a rotation ratio between the pointers of 10 to 1.

The lowest reading dial shall be farthest to the right and its pointer shall rotate in a clockwise direction when viewed from the front.

The reading dial centres shall lie on a straight line or on the arc of a circle or ellipse. Each dial shall be marked to indicate the number of measured units per revolution of the pointer. There shall be no overall multiplier indicated on the register.

4-2.5.1 Proving Provisions for Pointer-Type Registers. Proving dials and test dials provided on pointer type registers shall not be in the same geometric line as the reading circles. 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. The quantity per revolution of the associated pointer shall be clearly marked. No numbers shall appear on the divisions.

The proving dial and test dial division markings and the size, shape and length of the pointers shall be such that the position of the pointers with respect to the dial markings can be accurately determined.

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.

4-2.6 Registers: Drum Type. The digits of the counter shall be in a straight horizontal line and shall be easily visible through a cutout(s) in the register face.

The arrangement of the counter drums and the cutout(s) on the register face shall be such that, with the exception of the fastest rotating drum, only one digit per drum is in full view at all times except when a drum is advancing from one position to another. The duration of this change period shall not exceed the time required for the fastest-rotating drum to make one-tenth of a revolution.

Where the last digit shown on a drum type register represents a multiple of applicable units of measurement, there shall be one of the following:

(a) a number of zeros marked on the register face immediately to the right of the last digit, and in line with it, so that the reading of the register with the additional zeros is in applicable units, or

(b) an inscription below the drum digits on the register face to show the applicable multiplier, such as
"Reading X 100 = m^3"
The multiplier shall be an integral power of 10.

4-2.6.1 Proving Provisions for Drum Type Registers. Drum type registers equipped with proving provisions shall have either a proving drum, a proving dial, or a proving dial and a test dial. Proving dials and test dials shall conform to the requirements set out in subclause 4-2.5.1.

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

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.

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

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

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.

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.

4-2.7 Registers: Electronic Display. The operation and readability of electronic display registers shall be suitable for use under the variety of environmental conditions which may be encountered in intended operation such as temperature, bright light, humidity, etc.

If one electronic display is used to indicate several different quantities, a code shall be provided to identify the quantity being displayed. When not controlled by the operator, the minimum display time shall be six seconds. The units, or acceptable abbreviations, associated with the displayed quantity and applicable multiplier, if other than unity, shall be

displayed or indicated by a code, lights or otherwise. Where codes are used, an explanation of the codes shall appear on the device in a convenient location.

Where electronic display register(s) are used with a meter which has no other register conforming to the requirements of clause 4-2.5 or 4-2.6, the register shall incorporate provisions for proving the meter with sufficient resolution that at rated capacity of the meter the time required to make the test is no more than two minutes.

4-3 MARKINGS

Registers forming an integral part of a meter shall be exempt from the requirements set out in clauses 3-5.1 and 3-5.2.

All registers shall have the following information marked.

4-3.1 Identification. Every register shall have on it an indelible marking of the manufacturer's part number which shall be unique for each model of register.

4-3.2 Units of Registration. Where a register is not intended to display more than one quantity, the units being registered shall be prominently marked on or adjacent to the register face. For example: cubic metres, cubic feet, or such symbols as m^3 or ft^3.

4-4 PERFORMANCE TESTS

4-4.1 Tests at Reference Conditions. Registers shall be tested at reference ambient temperature to establish that gear ratios, or display ratios between all dials, drums and displayed numerals are correct and in agreement with the intended values.

Tests shall be made to establish that the proving and test dial capacities, where present, are correct as marked on the register face plate.

The overall gear ratio of mechanical registers from the input shaft to the lowest reading dial or drum shall be established and this ratio shall be correct for use on the intended meter.

4-4.2 Tests at Other Than Reference Conditions. Electronic display registers shall be subjected to the tests set out in clause 4-4.1 at temperatures of -30°C and +40°C.

No error shall be exhibited.

SECTION 5 - DIAPHRAGM METERS

CONTENTS

SECTION 5 - DIAPHRAGM METERS

5-1 SCOPE

This section of these specifications applies to positive displacement diaphragm type meters.

5-2 MECHANICAL REQUIREMENTS

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

5-2.1 Registers. Volume capacity of the proving dial or drum and test dial shall correspond to an integral number of complete revolutions of the primary measuring mechanism of the meter.

5-2.2 Output Shaft. Where a meter is equipped with an external output shaft that can drive an auxiliary device, the volume capacity per revolution of the shaft shall correspond to an integral number of complete revolutions of the primary measuring mechanism of the meter.

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.

Nameplates of temperature correcting meters shall have a red background and shall show the temperature to which the registered volume is corrected (e.g. 15°C or 60°F).

5-3.2 Diaphragms. The name or trade mark of the manufacturer of the diaphragm, the type designation of the material used and the year of manufacture shall be marked on the diaphragm in such a location that these markings are visible when the diaphragm assembly is in place.

5-4 PERFORMANCE TESTS

5-4.1 Reference Conditions for Tests. In addition to the requirements of subsection 3-6, the following shall apply.

5-4.1.1 **Connection Pipes to the Meter.** Pipes connecting to the inlet and outlet of the meter under test shall be of the same nominal size as the meter connections.

The length of straight pipe connected to the inlet and outlet shall be not less than 9.5 pipe diameters.

Each pipe connection shall have a pressure tap as set out in subclauses 5-4.1.2 and 5-4.1.3.

5-4.1.2 Location of Pressure Taps. The pressure tap on the piping connected to the inlet side of the meter shall be located 1.0 pipe diameter upstream from the meter connection fitting, or where no such fitting is used, from the threaded meter connection.

The pressure tap on the piping connected to the outlet side of the meter shall be located 1.0 pipe diameter downstream from the meter connection fitting, or where no such fitting is used, from the threaded meter connection.

5-4.1.3 Pressure Tap Holes. The pressure tap holes on the pipes connecting to the meter shall be not less than 3 mm nor more than 6 mm in diameter and shall be drilled perpendicularly to the axis of the pipe so that the centre line of the hole intersects the centre line of the pipe. The pipe's inside wall at the pressure hole and the inside surface of the pressure tap junction with the pipe shall be smooth, free of burrs and slightly rounded. Pressure fittings shall not project into the fluid passage nor distort the inner surface of the pipe.

5-4.1.4 Pressure Measurement. Measurement of static pressure shall be made at the pressure tap located on the piping connected to the inlet side of the meter. Measurement of differential pressure shall be made between the two pressure taps located on the piping connected to the inlet side and the outlet side of the meter.

5-4.2 Tests at Reference Conditions.

5-4.2.1 Apparent Rated Capacity. The apparent rated capacity of the meter shall be established. The apparent rated capacity is the rate of flow of air at existing test conditions (atmospheric pressure and relative humidity) through the meter which produces a pressure drop of 125 Pa across the meter when the inlet pressure at the meter is 500 Pa.

5-4.2.2 True Rated Capacity. Where the density of air used to establish the apparent rated capacity pursuant to subclause 5-4.2.1 differs from the density of dry air at standard conditions, the following formula shall be used to convert the apparent rated capacity to the true rated capacity of the meter:

$$Q_T = Q_A \times \left(\frac{dt}{db}\right)^{0.5}, \text{ where}$$

Q_T = true rated capacity
Q_A = apparent rated capacity
dt = density of air at test conditions
db = density of dry air at standard conditions

The manufacturer's rated capacity on the nameplate shall not exceed the true rated capacity.

5-4.2.3 Meter Calibration. Tests shall be conducted to determine the accuracy of the meter calibration at 25% and 150% of the manufacturer's declared capacity. Where there is an error greater than $\pm$ 0.5% at either test point or the spread between the test points exceeds 0.5%, the meter shall be adjusted.

Where the meter cannot be adjusted to perform within the above limits, it shall be rejected and no further testing shall take place.

5-4.2.4 Low Load Registration. A test shall be conducted with the meter inlet pressure at 500 Pa to determine the rate of flow of air at which the meter starts to register continuously.

The meter shall start to register continuously at a flow rate not greater than 1% of its declared rated capacity.

5-4.2.5 Registration. Tests shall be made at flow rates between 5% and 200% of the true rated capacity with the pressure at the meter inlet at 500 Pa.

In addition, meters may be tested at any inlet pressure up to their maximum allowable operating pressure.

The error of registration shall not exceed $\pm$ 1.0% of the true value, regardless of the pressure of the flowing medium.

5-4.3 Tests at Other Than Reference Conditions. Meters shall be tested at ambient temperatures of -30°C and +40°C. At -30°C the meter shall be tested with the flowing gas temperature at 0°C and -10°C, and at +40°C with the flowing gas temperature at +10°C and +20°C.

The error of registration for non-temperature correcting meters shall not exceed ± 1.0% of the true value, and for temperature correcting meters the error shall not exceed ± 1.5% of the true value.

SECTION 6 - ROTARY METERS

CONTENTS

SECTION 6 - ROTARY METERS

6-1 SCOPE

This section of these specifications applies to all positive displacement rotary type gas meters.

6-2 MECHANICAL REQUIREMENTS

In addition to the requirements set out in subsection 3-3 and section 4, the following shall apply.

6-2.1 Registers. Where mechanical registers are employed on meters with built-in correcting provisions, both the corrected and uncorrected registers shall have proving drums or dials divided into ten equal divisions and each division shall have at least five equally spaced subdivisions.

6-2.2 Sealing. Meters of modular design which allow interchangeability of modules shall have suitable provision for effectively sealing each module separately in such a manner that the seal of each module is visible when the whole meter is assembled. In addition, there shall be provision for sealing modules together.

6-3 MARKINGS

6-3.1 Nameplates. In addition to the requirements of subsection 3-5, the following information shall be marked:

(a) Maximum allowable operating pressure.
(b) Maximum flow rate (at line conditions).

6-3.1.1 Temperature Corrected Volume. Nameplates of non-modular integral temperature correcting meters and interchangeable temperature correcting modules shall have a red background and shall show the temperature to which the registered volume is corrected (e.g. 15°C or 60°F).

6-3.1.2 Pressure Corrected Volume. Nameplates of integral pressure correcting meters and pressure correcting modules shall have the following additional information marked

(a) Pressure correction range.
(b) Base pressure.

(c) Where a gauge pressure sensor is used, the atmospheric pressure, or range of atmospheric pressures, for which the device is suitable.

Where a pressure correcting meter or pressure correcting module is provided with an adjustment whereby the contractor is able to change the base pressure or the atmospheric pressure setting, a nameplate, tag, sticker, or other suitable means shall be provided for marking the applicable information.

6-3.2 Gear Reduction Ratio. 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.

In addition, gear reduction assemblies which can be installed on more than one model of meter shall be marked to show the maker's part number of the gear reduction assembly, and the gear reduction ratio of the assembly.

6-4 PERFORMANCE TESTS

6-4.1 Pressure Measurement. Where pressure taps are located on the case of the meter, they shall be used in all measurements of pressure drop across the meter.

In the case where no pressure taps are provided on the meter, the pressure drop shall be measured between two points as close as possible to the inlet and outlet of the meter.

All measurements of static pressure in the flowing gas shall be taken at the pressure tap on the inlet side of the meter.

6-4.2 Test Medium Pressure. Except as may otherwise be stated herein, the pressure of gas during tests shall be near atmospheric or the minimum operating pressure specified by the manufacturer, whichever is greater.

6-4.3 Temperature Measurement. Temperature of the flowing gas shall be measured at the inlet of the meter.

6-4.4 Tests at Reference Conditions.

6-4.4.1 Starting Differential Pressure. With a differential pressure gauge connected to the pressure taps as set out in clause 6-4.1, a valve controlling an air source shall be connected to the meter inlet with the meter outlet open to atmosphere. The valve shall be slowly opened to the point where the meter starts and continues to rotate. At this point the valve shall be closed and the meter allowed to come to rest. The valve shall now be slowly opened again to the point where the meter just starts to rotate and at this point the reading of the differential gauge shall be taken.

The starting differential pressure for the meter shall not exceed 25 Pa. Meters not meeting this requirement shall not be tested further for approval of type.

6-4.4.2 Uncorrected Registration. Tests shall be made at the following percentages of the maximum flow rate: 10 or lower as claimed, 25, 50, 75 and 100. In addition, meters may be tested at the above flow rates at any pressure up to the maximum operating pressure.

The error of the uncorrected registration shall not exceed $\pm$ 1.0%, regardless of the pressure of the flowing medium.

6-4.5 Tests at Other Than Reference Conditions. Meters shall be tested at ambient temperatures of -30°C and +40°C.

6-4.5.1 Uncorrected Registration. With a flow rate of 25% of the maximum, meters shall be tested at -30°C with the flowing gas temperatures at 0°C and -10°C, and at +40°C with the flowing gas temperatures at +10°C and +30°C.

The error of the uncorrected registration shall not exceed $\pm$ 1.0%, regardless of the pressure of the flowing medium.

SECTION 7 - TURBINE METERS

CONTENTS

SECTION 7 - TURBINE METERS

7-1 SCOPE

This section of these specifications applies to axial-flow type turbine meters.

7-2 MECHANICAL REQUIREMENTS

In addition to the requirements of subsection 3-3 and section 4, the following shall apply.

7-2.1 Registers. Where mechanical registers are employed on meters with built-in correcting provisions, both the corrected and uncorrected registers shall have proving drums or dials divided into ten equal divisions and each division shall have at least five equally spaced subdivisions.

7-2.2 Sealing. Meters of modular design which allow interchangeability of modules shall have suitable provision for effectively sealing each module separately in such a manner that the seal of each module is visible when the whole meter is assembled. In addition, there shall be provision for sealing modules together.

7-3 MARKINGS

7-3.1 Nameplates. In addition to the requirements set out in subsection 3-5, the following information shall be marked:

(a) Maximum allowable operating pressure, and where applicable, minimum operating pressure.
(b) Maximum flow rate (at line conditions).

7-3.2 Measuring Cartridge. Where a meter is designed for operation with interchangeable cartridges, the information required by clause 7-3.1 shall appear on both the meter case and the interchangeable cartridge. The direction of flow shall be marked on the cartridge.

7-3.3 Temperature Corrected Volume. Nameplates of non-modular integral temperature correcting meters and interchangeable temperature correcting cartridges shall have a red background and shall show the temperature to which the registered volume is corrected (e.g. 15°C or 60°F).

7-3.4 Pressure Corrected Volume. Nameplates of integral pressure correcting meters and cartridges shall have the following additional information marked:

(a) Pressure correction range.
(b) Base pressure.
(c) Where a gauge pressure sensor is used, the atmospheric pressure, or range of atmospheric pressures, for which the device is suitable.

Where a pressure correcting meter is provided with an adjustment whereby the contractor is able to change the base pressure or the atmospheric pressure setting, a nameplate, tag, sticker, or other suitable means shall be provided for marking the applicable information.

7-3.5 Change Gears. Where change gears are provided, the number of teeth shall be permanently marked on each of the change gears in a such a location as to be legible with the change gears in place.

7-3.6 Pulse Output. Where a meter is equipped with a pulse generator, the requirements of the section dealing with electrical pulse devices shall apply.

7-4 PERFORMANCE TESTS

7-4.1 Reference Conditions for Tests. In addition to the requirements of subsection 3-6, the following shall apply.

7-4.1.1 Interior of Connection Pipes. The inside walls of the pipes shall be smooth, not exceeding commercial roughness, and any welds and protrusions shall be ground to the internal diameter of the pipe. There shall be no protrusion of gaskets into the bore of the pipe.

7-4.1.2 Pipe-Meter Alignment. The alignment of the companion pipe flanges with the meter inlet and outlet connections shall be concentric with no internal protrusions.

7-4.1.3 Flow Rate Stability. For each rate of flow at which the meter is tested, the peak to peak fluctuations in flow rate shall be minimized and in no case shall exceed 2 percent of the average flow rate.

7-4.1.4 Test Configuration. The meter shall be installed according to the configuration recommended by the manufacturer. Where more than one configuration is recommended, those judged to most likely produce inaccurate measurement shall be selected for testing.

7-4.2 Temperature Measurement. The temperature of the air flowing through the meter shall be sensed at a point on the downstream side of the meter at a distance recommended by the manufacturer but no further than 5 times the nominal pipe diameter.

7-4.3 Pressure Measurement. Where a pressure tap is located on the meter body, it shall be used as a point of pressure sensing during testing, unless otherwise recommended by the manufacturer. In all other cases pressure shall be measured as close as possible to the inlet of the meter.

7-4.4 Test Medium Pressure. Except as may otherwise be stated, the pressure of gas during tests shall be near atmospheric or the minimum operating pressure specified by the manufacturer, whichever is greater.

7-4.5 Tests at Reference Conditions. Tests shall be conducted with the meter at the reference conditions set out in clause 3-6.1. The meter shall be installed in the test configuration determined according to subclause 7-4.1.4.

7-4.5.1 Uncorrected Registration. Tests shall be made at the following percentages of the maximum flow rate: 10 or lower as claimed, 25, 50, 75 and 100.

In addition, meters may be tested at the above flow rates at any pressure up to the maximum operating pressure.

The error of the uncorrected registration shall not exceed $\pm$ 1.0%, regardless of the pressure of the flowing medium.

7-4.5.2 Effect of Swirl. The inlet to the selected configuration shall be preceded in turn by a clockwise and a counter clockwise swirl generator, constructed of two ninety degree elbows connected together orthagonally. The swirl generator shall be installed adjacent to the inlet to the meter installation configuration determined pursuant to subclause 7-4.1.4.

Tests shall be made at 25, 50, 75 and 100 percent of maximum flowrate.

The error of the uncorrected registration shall not exceed ± 1.0%.

Meters not meeting this performance requirement in the two recommended configurations judged most likely to produce inaccurate measurement shall not be considered for approval of type.

7-4.5.3 Measuring Cartridge Interchangeability. Where the manufacturer claims that the measuring cartridge of the meter can be interchanged between different meter cases, tests shall be conducted to determine the effect of this interchangeability on measurement accuracy.

The accuracy of registration of the meter following such interchange shall remain within the tolerances set out herein.

7-4.6 Tests at Other Than Reference Conditions. Meters shall be tested at ambient temperatures of -30°C and +40°C.

7-4.6.1 Uncorrected Registration. With a flow rate of 25% of the maximum, meters shall be tested at -30°C with the flowing gas temperatures at 0°C and -10°C, and at +40°C with the flowing gas temperatures at +10°C and +30°C.

The error of the uncorrected registration shall not exceed ± 1.0%, regardless of the pressure of the flowing medium.

SECTION 8 - ORIFICE METERS

CONTENTS

SECTION 8 - ORIFICE METERS

8-1 SCOPE

This section of these specifications applies to primary elements of orifice meters for the measurement of natural gas.

This section does not cover the equipment used in the determination of the pressures, temperatures, and other variances which must be known for the accurate measurement of gas quantities.

8-2 MECHANICAL REQUIREMENTS

8-2.1 General. These specifications adopt the requirements set out in Section 4 of the second edition of the American National Standard ANSI/API 2530, "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids", (hereinafter referred to as the ANSI/API Standard), except as delineated below.

8-2.2 Orifice Plates. Subsection 4.2 of the ANSI/API Standard shall apply with exception of clause 5.2.3. The recommendation for the limits of the Beta ratio in clause 4.2.7 shall be mandatory. The orifice shall be circular in shape.

8-2.3 Meter Tubes. Subsection 4.3 of the ANSI/API Standard shall apply with the exception that the measured (i.e. the actual) inside diameter of the upstream meter tube shall not exceed the allowable tolerance specified in Figure 3 of the ANSI/API Standard.

8-2.4 Orifice Flanges. In addition to the requirements of subsection 4.6 of the ANSI/API Standard, 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 4.8 of the ANSI/API Standard are exceeded under dynamic conditions.

8-3 MARKINGS

8-3.1 Nameplates. In addition to the requirements set out in subsection 3-5, the following information shall be provided on a nameplate located on the orifice fitting where one is used, or, otherwise, on or adjacent to the orifice flange.

(a) Published inside diameter of meter tubes.
(b) Maximum operating pressure.
(c) Nominal thickness of orifice plate to be used.
(d) Nominal thickness of orifice sealing ring(s) or gaskets to be used.

A nameplate, tag, sticker, or other suitable means shall be provided for marking the maximum permissible Beta ratio.

8-3.2 Orifice Plates.

8-3.2.1 Markings by the Manufacturer. The manufacturer of the orifice plate shall mark the nominal diameter of the orifice on the downstream side of the outer perimeter of the orifice plate or on the downstream side of the orifice plate handle, where present. The nominal diameter shall be marked to the nearest one thousandth of an inch.

8-3.2.2 Markings by the Contractor. The contractor shall mark each plate in a manner which identifies the contractor and the plate number.

Note: The markings on the orifice plate shall be made by engraving, chemical means, or equivalent which will ensure indelible marking without distorting the plate.

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 4 of the ANSI/API Standard.

The results of all measurements shall not exceed the tolerances set out in Section 4 of the ANSI/API Standard.

8-4.3 Compressibility of Orifice Plate Sealing Material.

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 10 of the ANSI/API Standard, 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 10 of the ANSI/API Standard, 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

SECTION 9 - MASS FLOW METERS

CONTENTS

SECTION 9 - MASS FLOW METERS

9-1 SCOPE

This section of these specifications applies to devices which meter flowing gas directly in units of mass.

9-2 MECHANICAL REQUIREMENTS

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

9-2.1 Unit of Measurement. The unit of measurement shall be the kilogram.

9-3 MARKINGS

9-3.1 Nameplate. In addition to the requirements set out in subsection 3-5, the following shall be marked:

(a) Operating pressure range.
(b) Range and type of output signal, where provided.
(c) Maximum mass flow rate.

9-3.2 Operating Information. Where the values of operating parameters may be set by the contractor, the manufacturer shall provide a nameplate, tag, sticker or other suitable means for marking the required information.

9-4 PERFORMANCE TESTS

In addition to the requirements set out in subsection 3-6, the following shall apply.

9-4.1 Test Gas. The device shall normally be tested using dry compressed air, properly filtered to remove foreign matter.

9-4.2 Test Points. The device shall be tested at the minimum nominal mass flow rate and rates of 10%, 25%, 50%, 75% and 100% of the nominal mass flow rate range.

9-4.3 Variation of Mass Flow Rate. The range of mass flow rates through the device shall be attained as follows:

(a) The relative density and temperature of the flowing medium shall remain constant.
(b) The test points set out in clause 9-4.2 shall be attained firstly by varying the velocity of the medium flowing through the device and holding the pressure constant, and secondly by varying the pressure and holding the velocity constant.

Where the manufacturer specifies restrictions on the range of gas velocities or densities within which the device can operate, these restrictions will be observed at all test points. In the case where a test mass flowrate would result in any operating parameter which is beyond the range stated by the manufacturer, no test shall be conducted at that point.

9-4.4 Tests at Reference Conditions. The device shall be tested at the flow rates set out in clause 9-4.2, subject to the conditions of clause 9-4.3.

The error of registration shall not exceed $\pm$ 0.5%.

9-4.5 Tests at Other Than Reference Conditions. The device shall be tested at an ambient temperature of -30°C with the flowing gas temperature at 0°C and -10°C, and at an ambient temperature of +40°C with the flowing gas temperature at +10°C and +20°C. The flow rates shall be as set out in clause 9-4.2, subject to the conditions of clause 9-4.3.

The error of registration shall not exceed $\pm$ 0.8%.

SECTION 10 - DISPENSERS FOR NATURAL GAS

CONTENTS

SECTION 10 - DISPENSERS FOR NATURAL GAS

10-1 SCOPE

This section of these specifications applies to dispensers of gas for the refuelling of motor vehicles, tanks and storage cylinders.

10-2 MECHANICAL REQUIREMENTS

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

10-2.1 Sealing. Access to the price setting mechanism shall be limited to authorized personnel by provision of a lock and key arrangement or equivalent.

Where a dispenser comprises more than one separate assembly, the interconnecting cables and tubing shall be so arranged as to be capable of being sealed in a manner which will prevent replacement of any assembly without breaking a seal.

There shall be provision for adjusting the price per unit of the commodity being sold without the necessity of breaking a seal.

10-2.2 Units. The preferred unit of registration is the kilogram or the megajoule. If the commodity is registered in units of volume, the volume shall be corrected to standard conditions.

10-2.3 Adjustments.

10-2.3.1 Range. The maximum range of any adjustment affecting the accuracy of the total delivery display which is accessible without removing a portion of the exterior housing shall not exceed plus or minus 2 percent. Such external adjustment shall not be capable of being changed when the dispenser is in use and, except in the case of a zero adjustment, shall be sealable.

Any adjustment for accuracy of range exceeding plus or minus 2 percent shall not be accessible without removing a sealable portion of the dispenser housing and shall itself be sealable.

Note: The dispenser housing may comprise more than one housing, each enclosing discrete components of the dispenser.

10-2.3.2 Price. It shall not be possible to change the unit price during calculation of the total price for any given delivery.

10-2.4 Register/Displays. Dispensers shall be equipped with a register with a display of total delivery as follows:

(a) TOTAL DELIVERY DISPLAY. The capacity of the display shall be not less than 99.999 kg with a resolution of at least of 1 gram, or 9999.9 MJ with a resolution of at least 0.1 MJ, or 99.999 standard cubic metres with a resolution of at least 0.001 standard cubic metres (9999.9 standard cubic feet with a resolution of at least 0.1 standard cubic feet). This display shall be resettable to zero.

Price-computing registers shall also have the following displays:

(b) TOTAL SALE DISPLAY. The capacity of the display shall not be less than $99.99, with a resolution of 1 cent. This display shall be resettable to zero.

(c) UNIT PRICE DISPLAY. This shall be an adjustable display with a resolution of 0.1 cent per unit of metered quantity.

10-2.4.1 Electronic Registers. Registers with electronic displays shall either:

(a) automatically show all display segments for at least 0.5 second and blank for at least 0.5 second after a register is reset to zero and before another delivery is started, to allow an operator to detect a segment that either indicates continuously or does not indicate, or

(b) incorporate an automatic self-testing system which checks the correct operation of all display elements prior to commencing a delivery and on detection of a fault prevents further use of the register.

The quantity indications, unit price and total price indications shall remain displayed for at least five minutes after a delivery is completed or until the next transaction is initiated, or until the current transaction is finalized.

10.2.5 Interlocks.

10-2.5.1 Register. A dispenser shall be designed so that it is inoperable after a transaction is completed until the resettable registers are reset to zero by means of an automatic interlock.

10-2.5.2 Hose Pressure. Delivery hoses and piping downstream of the meter shall not exceed 500 cm^3 in volume unless the hoses are automatically filled with gas at the delivery pressure before a zero condition is established on the total delivery and total sale displays.

10-2.6 Ticket Printer.

10-2.6.1 Ticket Information. Where a ticket printer forms part of or is used in conjunction with a dispenser, the ticket shall carry the following information:

(a) Name of the contractor and address at which the dispenser is installed.
(b) An identification number for the meter, or if there is only one meter, the identification number of the dispenser.
(c) The total delivery and units indicated by the register.
(d) Unit price of gas delivered (where used with a price-computing register).
(e) Total sale indicated by the register (where used with a price-computing register).
(f) Date that the delivery was made.
(g) An automatically advanced sequential sales number.

A ticket printer shall be designed so that a jammed ticket can be removed without breaking any inspection seal.

10-2.6.2 Ticket Printer Interlock. Where a ticket printer is provided with a dispenser, an interlock shall be incorporated such that a ticket is printed for every transaction.

10-2.7 Dispenser Configuration. Dispensers intended for refuelling from both sides shall have registers on both sides.

10-2.8 Reverse Flow Prevention. There shall be means provided to prevent flow from the vessel back through the dispenser in the event that the vessel to be refilled has a higher initial pressure than the dispenser delivery pressure.

10-3 ELECTRICAL REQUIREMENTS

In addition to the requirements of subsection 3-4, the following shall apply.

10-3.1 Power Mains Failure. Dispensers which operate from the mains power supply shall, in the event of a power outage, either:

(a) continue to operate satisfactorily for:
  (i) 24 hours where a back-up supply which automatically recharges upon restoration of the power is used, or
  (ii) 7 days where any other type of back-up supply is used,

or,

(b) retain programming and metering information for the applicable period set out in clause 10-3.1(a), and shall be capable upon demand, of displaying quantity, unit price and total price at any time up to 15 minutes after the the power outage.

10-4 MARKINGS

In addition to the requirements of subsection 3-5, the following shall apply.

Each of the major components that make up a dispenser shall bear a nameplate showing the name of the manufacturer and model or type designation of the component. These nameplates shall be clearly visible with the cover(s) removed.

10-5 PERFORMANCE TESTS

In addition to the requirements set out in subsection 3-6, the following shall apply.

10-5.1 Test Gas. The test gas used will normally be compressed dry air, properly filtered to remove foreign matter.

10-5.2 Adjustments. Prior to commencing tests, the display of total delivery shall be adjusted to register as close to zero error as practicable.

10-5.3 Tests At Reference Conditions. Test cylinders, having an initial pressure within the range from atmospheric to the declared maximum delivery pressure of the dispenser shall be partially or completely filled. No test shall result in a delivery of less than one kilogram. For dispensers incorporating the pressure control equipment required by CGA B-149, the reference pressure at the inlet to the dispenser shall be 22 MPa or the maximum rating declared by the manufacturer, whichever is lower. For dispensers not incorporating the pressure control equipment required by CGA B-149, the reference pressure at the inlet to the dispenser shall not exceed that required by CGA B-149.

The error of the total delivery display shall not exceed $\pm$ 1.0%.

10-5.4 Tests At Other Than Reference Temperature. The dispenser shall be tested at ambient temperatures of -30°C and +40°C. At -30°C the dispenser shall be tested with the flowing gas temperature at 0°C and -10°C, and at +40°C with the flowing gas temperature at +10°C and +20°C.

The error of the total delivery display shall not exceed $\pm$ 2.0%.

10-5.5 Tests At Other Than Reference Pressure. Tests at reference temperature set out in clause 10-5.3 shall be repeated with inlet pressure to the dispenser set at 60 percent and 80 percent of the reference pressure.

The error of the total delivery display shall not exceed $\pm$ 1.5%.

10-5.6 Total Sale Display Accuracy. The total sale display shall agree to within plus or minus one cent with the value obtained by multiplying the displayed price per unit delivery by the total delivery.

10-5.7 Preset Quantity. Where the quantity of gas to be delivered is preset, the dispenser shall deliver at least the preset quantity plus or minus one minimum increment of clause 10-2.4(a) according to the display at the dispenser before the flow is automatically stopped.

10-5.8 Preset Sale. Where the total sale of the gas to be delivered is preset, the dispenser shall deliver at least the preset total sale plus or minus one cent according to the display at the dispenser before the flow is automatically stopped.

10-5.9 Display Reset Accuracy. Where a mechanical display is used with a dispenser, the error in resetting the display to zero shall not exceed 3° of movement from an indicator mark.

SECTION 11 - RECORDERS

CONTENTS

SECTION 11 - RECORDERS

11-1 SCOPE

This section of these specifications applies to single or multiple parameter mechanical recording devices used to measure and record flowing gas temperature, pressure, metered volume, and time.

11-2 MECHANICAL REQUIREMENTS

In addition to the requirements set out in subsection 3-3, the following shall apply.

11-2.1 Multitrace Recorders. Each trace shall be distinguishable from the other traces. The differential pressure pen*, where provided, shall be designed to track the arc lines on the chart with the least error. In other multitrace recorders the static pressure pen shall track the arc lines with the least error.

* The word "pen" is used throughout these specifications to refer to marking devices which leave permanent records on charts. Equivalent technologies which create a record of acceptable legibility are also permissible.

11-2.2 Chart Changing. The design of the recorder shall be such that it is possible to change the chart without changing the calibration or operation of the recorder.

11-2.3 Recording Mechanism. The recording mechanism shall be designed and constructed so as to ensure a continuous and legible trace on the chart. The width of the recorded trace shall not exceed 0.6 mm.

11-2.4 Charts. Charts supplied with recorders submitted for approval shall be of an approved type or shall be subject to the requirements of these specifications.

11-2.5 Chart Drives. Chart drives supplied with recorders submitted for approval shall be of an approved type or shall be subject to the requirements of these specifications.

11-3 MARKINGS

In addition to the requirements set out in subsection 3-5, the following information shall be marked:

11-3.1 Recorder.

(a) Range(s) of temperature and/or pressure.
(b) Colour of trace for each recorded parameter, in the case of multitrace recorders.
(c) Time interval between time marks, where provided.
(d) Volume represented by:
  (i) one complete chart revolution (meter driven chart).
  (ii) one volume cycle or one full scallop (clock-driven chart).
(e) Number of revolutions of the input shaft for:
  (i) one complete chart revolution (meter driven chart).
  (ii) one full scallop or volume cycle (clock-driven chart).

In the event that the ratio under (e) is adjustable, the nameplate shall indicate the possible settings. In the event that any of the above parameters can be set or adjusted by the contractor, a nameplate, tag, sticker, or other means suitable to indicate the setting shall be provided, or it shall be possible to determine the setting by examining the device.

11-3.2 Temperature and Pressure Elements.

(a) Manufacturer's name or registered trade mark.
(b) Type, model or class designation for the elements.
(c) Ranges of temperature and pressure.
(d) On differential pressure elements, the maximum operating pressure shall be marked, and the pressure connection ports shall be marked to distinguish the low pressure port from the high pressure port.

11-4 PERFORMANCE TESTS

11-4.1 Chart Trace. Tests shall be made to establish that a clear and legible trace is produced on the chart for the complete range of measurement parameter(s).

11-4.2 Arcing. With the recording chart held stationary, all pens at their full scale values, and the highest priority pen on an arc line, the pens shall be returned to their minimum values. (For temperature recorders this test shall be made with the link between the recording pen and the actuating element disengaged).

The trace left by the highest priority pen shall not depart from the arc line by more than 1 mm at any point. The trace(s) left by the other pen(s) shall not depart from the time arc line by more than 5 mm.

11-4.3 Tests at Reference Conditions. During these tests the device, excluding any flowing gas temperature sensing element, shall be maintained at reference temperature.

Where applicable, the device shall be driven continuously by a test rig so as to simulate the drive from a meter at the maximum rate of rotation specified by the manufacturer. The values of parameters shall not be changed abruptly during tests.

11-4.3.1 Temperature Record. Tests shall be made with the flowing gas temperature sensing element held at the minimum temperature marked on the nameplate, at 25%, 50% and 75% of the range, and at the maximum temperature marked on the nameplate.

The error shall not exceed $\pm$ 1.0°C.

11-4.3.2 Pressure Record. Tests shall be conducted at 25%, 50%, 75% and 100% of pressure range, first with increasing pressure and then with decreasing pressure.

Differential pressure recorders shall be tested first with the low pressure port open to atmosphere at 10%, 25%, 50%, 75% and 100% of differential pressure range. Tests shall then be repeated with an applied static pressure equivalent to 75% of the maximum operating pressure.

The error shall not exceed $\pm$ 0.5% of calibrated range at any test point. Differential pressure recorders shall perform within the stated tolerance regardless of the pressure applied to the low pressure port.

11-4.3.3 Volume Record. For clock-driven recorders, tests shall be made to verify that the number of revolutions of the input shaft per volume cycle or full scallop is correct as marked. Where more than one ratio is available, each shall be checked.

For meter-driven recorders, tests shall be made to verify that one chart revolution corresponds to the number of revolutions of the input shaft marked on the nameplate.

The gear ratios shall be as marked.

11-4.3.4 Time Record. Where a meter-driven volume recorder marks time intervals on the chart, tests shall be made to establish the accuracy of the time intervals.

The error shall not exceed the applicable tolerance set out in the section on "Chart Drives and Timing Devices".

11-4.4 Tests at Other Than Reference Conditions. The recorder, 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.

11-4.4.1 Temperature Record. 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.

The error shall not exceed $\pm$ 1.5°C.

11-4.4.2 Pressure Record. Tests shall be made at 25%, 50%, 75% and 100% of pressure range, first with increasing pressure and then with decreasing pressure. Differential pressure recorders shall be tested with the low pressure port open to atmosphere at 10%, 25%, 50%, 75% and 100% of differential pressure range.

The error shall not exceed $\pm$ 1.0% of calibrated range.

SECTION 12 - CHART DRIVES AND TIMING DEVICES

CONTENTS

SECTION 12 - CHART DRIVES AND TIMING DEVICES

12-1 SCOPE

This section of these specifications applies to chart drives and auxiliary timing devices. This section also applies to other timing devices which have a direct time output signal.

Where a timing device forms an integral part of another device in which the end measured value depends in part on proper functioning and accuracy of the timing device, (e.g. integrators), the requirements of the section of these specifications applicable to the complete measurement device shall prevail.

12-2 MECHANICAL REQUIREMENTS

In addition to the requirements set out in subsection 3-3, the following shall apply.

12-2.1 Circular Chart Drive Rotational Period. The maximum rotational period shall be 31 days.

12-3 MARKINGS

In addition to the requirements set out in subsection 3-5, the following information shall be marked, as applicable.

12-3.1 Auxiliary Timing Devices.

(a) Details of time output signal, where provided.

12-3.2 Circular Chart Drives.

(a) Rotational period.
(b) Rewind period (spring driven chart drives).
(c) Direction of rotation.

12-3.3 Strip Chart Drives.

(a) Time base (chart speed, length per unit time).
(b) Direction of travel.

12-4 PERFORMANCE TESTS

In addition to the requirements set out in subsection 3-6, the following shall apply.

12-4.1 Testing Under Load. All tests shall be made under loaded conditions, that is, with the chart drive or timing device performing its intended function.

12-4.2 Spring Wound Chart Drives. Chart drives shall be fully wound prior to commencing tests. Accuracy shall be determined at approximately 25%, 50%, 75% and 100% of the nominal rotational period. The drive spring shall not be rewound during this test.

Chart drives with provision for changing chart speed shall be tested at each speed.

12-4.3 Synchronous Motor, Electronic and Similar Timing Devices. These types of timing devices shall be tested over a time period of sufficient duration to establish performance. Where gears are incorporated in a timing device, the test shall be of sufficient duration that the slowest moving gear shall make at least one complete revolution.

12-4.4 Tests at Reference Conditions. The timing device shall be maintained at reference ambient temperature. Tests shall be made in accordance with the provisions set out in clauses 12-4.1, 12-4.2 and 12-4.3, as applicable.

For spring wound chart drives, the error calculated for each 25% of the nominal rotational period shall not exceed 1.5 minutes in 24 hours.

For devices synchronized to the frequency of power mains, the error, when compared to the mains, shall be zero.

For electronic and similar timing devices, the error shall not exceed 10 seconds in 24 hours.

12-4.5 Tests at Other than Reference Conditions. The device shall be tested at ambient temperatures of -30°C and +40°C.

For spring wound chart drives, the error calculated for each 25% of the nominal rotational period shall not exceed 2 minutes in 24 hours.

For devices synchronized to the frequency of power mains, the error, when compared to the mains, shall be zero.

For electronic and similar timing devices, the error shall not exceed 20 seconds in 24 hours.

SECTION 13 - CHARTS

CONTENTS

SECTION 13 - CHARTS

13-1 SCOPE

This section of these specifications applies to charts.

13-2 MECHANICAL REQUIREMENTS

13-2.1 Chart Material. Charts shall be made from a suitable material which will assure strength, surface smoothness, ability to take ink or other means of recording, and provide dimensional stability under the humidity and temperature variations set out herein. Chart material shall be sufficiently strong not to tear during normal operation of the instrument in which it is used and shall withstand, without damage, subsequent handling during processing of the recorded information.

Charts shall have a hard, smooth surface in order to present minimal resistance to the motion of the pen or other marking device. The surface shall be free from loose or easily detachable particles which might tend to clog the marking device.

13-2.2 Chart Dimensions. All circular charts shall have a clean cut hole in the centre.

Strip charts shall have perforations on the edges which shall be so sized and so spaced that the chart travels smoothly without sideways motion and without tendency to ride up on the sprockets.

Strip charts made of paper material shall have the perforations on one edge slotted to allow for changes of chart width caused by changes in humidity level.

13-3 MARKINGS

The requirements set out in subsection 3-5 shall not apply.

13-3.1 Chart Identification. Charts shall bear the following information:

(a) Name or registered trade mark of the chart manufacturer.
(b) Chart identification number or code.

Circular charts shall have the identification information on the front.

Strip charts shall have the identification information printed repeatedly on a chart edge no less than once every 60 cm.

13-3.2 Range Graduations. Charts shall have major graduations representing some regular function of the full chart range. Major graduations shall be clearly marked as to the value of the recorded quantity. The marking of the major graduations shall represent either the actual value of the recorded quantity or percentage of the full chart range.

Where more than one parameter is to be recorded on the same circular chart the graduations for each parameter shall be clearly identified and where the parameters have different full scale ranges the chart face shall be segmented, each segment graduated to the appropriate full scale value and representing not more than 20 percent of the chart rotational period. Strip charts shall not be segmented.

On linear charts, and wherever possible on non-linear charts, the space between major graduation lines shall be divided into at least five minor subdivisions with minor graduation lines distinctively thinner than major lines. Square root or other non-linear functions shall have minor graduation lines which are truly representive of the recorded function.

In the case where there are ten minor divisions, there shall be one submajor line between the fifth and sixth minor divisions. The submajor lines shall be narrower than major lines but wider than minor lines.

For charts with time arc lines the recorded quantity markings shall be made along the time arc lines and not along chart radii or chart width.

13-3.3 Time Graduations. Major time lines representing hours, half days, or days, depending on speed of chart motion, shall have the same width as the major range lines. Minor time lines, representing fractions of an hour or day shall be narrower than the major time lines.

The time parameter, hours, or hours and days, shall be clearly marked on the edge or outer periphery of the chart and there shall be a clear marking, by a heavy width line or otherwise, of the night period corresponding to the duration from 18:00 hours of one day to 06:00 hours of the following day.

13-4 PERFORMANCE TESTS

13-4.1 Eccentricity and Roundness. With a sample chart mounted in an appropriate instrument or jig the recording pen

mounted in an appropriate instrument or jig the recording pen shall be set at a fixed position close to the full scale graduation line and the chart rotated slowly so that a trace of a circle is made.

The maximum and the minimum distance between the traced line and the chart graduation line shall be measured as Cmax and Cmin respectively.

The value for Cmax minus Cmin shall not exceed ± 0.2 percent of the average radius of the full scale graduation line.

13-4.2 Range Graduations. Taking the zero graduation as reference line, measurements shall be made to establish correctness of other range graduations in accordance with the applicable function. At least ten measurements shall be made across the chart range.

In no case shall the markings depart from the required position by more than ± 0.1 percent of the distance between the minimum value and full scale of the chart.

Note: For charts where the pen travels in an arc, the above distance shall be measured along an arc line or shall be measured radially based on calculation of the correct radial distance.

13-4.3 Test for Humidity Effects. The sample chart shall be mounted on an appropriate instrument or jig and placed in an environmental chamber. With the temperature at 23 ± 2°C the relative humidity shall be set at 85 percent and stabilized for 24 hours. The test apparatus shall be energized from outside the chamber to make a one-revolution trace. The relative humidity shall be reduced to 15 percent and stabilized for a further 24 hours, whereupon a second one-revolution trace shall be made.

The distance between the traces shall be measured. A similar test shall be conducted for strip charts, with the pen set within the graduated portion of the chart nearest the slotted holes.

The maximum change caused by the humidity test shall not exceed 1.0 percent of the full scale diameter of the chart.

13-4.4 Tests for Temperature Effects. If the material of construction of a chart is judged to be subject to dimensional changes due to changes in temperature, the chart shall be tested for such effects at ambient temperatures of -30°C and +40°C.

The temperature effect shall not exceed ± 1.0 percent of the full scale diameter of the chart.

SECTION 14 - MECHANICAL CORRECTING DEVICES

CONTENTS

SECTION 14 - MECHANICAL CORRECTING DEVICES

14-1 SCOPE

This section of these specifications applies to mechanical devices which effect automatic correction of volume from the metered gas conditions to the volume expressed at base temperature or at base pressure, or at both base temperature and base pressure, and which may or may not include supercompressibility corrections. Such devices may be incorporated entirely within a meter, or be of a modular nature, or be intended for use as an auxiliary attachment. The requirements of this section do not apply to internally temperature correcting diaphragm meters.

14-2 MECHANICAL REQUIREMENTS

In addition to the requirements set out in subsection 3-3, the following shall apply.

14-2.1 Level Indicator. Where the operation of a device depends on it being level, it shall be equipped with a suitable level indicator.

14-2.2 Frequency of Integration. Intermittent type integrators shall integrate at least once for every ten revolutions of the input shaft.

14-3 MARKINGS

In addition to the requirements set out in subsection 3-5, the following information shall be marked on the device or the host meter, where applicable:

14-3.1 Integrator.

(a) Flowing gas temperature range.
(b) Pressure range.
(c) Fixed parameters for supercompressibility factor (such as gas relative density, N_2, and CO_2 content).
(d) Volume per revolution of input drive.
(e) Base temperature.
(f) Base pressure.
(g) Atmospheric pressure.
(h) For auxiliary correcting devices, the maximum speed of rotation of the input drive.

Where any of the above parameters can be set or adjusted by the contractor, a nameplate, tag, sticker, or other suitable means shall be provided for marking this information.

14-3.2 Temperature and Pressure Elements.

(a) Manufacturer's name or registered trade mark.
(b) Type, model or class designation for the elements.
(c) Ranges of temperature and pressure.

14-4 PERFORMANCE TESTS

14-4.1 Tests at Reference Conditions. Integral correcting devices shall be installed in the host meter for testing. Auxiliary correcting devices shall be driven by a test rig. The device, excluding any flowing gas temperature sensing element, shall be maintained at reference temperature. Various levels of gas temperature shall be achieved by placing the flowing gas temperature sensing element in a temperature controlled bath or by varying the temperature of flowing gas.

Integral correcting devices shall be tested at 10% of maximum flowrate and at maximum flowrate. Auxiliary devices shall be tested at 10% and 100% of the maximum speed of rotation specified by the manufacturer.

14-4.1.1 Temperature Correcting Devices. Tests shall be made with the flowing gas temperature sensing element held at the minimum temperature marked on the nameplate, at 25%, 50% and 75% of the range, and at the maximum temperature marked on the nameplate.

The difference between the error of the corrected registration and the uncorrected registration shall not exceed $\pm$ 0.8%.

14-4.1.2 Pressure Correcting Devices. Pressure tests shall be made at 25%, 50%, 75% and 100% of the pressure range, first with increasing pressure and then with decreasing pressure, ensuring that in reaching any test point, the change in pressure is in one direction only.

The difference between the error of the corrected registration and the uncorrected registration shall not exceed $\pm$ 0.8%.

14-4.1.3 Temperature and Pressure Correcting Devices. The following four tests shall be made:

(a) **Test No. 1.** Pressure held at 50% of range and the flowing gas temperature sensing element temperature varied as set out in subclause 14-4.1.1.

(b) **Test No. 2.** Flowing gas temperature sensing element held at a temperature corresponding to 50% of span and pressure varied as set out in subclause 14-4.1.2.

(c) **Test No. 3.** Pressure held at 100% of range and the flowing gas temperature sensing element held at minimum and maximum temperature.

(d) **Test No. 4.** Pressure held at 25% of range and the flowing gas temperature sensing element held at minimum and maximum temperature.

The difference between the error of the corrected registration for any combination of temperature and pressure and the uncorrected registration shall not exceed 1.0%.

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

14-4.1.4 Out-of-Level Tests. For auxiliary correcting devices not equipped with a level indicator, at least two tests shall be selected from those set out in subclauses 14-4.1.1, 14-4.1.2 or 14-4.1.3, as applicable, to determine that the device remains within tolerance when out of level by 5 degrees.

14-4.2 Tests at Other Than Reference Conditions. 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 clause 14-4.1 shall apply.

14-4.2.1 Temperature Correcting 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.

The difference between the error of the corrected registration and the uncorrected registration shall not exceed $\pm$1.3%.

14-4.2.2 Pressure Correcting Devices. Tests shall be made as set out in subclause 14-4.1.2.

The difference between the error of the corrected registration and the uncorrected registration shall not exceed ± 1.3%.

14-4.2.3 Temperature and Pressure Correcting Devices. Tests shall be made at -30°C with the combinations of parameters set out in Table 1.

TABLE 1

Test No.	1	2	3
Flowing Gas Temperature, % of Span	25	25	25
Pressure, % of Max.	25	50	75

At +40°C, tests shall be made with the combinations of parameters set out in Table 2.

TABLE 2

Test No.	1	2	3
Flowing Gas Temperature, % of Span	75	75	75
Pressure, % of Max.	25	50	75

The difference between the error of the corrected registration for any combination of temperature and pressure and the uncorrected registration shall not exceed ± 1.5%.

Where, in addition, the device corrects for supercompressibility, the difference between the errors of the two registrations shall not exceed ± 2.0%.

SECTION 15 - ELECTRONIC CORRECTING DEVICES

CONTENTS

SECTION 15 - ELECTRONIC CORRECTING DEVICES

15-1 SCOPE

This section of these specifications applies to devices which process information related to the measurement of natural gas and electronically perform calculations based on the information received. It applies to devices such as flow computers for use with orifice meters and volumetric meters and to built-in or auxiliary temperature, pressure, supercompressibility, and/or mass correcting devices.

15-2 MECHANICAL REQUIREMENTS

The requirements of subsection 3-3 shall apply.

15-3 PROGRAMMING

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 American National Standard ANSI/API 2530, "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 American National Standards ANSI/API 2530 - "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids", or the American Gas Association publication, AGA Report No. 3 - "Orifice Metering of Natural Gas".

15-3.2 Frequency of Sampling. The device shall be capable of sampling applicable inputs at least every 30 seconds. Where no input is received from the primary meter, no sampling need take place.

15-3.3 Verifiability. Electronic correction devices shall provide for the verification of any of the constants set out in clauses 15-3.4 and 15-3.5 which may be programmed by the user. The design shall be such that user-programmable constants are verifiable either by displaying or printing the programmed value,

or by switch settings or jumper locations, or other means. Where codes are used, a legend shall appear on the device.

15-3.4 Constants. The following is a list of those constants which, where used, may be fixed by the manufacturer or programmable by the user:

(a) Base pressure.
(b) Base temperature.
(c) Diameter of inside of pipe.
(d) Diameter of orifice.
(e) Basic orifice factor.
(f) Pressure tap location (code).
(g) Information content of each variable input, (e.g. pulses/m^3, ma range/pressure range, etc.).

15-3.5 Other Quantities. The following quantities, where used, may be fixed by the manufacturer, programmable by the user, or live inputs:

(a) Relative density.
(b) Mol percent CO_2 content.
(c) Mol percent N_2 content.
(d) Calorific power.
(e) Atmospheric pressure.
(f) Flowing gas pressure.
(g) Flowing gas temperature.

NOTE: Devices using any of the above in the form of a fixed or programmable input, may, subject to the Electricity and Gas Inspection Regulations and the specifications made pursuant thereto, have restrictions placed on their application and/or rangeability.

15-3.6 Multi-Channel Correcting Devices. Where a correcting device is designed to process information from more than one primary meter or orifice run, it shall be capable of accepting the required inputs separately for each primary meter or orifice run, except that the inputs for base pressure, base temperature, atmospheric pressure, relative density, mol percent CO_2 content, mol percent N_2 content, and calorific power may, in some cases, be common for all primary meters and orifice runs.

Multi-channel correcting devices with common inputs for relative density, mol percent CO_2, mol percent N_2 or calorific power shall be limited to use with groups of primary meters and orifice runs which are fed from a common supply of gas.

Multi-channel correcting devices with a common input for atmospheric pressure shall be limited to use with groups of primary meters and orifice runs which are such that the requirements of the Electricity and Gas Inspection Regulations will be complied with.

15-4 MARKINGS

15-4.1 Nameplate. In addition to the requirements of subsection 3-5, the following information shall appear on the nameplate:

(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.

15-5 PERFORMANCE TESTS

15-5.1 Tests at Reference Conditions.

15-5.1.1 Devices without Sensors. These tests apply to devices which accept electrical signals representing measurement parameters. Tests shall be conducted with the device at the reference conditions set out in clause 3-6.1.

The device shall be tested with:

(a) All inputs and programmable constants at their median 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.

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.

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 Devices with Sensors. These tests apply to devices which incorporate sensors.

Integral correcting devices shall be installed in the host meter for testing. Auxiliary correcting devices shall be driven by an electrical or mechanical test rig. The device, excluding any flowing gas temperature sensing element, shall be maintained at reference temperature. Various levels of gas temperature shall be achieved by placing the flowing gas temperature sensing element in a temperature controlled bath, or by varying the temperature of flowing gas.

Integral correcting devices shall be tested at 10% of maximum flow rate and at maximum flow rate. Auxiliary devices shall be tested at 10% and 100% of the maximum speed of rotation or input frequency specified by the manufacturer.

(a) Temperature Correcting 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.

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

(b) Pressure Correcting Devices. Pressure tests shall be made at 25%, 50%, 75% and 100% of the pressure range, first with increasing pressure and then with decreasing pressure.

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

(c) The following four tests shall be made:
Test No. 1. Pressure held at 50% of range and the flowing gas temperature sensing element temperatures varied as set out in item (a) above.
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 (b) above.
Test No. 3. Pressure held at 100% of range and the flowing gas temperature sensing element held at minimum and maximum temperature.
Test No. 4. Pressure held at 25% of range and the flowing gas temperature sensing element held at minimum and maximum temperature.

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

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

15-5.2 Tests at Other Than Reference Conditions.

15-5.2.1 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.

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

15-5.2.2 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 subclause 15-5.1.2 shall apply.

(a) Temperature Correcting 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.

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

(b) Pressure Correcting Devices. Tests shall be made as set out in item (b) in subclause 15-5.1.2.

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

(c) Temperature and Pressure Correcting Devices. Tests shall be made at -30°C with the combination of parameters set out in Table 1.

TABLE 1

Test No.	1	2	3
Flowing Gas Temperature, % of Span	25	25	25
Pressure, % of Max.	25	50	75

At +40°C, tests shall be made with the combination of parameters set out in Table 2.

TABLE 2

Test No.	1	2	3
Flowing Gas Temperature, % of Span	75	75	75
Pressure, % of Max.	25	50	75

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 $\pm$ 1.5%.

SECTION 16 - TEMPERATURE AND PRESSURE TRANSDUCERS

CONTENTS

SECTION 16 - TEMPERATURE AND PRESSURE TRANSDUCERS

16-1 SCOPE

This section of these specifications applies to devices which provide an electrical output in response to temperature or pressure.

16-2 MECHANICAL REQUIREMENTS

The requirements of subsection 3-3 apply.

16-3 MARKINGS

16-3.1 Nameplate. In addition to the requirements set out in subsection 3-5, the following information shall be marked:

(a) Maximum allowable operating pressure.
(b) Design temperature or pressure range (maximum temperature or pressure range over which the device can be calibrated).
(c) Type and range of output signal.

16-3.2 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.

16-3.3 Operating Information. Where the operating temperature range or pressure range can be adjusted by the contractor, a nameplate, tag, sticker, or other suitable means shall be provided for marking the temperature range or pressure range for which the device is calibrated.

16-3.4 Differential Pressure Transducers. The pressure connection ports shall be marked to distinguish the low pressure port from the high pressure port.

16-4 PERFORMANCE TESTS

16-4.1 Preconditioning of Pressure Transducers. Prior to the commencement of tests, the transducer shall be energized and the pressure element subjected to its maximum design pressure.

16-4.2 Tests at Reference Conditions. Tests shall be conducted with the device at the reference conditions set out in clause 3-6.1.

16-4.2.1 Temperature Transducers. Tests shall be made with the flowing gas temperature sensing element held at the minimum temperature marked on the nameplate, at 25%, 50% and 75% of the range, and at the maximum temperature marked on the nameplate.

Temperature transducers shall measure temperature with an error not greater than ± 0.5°C at any test temperature.

16-4.2.2 Pressure Transducers. Pressure transducers shall be tested at 25%, 50%, 75%, and 100% of calibrated pressure range, first with increasing pressure and then with decreasing pressure.

Pressure transducers shall measure pressure with an error not greater than ± 0.5% of reading at any test pressure.

16-4.2.3 Differential Pressure Transducers.

16-4.2.3.1 Low Pressure Tests. Differential pressure transducers shall be tested at 10%, 25%, 50%, 75% and 100% of calibrated differential pressure range with the low pressure port open to atmosphere, first with increasing pressure and then with decreasing pressure.

Differential pressure transducers shall measure pressure with an error not greater than ± 0.5% of reading at test pressures of 25% of range and above, and with an error not greater than ± 1.0% of reading at 10% of range.

16-4.2.3.2 High Pressure Tests. The tests set out in subparagraph 16-4.2.3.1 shall be repeated with static pressure equivalent to 75% of the maximum operating pressure applied to the low pressure port.

The errors shall not exceed ± 1.0% of reading at test pressures of 25% of range and above, and shall not exceed ± 2.0% of reading at 10% of range.

16-4.3 Tests at Other than Reference Conditions. Tests shall be conducted with the device, excluding the flowing gas temperature sensing element, at ambient temperatures of -30°C and +40°C.

16-4.3.1 Temperature Transducers. 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 flowing gas temperature sensing element at a temperature corresponding to 75% of span.

The error shall not exceed ± 1.0°C.

16-4.3.2 Pressure Transducers. Pressure transducers shall be tested at 25%, 50%, 75%, and 100% of calibrated pressure range, first with increasing pressure and then with decreasing pressure.

The error shall not exceed ± 1.0% of reading.

16-4.3.3 Differential Pressure Transducers. Differential pressure transducers shall be tested at 10%, 25%, 50%, 75% and 100% of calibrated differential pressure range with the low pressure port open to atmosphere, first with increasing pressure and then with decreasing pressure.

The errors shall not exceed ± 1.0% of reading at test pressures of 25% of range and above, and shall not exceed ± 2.0% of reading at 10% of range.

SECTION 17 - DENSITOMETERS

CONTENTS

SECTION 17 - DENSITOMETERS

17-1 SCOPE

This section of these specifications applies to devices used for the measurement of absolute gas density.

17-2 MECHANICAL REQUIREMENTS

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

17-2.1 Filters. Where the design of the device is such that foreign matter in gas can adversely affect its operation or impair its accuracy, the manufacturer shall incorporate suitable filters.

17-2.2 Gas Flow Passages. The inlet and outlet connections and the gas passages of a densitometer so equipped shall be of sufficient size to ensure minimal pressure drop with adequate gas flow through the device in order to respond rapidly to changes of density in the metered gas.

17-2.3 Densitometer Output. The measurement of gas density shall be continuous.

17-3 MARKINGS

17-3.1 Nameplate. In addition to the requirements set out in subsection 3-5, the following information shall be marked, where applicable:

(a) Operating pressure range.
(b) Operating density range.
(c) The minimum required gas flow through the device.
(d) Output signal characteristics and, where linear, signal to density conversion factor.

Due to the possible diversity of devices which may be submitted for approval of type, the above listing may not be sufficient to cover all cases. Markings shall be provided to identify all necessary information.

17-3.2 Operating Information. Where the values of operating parameters may be set by the contractor, the manufacturer shall

provide a nameplate, tag, sticker or other suitable means for marking the required information.

17-4 PERFORMANCE TESTS

In addition to the requirements set out in subsection 3-6, the following shall apply.

17-4.1 Standard Gas. Chemically pure, dry nitrogen shall normally be used as the test gas. Where the specified density range cannot be obtained with nitrogen, another suitable gas may be used.

17-4.2 Gas Flow Rate. The flow of gas through the densitometer, where applicable, shall be set at a minimum rate specified by the manufacturer or at zero flow where not specified.

17-4.3 Tests at Reference Conditions. Tests shall be conducted with the device and the test gas at reference temperature.

Tests shall be made by varying the pressure of the test gas to produce densities corresponding to 10%, 50% and 90% of the nominal range of density for the device.

The errors shall not exceed $\pm$ 0.3%.

17-4.4 Tests at Other Than Reference Conditions. Tests shall be conducted with the device at ambient temperatures of -30°C and +40°C.

For the low ambient temperature tests, the test gas shall be conditioned so that its temperature at the inlet of the device is -10°C. For the high ambient temperature tests, the test gas shall be conditioned so that its temperature at the inlet to the device is +30°C.

Tests shall be made at densities corresponding to 10%, 50% and 90% of the range of density for the device.

The errors shall not exceed $\pm$ 0.5%.

SECTION 18 - RELATIVE DENSITY DEVICES

CONTENTS

SECTION 18 - RELATIVE DENSITY DEVICES

18-1 SCOPE

This section of these specifications applies to devices used for the measurement of the relative density of gas.

18-2 MECHANICAL REQUIREMENTS

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

18-2.1 Range of Relative Density. The minimum range of relative density for natural gas applications shall be from 0.500 to 0.800. Devices for other applications shall have a range suitable for the intended purpose.

18-2.2 Filters. Where the design of the device is such that foreign matter in gas and/or air can adversely affect its operation or impair its accuracy, the manufacturer shall incorporate suitable filters.

18-2.3 Air Dryer. Where the device requires dry air for its operation, the manufacturer shall provide a suitable dryer for elimination of moisture from the air.

18-3 MARKINGS

18-3.1 Nameplate. In addition to the requirements set out in subsection 3-5, the following information shall be marked, where applicable:

(a) Range of gas and air flow rates.
(b) Range of inlet gas and air pressure.
(c) Range of gas relative density.
(d) Range of output signal and its relationship to relative density.

Due to the possible diversity of devices which may be submitted for approval of type, the above listing may not be sufficient to cover all cases. However, the markings shall be suitable to identify the vital information in accordance with the nature of the device.

18-3.2 Operating Information. Where the values of operating parameters may be set by the contractor, the manufacturer shall

provide a nameplate, tag, sticker or other suitable means for marking the required information.

18-4 PERFORMANCE TESTS

In addition to the requirements set out in subsection 3-6, the following shall apply.

18-4.1 Inlet Gas Pressure. Inlet gas pressure shall be as specified by the manufacturer. Where a range of inlet pressure is stated, tests shall be made with the lowest, median, and highest inlet gas pressures.

Where the operation of the device requires air, the device may be tested with any combination of gas and air pressures within the ranges stated by the manufacturer.

18-4.2 Gas Flow Rate. During tests, gas and air flow rates through the device shall be as specified by the manufacturer. Where ranges of flow rates are stated, the device shall be tested with the lowest, median, and highest flow rates stated by the manufacturer.

18-4.3 Tests at Reference Conditions. The device shall be maintained at reference ambient temperature. Gas and air entering the device during testing shall be maintained at reference ambient temperature $\pm$ 0.5°C.

Tests shall be made with three standard gases of relative density corresponding to approximately 10%, 50% and 90% of the range of relative density for the device. Other conditions for tests shall be as set out in clauses 18-4.1 and 18-4.2.

The errors shall not exceed $\pm$ 0.5%.

18-4.4 Tests at Other Than Reference Conditions. Tests shall be conducted with the device at ambient temperatures of -30°C and +40°C. The temperature of inlet air to the device shall be the same as the ambient temperature.

Tests shall be made with three standard gases as set out in clause 18-4.3.

For the low ambient temperature tests, the standard gas shall be conditioned so that its temperature at the inlet of

the device is -10°C. For the high ambient temperature tests, the standard gas shall be conditioned so that its temperature at the inlet to the device is +30°C.

The errors shall not exceed $\pm$ 0.7%.

SECTION 19 - CALORIMETERS

CONTENTS

SECTION 19 - CALORIMETERS

19-1 SCOPE

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

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 calorific power 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 calorific power over time shall be of an approved type or shall be subject to the requirements of these specifications.

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 calorific power. Where applicable, the units of calorific power shall include the pertinent base conditions.
(b) Type and range of auxiliary output signal* (if provided).

* 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.

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 calorific power.

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 calorific power 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 calorific power with an error not greater than $\pm$ 0.1 MJ/m^3 (at standard conditions) or $\pm$ 2.7 $Btu_{(60.5)}/ft^3$ (at standard conditions).

SECTION 20 - GAS CHROMATOGRAPHS

CONTENTS

SECTION 20 - GAS CHROMATOGRAPHS

20-1 SCOPE

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

20-2 MECHANICAL REQUIREMENTS

The requirements of subsection 3-3 shall apply.

20-3 MARKINGS

20-3.1 Nameplate. In addition to the requirements set out in subsection 3-5, the following information shall be marked:

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

* 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.

20-4 PERFORMANCE TESTS

20-4.1 Tests at Reference Conditions. The chromatograph shall be set up and calibrated according to the manufacturer's instructions. 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. If different ranges are specified by the manufacturer, the device shall be tested using samples of known concentration within the specified 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
Iso-Butane	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 %.

The true calorific power and relative density of the sample gas shall be calculated using the true relative concentrations of all components of the sample gas.

Where a device provides relative concentrations as an output, the resulting calorific power and relative density shall be calculated in accordance with AGA's Transmission Measurement Committee Report No. 5 - "Fuel Gas Energy Metering".

The calorific power error shall not exceed $\pm$ 0.1 MJ/m^3, and the relative density error shall not exceed $\pm$ 0.5%.

Where a device provides calorific power and/or relative density as a direct output, with or without providing relative concentrations of gas constituents, the performance requirements set out above shall apply.

Where a device is intended to detect the concentrations of only nitrogen and carbon dioxide the error shall not exceed $\pm$ 0.1 mol %.

20-4.2 Tests at Other Than Reference Conditions. Tests shall be conducted at ambient temperatures over the range from -30°C to +40°C or over the range stated on the nameplate, whichever is less.

The device shall perform within the allowable errors set out in clause 20-4.1.

SECTION 21 - ELECTRICAL PULSE DEVICES

CONTENTS

SECTION 21 - ELECTRICAL PULSE DEVICES

21-1 SCOPE

This section of these specifications applies to pulse generators and associated pulse transmitting and receiving devices. It does not apply to flow computers.

21-2 MARKINGS

In addition to the requirements set out in subsection 3-5, the following shall apply.

21-2.1 Pulse Generators as Separate Units. 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 (for form C contacts).

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

21-2.2 Pulse Generator Incorporated in a Meter. Where a meter incorporates a pulse generator, the following information shall be marked on a nameplate mounted on the host meter:

(a) The 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 (for form C contacts).
(c) Departmental approval number for the meter with the pulse generator.

21-2.3 Relays and Signal Amplifiers. The following information shall be marked on a nameplate attached to the device:

(a) Type of input and output signals.
(b) Maximum voltage and frequency of input signal, and of output signal for amplifiers.
(c) Minimum input voltage.
(d) Connection diagram (need not be readily visible).

21-2.4 Pulse Receivers. The following information shall be marked on a nameplate attached to the receiver:

(a) Type of input signal.
(b) Minimum input voltage.
(c) Maximum voltage and frequency of input signal.
(d) Number of pulses for each incremental advance of registered quantity.
(e) Units of registered quantity.
(f) Connection diagram (need not be readily visible).

21-3 PERFORMANCE TESTS

21-3.1 Tests at Reference Conditions. The device shall be connected so as to initiate or receive pulses, or both, and the pulse input and/or output shall be connected to a counter for the purpose of recording transmitted pulses.

Tests shall be made at the maximum pulse rate specified by the manufacturer for sufficient time to ensure that the accumulated pulses can be determined with a resolution of at least 0.01 percent.

The error shall not exceed $\pm$ 0.05%.

The tests shall be repeated with the minimum level of input signal voltage to relays, amplifiers and pulse receivers.

There shall be no deterioration of performance.

21-3.2 Tests at Other Than Reference Conditions. The tests shall be repeated with the device maintained at -30°C and +40°C.

The error shall not exceed $\pm$ 0.05%.

SECTION 22 - PRESSURE REGULATORS

CONTENTS

SECTION 22 - PRESSURE REGULATORS

22-1 SCOPE

This section of these specifications applies to pressure regulators intended for use in pressure factor metering.

22-2 MECHANICAL REQUIREMENTS

The requirements of subsection 3-3 shall apply.

22-3 MARKINGS

In addition to the requirements set out in subsection 3-5, the following shall apply.

22-3.1 Nameplate. In addition to the requirements of clause 3-5.1, the maximum allowable operating pressure shall appear on the nameplate.

22-3.2 Operating Information. A nameplate, tag, sticker, or other suitable means shall be provided for marking inlet pressure range, outlet pressure set point, orifice size(s), and spring identification.

22-4 PERFORMANCE TESTS

22-4.1 Tests at Reference Conditions. The device shall be tested at various combinations of inlet pressures, outlet pressures, flow rates, springs, and orifices for which approval of type is sought. Test points shall be selected from within the regulator's operating range to establish the acceptability of the manufacturer's published performance data. Tests for any combination of orifices, springs and any other interchangeable components will consist of adjusting the regulator according to the manufacturer's instructions*, varying the flow rate while maintaining the inlet pressure constant, and varying the inlet pressure while maintaining the flow rate constant.

* Where no specific adjustment instructions are provided by the manufacturer, the set pressure shall be adjusted with the inlet pressure at 50% of its range and the flow rate at 10% of its range.

22-4.2 Tests at Other Than Reference Conditions. Selected tests conducted pursuant to clause 22-4.1 shall be repeated at

ambient temperatures of -30°C and +40°C. At -30°C the device shall be tested with the flowing gas temperature at 0°C and -10°C, and at +40°C with the flowing gas temperature at +10°C and +30°C.

22-4.3 Accuracy. The difference between the set pressure and the outlet pressure shall be such that the error in the resultant pressure factor for tests at reference conditions and other than reference conditions shall not exceed ±1.0% over the range of flow rates and inlet pressures claimed by the manufacturer. For the purposes of this section the error shall be determined as follows:

$$E = \left[\frac{Po - Pset}{Pset + Ps}\right] \times 100\%$$

where E = percent error
Po = regulator outlet pressure (gauge)
Pset = regulator set pressure (gauge)
Ps = standard pressure

NOTE: Strictly speaking, the ambient atmospheric pressure should be used in place of Ps in the denominator of the above equation. However, in this case, standard pressure shall be used to eliminate the effect varying atmospheric pressure would have on the repeatability of tests.